Environmental Impact Statement for South of Embley Project

This Environmental Impact Statement has been prepared to meet the assessment requirements for the Project under the *State Development and Public Works Organisation Act 1971* (Qld) and the *Environment Protection and Biodiversity Conservation Act 1999* (Cth).

Volume 1

Executive Summary

1. Introduction
2. Project Description
3. Land
4. Climate
5. Water Resources
6. Marine

Rio Tinto Alcan

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This Environmental Impact Statement (EIS) has been prepared to meet the environmental assessment requirements under both State and Commonwealth law.

Pursuant to the *State Development and Public Works Organisation Act 1971* (Qld), Queensland Coordinator-General has declared the South of Embley Project a "significant project" for which an EIS is required. This EIS is submitted in order to meet the Coordinator-General's assessment requirements as stated in the Terms of Reference for the Project.

Section 1.8 of this EIS contains more information on how to make a submission.

Pursuant to the *Environment Protection and Biodiversity Conservation Act 1999* (Cth), the Commonwealth Minister for Sustainability, Environment, Water, Population and Communities has decided that the South of the Embley Project is a "controlled action" for which an EIS is required. This EIS is submitted to meet the requirements of the tailored EIS guidelines for the Project. Section 1.8 of this EIS contains more information on how to make a submission.

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Environmental Impact Statement

for South of Embley Project

Executive Summary

EXECUTIVE SUMMARY

Project Overview

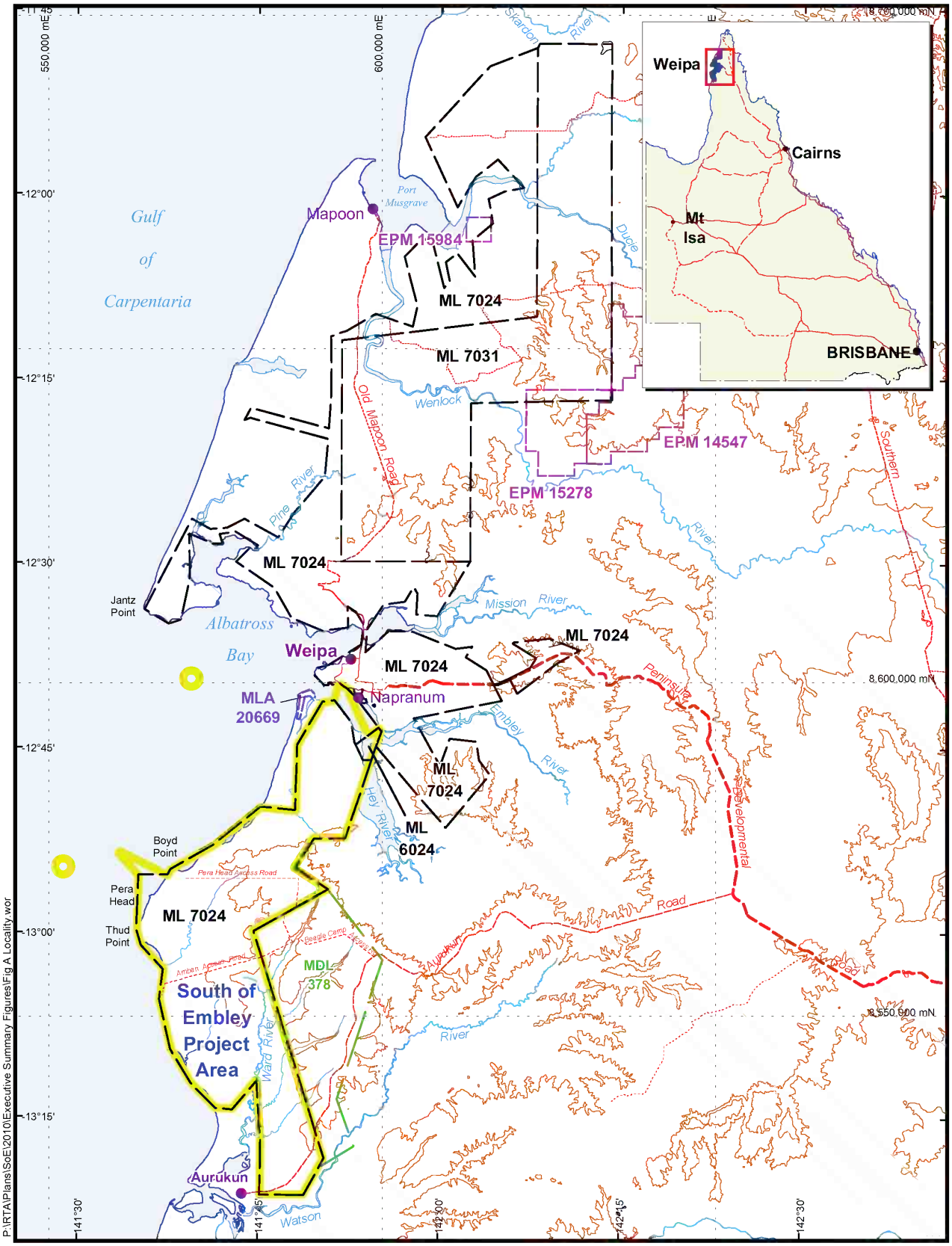
The proposed project, referred to as the South of Embley (SoE) Project (or "the Project"), consists of the construction and operation of a bauxite mine and associated processing facilities, barge and ferry terminals, and a port. The Project involves a staged increase in production up to 50 million dry product tonnes per annum (Mdptpa). The initial installed capacity is subject to ongoing feasibility studies but is likely to be either 15Mdptpa or 22.5Mdptpa. Actual production rates and the timing and size of capacity expansions would depend on market conditions. The EIS has been prepared to assess the impacts of several different levels of production along the expansion pathway: a minimum rate of 15Mdptpa, a maximum rate of 50Mdptpa, and a nominal intermediate rate of 30Mdptpa.

The Project is located near Boyd Point on the western Cape York Peninsula (refer **Figure A**). Boyd Point is approximately 40km south-west of Weipa and 40km north of Aurukun, with the closest mining areas being 4km from Napranum, 15km from Aurukun, and 50km from the nearest cattle station homesteads. The Project area would be predominantly located on a portion of ML7024 south of the Embley River, on ML6024, on certain Strategic Port Land with the Port of Weipa, and offshore dredging and disposal areas.

The main elements of the Project are:

- bauxite mining;
- bauxite processing and disposal of fine waste materials in tailings storage facilities;
- product bauxite stockpiles adjacent to the port facilities;
- construction and operation of port and ship-loading facilities between Boyd Point and Pera Head;
- dredging for the construction and maintenance of the port, and disposal of dredged spoil at an off-shore spoil ground;
- ancillary infrastructure including diesel-fuelled power station, workshops, warehouse, administration facilities, sewage treatment plants, general waste disposal and diesel storage;
- water infrastructure including a water supply dam on a freshwater tributary of Norman Creek (Dam C), a pump on the Ward River, pipeline, and up to 12 artesian bores;
- a temporary on-site camp for the construction phase – up to 630 beds; and
- dredging for the construction and operation of a new ferry terminal at Hornibrook Point, a roll on/roll off (RORO) barge facility at Humbug Point, and a new barge/ferry terminal on the western bank of the Hey River, and disposal of dredged spoil at the existing Albatross Bay spoil ground. The ferry and barge terminals would be used to transport workforce, materials and equipment between Weipa and the SoE Project.
- Modification of the east wharf at Lorim point to provide protected tug moorings.

The main infrastructure components are illustrated in **Figure B**. It is anticipated that construction would commence in early 2012, following receipt of relevant environmental approvals and Rio Tinto's internal project approvals. The initial construction phase is expected to take approximately three years. The estimated capital cost to establish 15Mdptpa capacity would be approximately $1,450 million. The final cost is subject to completion of feasibility studies. The Project has bauxite reserves capable of sustaining a mine life of approximately 40 years, depending on annual production rate.



P:\RTA\Plans\SoE\2010\Executive Summary Figures\Fig A Locality wor

RTA Mining Lease boundary
South of Embley Project Area
Oresome Australia Pty Ltd Mineral Sands Project
Chalco Aurukun Bauxite Project
Cape Alumina Pty Ltd's Pisolite Hills Project
Township
Drainage
Road/track
50m Topographic contour

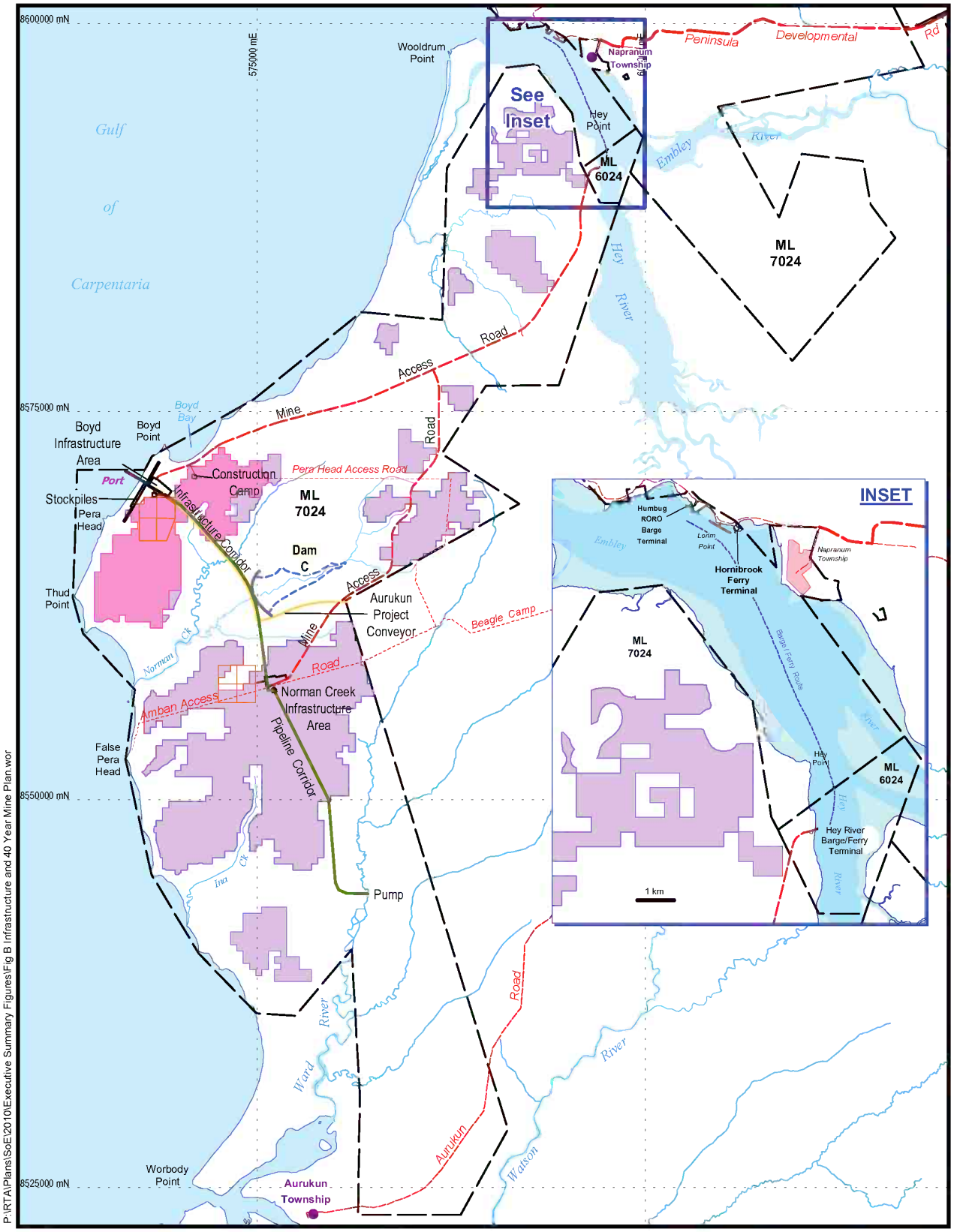
South of Embley Project

Fig. A: Locality Map

N

10 0 10km

Datum/Projection: GDA94/MGA Zone 54 Date: 09/06/2011



P:\RTA\Plans\SoE\2010\Executive Summary Figures\Fig B Infrastructure and 40 Year Mine Plan.wor

RTA Mining Lease boundary
Township
Road/track
Freshwater dam
Tailings storage facility
Barge / Ferry route
Mining Years 1 -13
Mining Years 14 - 40

South of Embley Project

Fig. B: Infrastructure and Conceptual 40 Year Mine Plan

N

5 0 5km

Datum/Projection: GDA94/MGA Zone 54 Date: 01/09/2010

The Project would deliver significant economic benefits to the local, regional, and state economies. Economic modelling predicts the following:

- The peak construction workforce is expected to be 630, with an average of 310 full-time equivalent jobs over the three years.
- Following commencement of production, the Project will generate direct employment for approximately 400 employees and 100 contractors (based on 15Mdptpa) and up to 1,020 employees and 255 contractors at maximum production (50Mdptpa).
- An estimated 1,170 jobs generated indirectly across other sectors of the Queensland economy, including approximately 790 jobs in the Far North Queensland (FNQ) region (based on a production rate of 15Mdptpa).
- A contribution to Queensland's economy of approximately $832 million per year (based on 15Mdptpa) and up to $3 billion per year at maximum production (50Mdptpa).
- Generation of approximately $123 million in taxes and royalties per year (based on 15Mdptpa) and up to $410 million in taxes and royalties per year at a maximum production rate (50Mdptpa).

The Proponent

The Project would be developed and operated by RTA Weipa Pty Ltd (RTA), which is wholly-owned subsidiary of Rio Tinto Aluminium Limited. These companies are in the Rio Tinto Alcan product group, which is one of five product groups operated by the global mining group, Rio Tinto.

Rio Tinto Alcan supplies bauxite, alumina and primary aluminium to Australia, New Zealand and export markets. About 37% of Australia's total production of bauxite, 36% of its alumina and 40% of its primary aluminium is provided by Rio Tinto Alcan.

Rio Tinto Alcan's Australian head office for bauxite and alumina is based in Brisbane. Bauxite and alumina interests in Queensland include the existing Weipa mine and the Yarwun and Queensland Alumina Limited alumina refineries in Gladstone. Rio Tinto Alcan also operates the Boyne Smelters Limited aluminium smelter in Gladstone.

RTA has a record of responsible environmental management during more than 40 years of mining bauxite in the Weipa region. RTA has not been the subject to any proceedings under a Commonwealth or State law for the protection of the environment. RTA has a Health, Safety and Environment Policy that includes commitments to minimise environmental impact and continually monitor and improve the way the company works.

The primary contact for the Project is detailed below:

Manager—South of Embley Project
Rio Tinto Aluminium Limited
GPO Box 153, Brisbane Qld 4001
Telephone 1800 308 938 (freecall)
Facsimile + 61 7 3328 6990
Email external.affairs@riotinto.com

Project Background and Need

RTA is currently mining the East Weipa and Andoom deposits located on ML7024 north of the Embley River. RTA is also mining from the adjacent Ely bauxite deposit (on ML7031) held by Alcan South Pacific Pty Ltd (acquired by Rio Tinto in 2007) under an agreement. Mined bauxite is trucked to one of two beneficiation plants located at Lorim Point and Andoom, on the northern bank of the Embley River. Product bauxite is railed from Andoom to Lorim Point and conveyed to RTA's stockpiles prior to shipment from the Port of Weipa.

The northern bauxite reserves are gradually depleting and with continuing demand for bauxite, RTA has undertaken extensive drilling programmes on ML7024. Significant bauxite reserves have been identified on the portion of ML7024 that lies south of the Embley River.

RTA plans to develop a new bauxite mine capable of producing a maximum of 50Mdptpa. The initial phase of mining operations would involve production to replace depleted East Weipa

production as well as developing third party markets. Production capacity would expand to replace Andoom production once those reserves are depleted. Production capacity would thereafter be expanded to 50Mdptpa when market conditions are suitable.

The option of not proceeding with the Project is not financially feasible as the bauxite reserves will be depleted in RTA's current mining areas leading to the progressive closure of the Weipa mine; without an alternative source, the Gladstone alumina refineries would lose a viable, ongoing source of bauxite and the town of Weipa would lose a major financial contributor.

Project Objectives

The key objectives of the SoE Project are to:

- extend the life of RTA's mining operations in Weipa beyond depletion of East Weipa and Andoom reserves;
- maintain continuity of bauxite supply to Gladstone refineries and third parties;
- enable increased bauxite production in the Weipa region in response to the rising world demand for this product and to enhance RTA's competitiveness as a bauxite producer;
- continue mining-related employment in the Western Cape region;
- maintain Weipa as the main residential and commercial support base for the Project;
- operate the mine in a manner that has an acceptable impact on surrounding communities and the environment;
- develop and operate the SoE Project in compliance with all relevant statutory requirements; and
- continue to maintain an open and honest relationship with stakeholders.

Project Alternatives

RTA has undertaken studies to optimise the Project design and a number of alternatives for various Project components have been considered but not adopted, including;

- beneficiation plant location – continued use of the Lorim Point beneficiation plant;
- port and stockpile location – use of existing facilities at Lorim Point;
- port vessel capacity – establishing a port capable of accepting bulk carrier vessels up to 90,000 dead weight tonnage (dwt);
- workforce housing and transport – establishing new workforce-only accommodation on-site with a drive-in drive-out and/or fly-in fly-out roster arrangement;
- barge and ferry terminal locations adjacent to existing Evans Landing Wharf;
- power supply – generating power at Weipa and installing a high voltage transmission line to the Project area;
- beneficiation plant technology – dry beneficiation;
- water demand management – use of thickened tailings;
- water supply – pumping water from Weipa via pipeline, desalinisation, two water supply dams and sole reliance on artesian water; and
- initial tailings storage facility establishment – locating a tailings storage facility on a non-mineralised area to the north of the Boyd beneficiation plant.

Approval Process

On 21 November 2008 the SoE Project was declared "a "significant project" for which an environmental impact statement (EIS) is required" under section 26(1)(a) of the *State Development and Public Works Organisation Act 1971* (Qld) (SDPWO Act), by the Queensland Coordinator-General.

RTA referred the Project to the Commonwealth Minister for Sustainability, Environment, Water, Population and Communities for a decision as to whether the Project constituted a controlled action under the provisions of the EPBC Act. On 2 October 2008, the Project was declared a "controlled action" under the *Environmental Protection and Biodiversity Conservation Act 1999* (Cwlth) (EPBC Act) (Referral No. 2008/4435). Following a change to the proposed port design to accommodate larger bulk carriers, RTA withdrew the referral and submitted a new referral for the revised Project. On 29 October 2010, the Project was declared a "controlled action" (Referral No. 2010/5642). In addition, the Minister also determined that an assessment under Part 8 of the EPBC Act is required before the consideration is given to issuing a permit under the *Environment Protection (Sea Dumping) Act 1981*. In accordance with the Commonwealth Minister's decision on the assessment approach, the Project will be assessed by way of an EIS under the EPBC Act (as well as an EIS under the SDPWO Act). One EIS document has been produced for assessment by the Commonwealth and the State and the EIS process shall meet the impact assessment requirements under both Commonwealth and State legislation. Approval under the Commonwealth *Environment Protection (Sea Dumping) Act 1981* (Sea Dumping Act) is required for the dredging and offshore disposal of dredged material. A sea dumping permit application was submitted to the Commonwealth Department of Sustainability, Water, Environment, Population and Communities on 1 October 2010. The EIS has also been scoped to meet the requirement of the Sea Dumping Act and includes information to support the application for a Sea Dumping Permit for dredging and disposal associated with Stage 1 capital dredging at the Port and capital dredging associated with the ferry and barge terminals.

Other key approvals required by the Project include:

- an amended environmental authority (mining lease);
- barge and ferry terminal development approvals; and
- amended licence to take artesian water.

Land

Lands within the Project area are not used for agriculture and are relatively undisturbed by development. Exploration activities have taken place throughout the Project area and are continuing. While overall there has been very little direct disturbance and the terrestrial environment is generally in good condition, some areas have been affected by camping, recreational vehicle use and rubbish dumping, and some areas have been significantly affected by frequent fires and damage from feral pigs. The Project would have no direct impact on agricultural land uses or management practices of surrounding land.

Areas to be disturbed during the 40-year mine plan comprise 27,290ha for mining areas; 700ha for a water supply dam; and approximately 1,400ha for other Project infrastructure established on non-mining areas. Generally, the area to be disturbed for mining contains Red Kandosol soils, which have low potential to develop accelerated erosion when cleared of vegetation. Yellow Kandosols and Redoxic Hydrosols occur along drainage lines, and these soil types would be disturbed for construction of dams and infrastructure. The Hydrosol soil types have a higher erosion potential. A range of erosion and sediment control measures would be employed, including restricting clearing to areas essential for mining, revegetating mined pits as soon as is practical, and completing vegetation clearing and mine development work during the dry season where possible. Vegetation buffers would be established, which provide "setback" distances of mining areas from sensitive riparian, wetland and estuarine vegetation types.

Most of the soils are only suitable for low intensity grazing of native pastures. There is no good quality agricultural land within the Project area. Overall, the post-mining land suitability for low intensity grazing is likely to be the same as the pre-mining suitability.

Soils at the Humbug barge terminal, the Hornibrook ferry terminal and the Hey River barge/ferry terminal sites would be disturbed by reclamation and cut and fill activities associated with construction. Soils at these locations were investigated for acid sulphate soil potential. The only soils that may require the addition of lime to manage acid generation are soils at the Hornibrook ferry terminal site.

Mine rehabilitation would be undertaken progressively during the life of the mine. RTA's objective for the rehabilitation of areas disturbed by SoE Project mining activities is to establish a self-sustaining vegetation community using appropriate local native tree, shrub and grass species. The final land use options would be developed and discussed with the Traditional Owners, as required under the Western Cape Communities Co-existence Agreement (WCCCA), and relevant government stakeholders. Approximately 60cm of soil would be stripped and then placed directly back on previously mined areas or stockpiled for future use in rehabilitation once a suitable area became available. Revegetation would be likely to include re-spreading of freshly stripped topsoil or stockpiled topsoil, ripping the mine floor to break up the compacted floor and increase water infiltration, and scarifying prior to seeding and fertilising. Native species seed mixes would be tailored to the anticipated post-mining conditions of the area to be rehabilitated. Preliminary rehabilitation success criteria for the Project area would be developed within three years of commencement of bauxite mining. Rehabilitation performance would be measured against the adopted criteria.

Climate

The Project area lies within the Australian Monsoon Zone and has a tropical climate with distinct wet and dry seasons. The mean annual rainfall at Weipa is 1,769mm falling on an average 109 days, with most occurring from December through to March. Key characteristics of the climate in this region are the occurrence of cyclones and wet season inundation of flood plains.

Cyclones, along with the associated storm surge and high winds, pose a risk to the safety of employees and the community, and may potentially damage infrastructure and revegetated areas. The risks to the safety of employees and the community would be managed by a detailed Business Resilience and Recovery (BRR) Plan and specific Cyclone Emergency Procedures. The heights of the port and barge/ferry terminals have been designed after taking into consideration maximum wave heights and storm surges resulting from cyclones. All plant and infrastructure would be designed and constructed to the relevant Australian Standards to reduce the risk of structural damage caused by high wind speeds.

Wet season inundation of flood plains and wetlands resulting from overtopping of main watercourse banks is a seasonal characteristic of the area. The main impact is restricted access for vehicles rather than flood damage. The design of land-based infrastructure (including dams) would incorporate appropriate flood design criteria for storms. The design of dams is based upon guidelines by the Australian Committee on Large Dams.

Surface Water

The main catchments within the Project footprint are the Norman Creek, Ina Creek and Ward River catchments. The surface waters of the Project area are used by Traditional Owners and visitors for fishing, camping and recreation.

The stream form within the Norman Creek catchment is diverse. Most streams are comprised of stable banks with a high sediment transport potential. Ongoing monitoring of geomorphic assessment sites in Norman Creek would be conducted.

The Project area freshwater streams are not unusual in terms of conductivity and hardness compared with streams in other bauxite areas. However, they have lower solute concentrations and lower hardness compared to other waters in northern Australia. The water quality characteristics of the Project area reflect the nature of water flowing through and within bauxite terraces, with the laterite layers acting as a physical and chemical filter resulting in very clear, almost salt-free surface waters. The Project area streams and tree swamps have naturally elevated dissolved aluminium concentrations.

Proposed mining activities may result in residual impacts on surface water quality, including potential impacts on sediment loads (sedimentation and turbidity/total suspended solids) and water chemistry (hydrocarbon contamination and altered metals concentrations). The water quality of natural surface drainage systems would be maintained by preserving riparian vegetation corridors, implementing mitigation strategies such as the proper handling and storage of dangerous goods and hazardous substances to prevent spills, and implementing sediment and erosion control measures. Analysis of crude ore from the Project, as well as tailings solids and liquid, tailings recovery slot water, and stockpile runoff from existing Andoom and East Weipa operations, indicates that runoff or leachate from crude ore and tailings are unlikely to be a significant contributor of aluminium to surface water and are not anticipated to have an adverse affect on surface or groundwaters. The process water ponds and tailings storage facilities are constructed as "turkeys' nests", and neither of these dams would contain contaminants in concentrations that are hazardous. Turbidity and a range of metals would be regularly monitored in surface waters to provide an early indicator of any potential water quality impacts.

Stormwater runoff generated within active mine areas would be predominantly contained within the internally draining mine pits and would then infiltrate through the pit floor and walls. In the event that the active pit or post-mining topography is not an internally draining pit, stormwater runoff would be directed via a sediment pond. Rainfall-runoff modelling showed that in undisturbed catchments within the Project area the proportion of surface runoff (<1% of rainfall) is unusually small and reflects the flat topography and the very high infiltration rates of the soils and lateritic strata. Given the low surface runoff rates and that mining pits retain overland flow, the risk of elevated sediment loads in catchment runoff during some stages of mine development is considered low.

The Project's principal water requirements are for process water, haul road watering, vehicle wash-down, dust suppression and potable supplies. The Project's water demands range from 16GL/year at 15Mdptpa to 64GL/year at 50Mdptpa. Water would be recycled from the tailings storage facilities, the mine industrial area drainage slots, heavy and light vehicle wash bays, stormwater runoff from product stockpiles and the wharf, treated effluent from the Boyd and Norman Creek sewage treatment plants, and used preferentially as process water. Water would be drawn in order of preference from tailings storage facilities, water recovered from slots adjacent to tailings storage facilities, water supply dam (Dam C), surface water stream (Ward River) and, lastly, artesian bores. Dam C would be constructed on a freshwater tributary of Norman Creek and would have a maximum storage capacity of 29GL and could be constructed in either in two stages or a single stage. The dam would be constructed in a single stage should expansion of production above 15Mdptpa be anticipated to occur quickly, or should an initial production capacity of 22.5Mdptpa be adopted. To maintain the reliability of the overall surface water supply from 30Mdptpa to 50Mdptpa production rates, some water would be pumped directly from the lower reaches of the Ward River. The artesian demand would therefore fluctuate depending on whether there is above or below average rainfall runoff into the dam.

The impact of Dam C on downstream flow was modelled. The key findings are:

- the effect of Dam C at 15Mdptpa, 30Mdptpa and 50Mdptpa production rates is to reduce mean annual flow immediately downstream in the Norman Creek tributary to 78.3%, 67.2% and 49.5% of original flow respectively; and
- considering the whole Norman Creek system catchment discharge (i.e. discharge into the estuary), the mean annual input into the estuary would be 93.5%, 90.2% and 84.9% of original flow respectively.

The presence of Dam C leads to an appreciable annual decline in flows immediately downstream on the particular branch of the Norman Creek on which it is built. However, when the catchment is considered as a whole, the overall decline (maximum 15%) is well within the range of normal year-to-year variation (the 10th percentile annual flow is 42% lower than the mean annual flow).

Dam C would be fitted with a low-level outlet pipe which would permit the controlled release of environmental flows when required. The spillways would be at a low gradient (<3%) and be designed to facilitate fish passage during spillway flow events.

The impact on the hydrological regime as a result of pumping from the Ward River was also modelled and found to be minor. The annual volume of water pumped from the Ward River would be capped at 1% of mean annual river flow at the pump station and the rate of pumping at all times would be less than 20% of the river flow rate.

The effect of mining on the discharge from catchments subject to mining was assessed using a rainfall–runoff model which showed that mining has a temporary impact on the partitioning of surface runoff and baseflow, and that as rehabilitation matures the overall hydrological regime at a catchment scale returns toward an "undisturbed" situation. The Ina Creek catchment has the largest proportion of area mined but the overall change to average annual discharge is very small (–1.4% at maximum impact; –2.2% post-closure). There are only very small changes to the discharge from the overall Norman Creek system (–1.0% at maximum impact; –1.8% post-closure) and overall Ward River system (–0.2% at maximum impact; –0.5% post-closure). The modelling indicates that the overall impact of mining on catchment discharge is very much less than the normal year-to-year variation driven by rainfall variation because surface runoff is extremely low and hence changes to surface drainage patterns have little impact on overall discharge into streams. The Project would not have any impact on the Watson River or Archer River and therefore the impact on discharge to the Archer Bay Aggregation would also be very minor, if any.

Groundwater

The groundwater resources in the area have been differentiated as shallow aquifer and artesian aquifer resources.

The bauxite layer (part of the Wyaaba beds) is highly permeable and is usually unsaturated. The bauxite overlies a kaolinite clay layer (part of the Bulimba Formation) which is generally of low permeability and typically contains macropores that allow preferential flow. The kaolinite layer is a transitional zone between the bauxite and the underlying sandstone Bulimba Formation. On the Weipa Peninsula north of the Embley River, the Bulimba Formation hosts a high yielding shallow aquifer which is used to supply existing RTA mining operations. However, the shallow aquifers in the Project area tend to be poorly developed and discontinuous. Generally, groundwater quality results are similar to that of surface waters with the exception of some higher concentrations of dissolved metals.

There is a large seasonal influence on the shallow aquifer water table which is separated from the artesian aquifers by the 500m thick mudstones of the Rolling Downs Group. The wet season water table level is generally below the base of the bauxite, rising within the bauxite only at the height of the wet season, if at all. The dry season water table level generally falls to 4 to 8m below the base of the bauxite, with the kaolinitic layer below the bauxite generally hosting the shallow aquifer during the dry season. Stream flow during the dry season tends to be maintained by baseflow originating predominantly from kaolinitic strata and is unlikely to originate from the bauxite. The removal of bauxite would only have the potential to change discharge from the shallow aquifer in situations where the bauxite is an appreciable source of baseflow.

Redirection of surface flow due to disturbance from mining does not greatly alter aquifer recharge characteristics because direct surface runoff from the bauxite plateau is a very small proportion of incident rainfall (<1%).

The artesian resources are hosted within the Gilbert River Formation and Garraway Beds. These are part of the Great Artesian Basin (GAB) aquifers, the main artesian groundwater resource in the region, and capable of supporting a large rate of abstraction. Typically, water bearing formations in the Project area are located at depths 750 to 1,000m below ground level. Artesian water quality is generally brackish (electrical conductivity ranging from 1,800µS/cm to 16,000µS/cm) with variable cation, anion and metals concentrations. The GAB aquifers are recharged primarily by direct infiltration of rainfall where the GAB sandstone outcrops along the

eastern margin of the region (the recharge area) – along the flanks of the Great Dividing Range, particularly along watercourses. Recharge springs are quite common in the recharge areas on Cape York Peninsula and result from overflow or the rejection of recharge from the overfilling of aquifers. These springs provide an important source of water for maintaining surface water flow during the dry season. Watercourse springs are also found on Cape York Peninsula and are the part of a watercourse where water enters the watercourse through its bed or banks to become baseflow in the watercourse.

The GAB Resource Operations Plan states that a decision associated with abstraction from a management unit connected to a spring is subject to the cumulative spring factor not exceeding 400mm head of water. The spring factors for the closest recharge and watercourse springs to the proposed borefield have been calculated and demonstrate that the cumulative spring factor limit of 400mm is not exceeded for any of the existing or proposed new bores.

RTA extracts artesian groundwater from borefields at both East Weipa and Andoom operations under an existing Water Licence which allows abstraction of up to 9GL per annum. There are no other large users of artesian groundwater on Cape York. RTA proposes to install an artesian borefield that accesses the Gilbert River Formation artesian aquifer as part of the Project and to apply to increase the artesian allocation to cover the fluctuations in artesian demand. It is proposed that a five-year moving average of 12GL per annum be established, with a peak abstraction of 15GL in any one year.

The potential impacts of artesian groundwater abstraction were modelled. The modelling results indicate that under the proposed licensed abstraction regime, the existing Water Licence condition relating to a 5m maximum relative drawdown would be met and that the aquifer could sustainably support abstraction rates greater than the proposed rate of 12GL per annum.

Discharge springs, which are defined as spring's supplied by underground water from the GAB, are not found in the Project area or Cape York. It is therefore unlikely that the threatened ecological community '*The community of native species dependent on natural discharge of groundwater from the Great Artesian Basin'* would occur in the Project area.

Marine

The marine impact assessment focused on the proposed port site, the spoil disposal ground offshore of Boyd Point, the existing Albatross Bay spoil ground and the proposed location for barge/ferry facilities, and impacts of sediment dredging, sea disposal of dredge spoil, and construction and operation of the port and barge/ferry terminals.

Initially, approximately 6,500,000m^3 of marine sediments would be dredged from the port site to establish the berth pockets and departure areas over a period of about 300 days. Dredged spoil would be transported to the new offshore spoil disposal ground. Initially annual maintenance dredging of approximately 890,000m^3 is expected to be required to maintain under keel clearance for ships. When the wharf is extended in a second stage to expand its capacity to at least 50Mdptpa, a further 2,400,000m^3 of dredged spoil would be generated and disposed of at the same offshore spoil ground and annual maintenance dredging would increase by 280,000m^3 per annum to a total of approximately 1,170,000m^3 per annum.

Minor volumes of material would be dredged at Hornibrook ferry terminal (18,680m^3), Humbug barge/ferry terminal (10,670m^3) and Hey River barge/ferry terminal (17,300 m^3) to obtain sufficient draft for project support vessels. Dredge spoil would be disposed of at the existing Albatross Bay spoil ground. At each of the barge/ferry terminal facilities dredging is likely to take only one to two weeks. Annual maintenance dredging of these areas would increase the annual dredge volume conducted by North Queensland Bulk Ports by approximately 7,000m^3.

Assessment of the chemical and physical characteristics of material to be dredged from the proposed port area and the barge/ferry terminals, using the framework of the *National Assessment Guidelines for Dredging* (NAGD), indicates that all dredge spoil is suitable for sea disposal and did not identify any constituents present at levels of environmental concern that would persist in the water column during dredging or sea disposal.

Water quality at the proposed port, new spoil ground, and proposed ferry and barge facilities all exhibit significant natural fluctuations in suspended sediment and turbidity. The extent of this natural variation buffers water quality impacts associated with dredging, disposal, construction and operation to some extent. Generally, these habitats may be described as being more resilient to short-term water quality changes.

Near shore fringing reef communities in the vicinity of the proposed port area occur at Boyd Point, Pera Head and between Pera Head and Thud Point. These comprise both reefs containing hard corals and low profile reefs containing soft coral-sponge assemblages. The importance of these reef systems (Boyd Point to Thud Point) in a regional context is considered to be high as they support resources that are of conservation, cultural, commercial and recreational importance. In particular, the near shore sponge and soft coral reefs provide a food resource for a range of turtle species in the area. Nine Mile Reef is accessed frequently by recreational fishers. No reefs need to be removed for dredging or wharf construction purposes.

At the proposed port site, a turbid plume would eventuate as material is released to the water column during the operation of the dredgers. The migration and dispersion of turbid plumes during capital dredging at the proposed port area and disposal at the proposed new spoil ground has been predicted through modelling. Model outputs identify that the turbid plume generated by port area capital dredging extends parallel, along the coast. During flood tides the plume extends from the dredge location to beyond Pera Head. During the ebb tide the dredge plume extends from Pera Head to Boyd Point. Under ambient conditions, Boyd Point and Pera Head reef areas demonstrate a high variation in turbidity, driven primarily by local wind and associated wave events. Median dredge-derived plume concentrations remain below event-based ambient ranges reported from reef habitats and the duration of peak dredge-derived plume periods are similar to natural event durations.

Modelling of turbid plumes generated by spoil disposal at the proposed new spoil ground identified a median TSS concentration of less than 1mg/L above background. The disposal plumes at the new spoil disposal ground tend to disperse along a southerly trajectory due to tidal currents and do not reach the Nine Mile Reef, which is located approximately 6km south-west of the spoil disposal ground. No impact to recreational or guided fishing over that area is predicted.

Sediment deposition modelling was used to predict sediment deposition rates over key reef habitat areas for seven different dredging periods representing different dredging activities. Based on modelled sedimentation predictions, reef systems between Boyd Point and Thud Point may experience impacts from increased sediment deposition.. The mean annual sediment deposition concentration recommended to guard against excessive coral recruit mortality is 3mg/cm^2/day. Daily deposition rates at Pera Head Reef, and reef systems south of Pera Head to Thud point, during the peak plume period, are predicted to be higher than 3mg/cm^2/day. The total rate of deposition during the peak plume period may represent a potential risk of mortality to coral recruits. However, the predicted sediment concentrations remain much lower than the recommended daily maximum sediment concentration. Corals already established on the reef are likely to be more resilient than recruits, as demonstrated by colony survival following natural events where deposition rates would be significantly higher than the recommended daily maximum sediment concentration.

The creation of a turbidity plume from dredging and subsequent deposition and re-suspension of fine sediments may adversely affect hard corals, which require sunlight for photosynthesis. Three light regimes related to coral sustainability were developed based on the relationship between TSS and light: "favourable", "light limited" and "unsustainable". Using TSS values from plume dispersion modelling and reef habitat depth profiles, a prediction of impact based on benthic light availability was made for reef habitats of the study area between Boyd Point and Thud Point during inshore and offshore dredging.

Modelling indicates that 86-89% of the hard coral reef habitat area mapped around Boyd Point, Pera Head and Thud Point would maintain a "favourable" light regime throughout the dredging program and is not considered to be at risk. The remaining reefs, during the peak plume period, would experience periods of reduced light availability for durations similar to ambient light

reduction events recorded at Boyd Point during field investigations. However, the predicted plume TSS concentrations remain well below reported maximum ambient concentrations. Whilst the change in light availability is not considered sufficient to initiate an acute response, the rate at which these corals can acclimatise is not well defined, and they remain at risk of developing sub-lethal responses to reduced light regimes. Modelling results indicate that, following the peak plume period, the receiving habitats enter a period of respite, where TSS reductions result in substantial improvements to the light climate. Given the relatively short duration of light attenuation, and general respite provided to coral reef systems after the peak plume period, these predicted light reductions are not thought to be a driver of acute impact associated with the dredging process. The analysis did not identify any coral habitats entering "unsustainable" light regimes.

The development of a reactive environmental monitoring program would be an important part of the dredging program. Monitoring of turbidity, deposition and photosynthetically active radiation is proposed to be undertaken at Boyd Point, Pera Head and Thud Point reef areas. The objective of this monitoring is to assist in identifying extended periods of high turbidity/low light availability which can lead to coral stress. Should signs of unacceptable coral stress become apparent, then dredging operations would be located to offshore in the departure channel to allow corals a period of respite and return to more favourable light conditions.

Seagrass habitats in the Albatross Bay area provide nursery habitat for fish and macroinvertebrates and species of conservation significance (e.g. dugongs and green turtles). Seagrass and mangroves are not present in the immediate vicinity of the proposed port development. Seagrass habitat was not identified in recent surveys of the dredge footprints of the Hornibrook ferry terminal or the Hey River terminal; however, patches of seagrass may occur in the vicinity. Isolated patches of seagrass have been identified within or immediately adjacent to the proposed dredge footprint at the Humbug barge terminal. The area of seagrass within the dredge area is conservatively estimated to be 1250m^2, which represents about 0.003% of the seagrass meadows within the Weipa region. Given the minor scale and short duration of dredging for the barge and ferry terminals, it is unlikely that sediment loads would approach critical levels for the seagrass.

The development footprints for all marine infrastructure components of the SoE Project (port area, proposed spoil ground, Albatross Bay spoil ground, Hornibrook ferry terminal, Humbug barge terminal and Hey River barge/ferry terminal) have been confirmed by field inspection as consisting primarily of soft sediment habitats that contain sparse epifauna typical of soft sediments, such as seapens and tube-dwelling anemones, soft-corals or sponges. These areas can also contain diverse and abundant assemblages of macrobenthic infauna. Physical disturbance from dredging, spoil disposal and marine infrastructure construction, as well as the turbidity plume caused by dredging, may potentially have a significant local impact on the infauna assemblage at the site of the proposed port facility, the new spoil ground, the barge/ferry terminals and the Albatross Bay spoil ground. However, the soft sediment habitats of the Gulf of Carpentaria are not considered to be sensitive marine habitats. The areas proposed to be impacted by dredging, spoil disposal and construction of marine infrastructure would be extremely small relative to the area of soft sediment habitats in the region, therefore, these impacts pose a low risk on a regional scale. Macrobenthic infaunal assemblages can recover over time from the impacts of dredging and spoil disposal. Monitoring of infauna is proposed be undertaken at the new spoil ground location and at the proposed port to identify the extent of smothering impact, spoil migration and recovery over time. Monitoring is also proposed for the ongoing maintenance dredging campaigns at a frequency of five years, or as required by the conditions of future sea dumping permits.

The most effective control strategy to minimise negative effects of dredging on adjacent habitats is to minimise dredging time, allowing sensitive receptors to enter a recovery phase as quickly as possible. It is anticipated the port area would be dredged over a period of up to 10 months; however, there would be periods of respite as the dredging operations move between inshore and offshore locations. Dredging at barge/ferry terminals should take only one to two weeks each.

Dugongs (listed as "Vulnerable" under the *Nature Conservation Act 1992* (Qld) and as a "migratory species" under the EPBC Act) occur in low densities in Albatross Bay and graze on the seagrass beds in the Embley estuary. The absence of seagrass within the footprints of marine infrastructure, except for a very small area within the Humbug barge terminal footprint, ensures that there would not be a significant impact on Dugong foraging habitat. The operation of the ferry is predicted to pose a moderate risk of boat strike to dugong in the Embley estuary. Transit lanes that follow the deepest water and avoid significant meadows of seagrasses would be implemented to help reduce the risk of boat strike.

Three 'threatened' (EPBC Act) sea turtle species are known to nest on the beaches in the vicinity of the Project area and forage in the surrounding waters. Another three 'threatened' (EPBC Act) sea turtle species use the Project area waters for foraging. Sea turtle populations are currently adversely impacted by feral pigs (predation of nests) and becoming entrapped in ghost nets.

Approximately 71ha of sponge/soft coral habitat occurs between Boyd Point and Pera Head (inclusive). It is predicted that sediment deposition from port area capital dredging would be at its greatest between these two locations and may locally affect feeding preferences in marine turtles. It is estimated that 117ha of similar habitat occurs between Pera Head and Thud Point, with more likely to occur at inshore reef areas south of Thud Point and north of Boyd Point, therefore regional impacts to feeding habitats are not predicted.

Changes to the above-water, night-time lighting regime can affect sea turtle hatchlings' attempts to find water; therefore, lighting from construction and operation of the port may affect sea turtles. RTA has developed and would implement a lighting plan at the port to mitigate the potential effects of lighting on sea turtle hatchlings. Measures to reduce feral pig numbers in the Pera Head to Boyd Point area and assistance with marine turtle research programs would be developed and implemented in liaison with RTA, Traditional Owners and the Queensland Department of Environment and Resource Management (DERM). Overall, without mitigation, a changed light regime is predicted to pose a high risk to marine turtles. However, proposed programs designed to reduce the primary threats (feral pigs and ghost nets) would minimise overall impacts on local marine turtle nesting activity and increase hatchling emergence. Turtle exclusion devices would be fitted to dredges to minimise entrainment of turtles. The risk of turtle deaths due to boat strike is low.

Three species of sawfish of conservation significance are likely to occur in Albatross Bay. Although fish species are able to move away from any local areas affected by a disturbance (e.g. dredging and dredge spoil deposition), physical disturbance to the dredge sites, deposition of spoil, and the re-suspension of disturbed and deposited sediment may have impacts of minor magnitude on sharks and rays, including sawfishes, and bony fishes at the proposed port facility, the proposed new spoil ground, and the ferry/barge terminals.

The Project area is included in the area where the Northern Prawn Fishery (NPF), the Gulf of Carpentaria Commercial Inshore Finfish Fishery and the Gulf of Carpentaria Commercial Line Fishery operate. Recreational fishers and guided fishing tour operators also utilise the Project area. There may be localised impacts on these fishing activities from turbid plume generation and spoil deposition as well as restricted access due to construction and operation of the port and barge/ferry terminals. However, the areas where these fisheries and recreational fishers operate is large and there is considerable area where they can still operate unimpeded.

To minimise the risk of introducing marine pests through ships' ballast water or hull fouling, all vessels owned and contracted by Rio Tinto would manage ballast water through a Ballast Water Management Plan which would comply with Australian mandatory requirements and the *International Convention for the Control and Management of Ships' Ballast Water and Sediments*. Ship hulls would not be cleaned at the proposed port. RTA would undertake regular mussel trap monitoring in the vicinity of the new port when overseas ships are utilised to provide a means of early detection of pest introduction.

To manage the risk of introducing pollutants to the marine environment, no fuel or chemicals would be unloaded at the proposed port facilities. Product spillage into the marine environment

could occur from routine loading operations. Bauxite is non-hazardous and the risk of impact to marine ecology is considered to be low. RTA proposes to adopt engineered designs that minimise the risk of dust generation and product spillage.

The construction of the proposed port, tug berths and the ferry/barge terminals would involve pile driving activities. Pile driving may cause underwater acoustic impacts such as avoidance behaviour on marine fauna (including EPBC Act threatened species) in the vicinity of this activity. To minimise these potential underwater noise impacts on marine fauna, RTA proposes that an exclusion zone be established and monitored prior to and during normal pile driving activities, a soft start approach be undertaken prior to normal pile driving and normal pile driving would not be conducted while threatened marine fauna species are indentified within the nominated exclusion zone. The proposed mitigation measures should ensure that any impacts associated with underwater noise from pile driving (predominantly avoidance behaviour) on marine fauna remain low. The extent of the exclusion zone would be defined based on further literature review and quantitative analysis of the potential underwater noise impacts from pile driving relating to threatened marine fauna. The final extent of the exclusion zone would be defined in consultation with DSEWPaC.

Terrestrial Flora and Fauna

The Project area is relatively homogenous in vegetation and landform, and is characterised by large areas of Darwin Stringybark (*Eucalyptus tetrodonta*) open forests or woodlands, dissected by smaller areas of riparian vegetation, vine thicket patches and paperbark swamps. There are no Protected areas within or near the Project area.

Of the 27 Regional Ecosystems (REs) occurring in the Project area three are listed under the *Vegetation Management Act 1999* (Qld) as "Of concern" (none are "endangered"). RE 3.5.2 (*Eucalyptus tetrodonta*, *Corymbia nesophila* tall woodland on deeply weathered plateaus and remnants) is the most widespread RE within the Project area, and is listed as "Least concern". It comprises approximately 87,500ha or 86% of the REs mapped in Project area, and occurs almost exclusively upon the bauxite plateau areas (which is the area where mining is proposed).

Disturbance to REs within the Project area would comprise approximately 27,300ha within mining areas; 700ha within the footprint of the water supply dam; and 1,400ha within the footprint of Project infrastructure established on non-mining areas. The aggregate area of 29,400ha of remnant vegetation to be disturbed is comprised entirely of "Least concern" REs, apart from approximately 0.3ha of "of concern" RE 3.2.6a (*Casuarina equisetifolia* woodland on foredunes) which would be disturbed for the ship loading facility. Approximately 28,970ha of RE 3.5.2 would be disturbed, representing 4.3% and 3.7% respectively of its subregional and bioregional distribution.

The disturbance of other REs would be much less than 10% of their total extent in the Project area, apart from RE 3.3.5 (evergreen notophyll vine forest on alluvia on major watercourses) (28.8%). The total area of RE 3.3.5 within the Project area is small (28.5ha) but 8.2ha occurs within the footprint of Dam C and associated infrastructure. However, in the sub-regional and bioregional context, the disturbance to RE 3.3.5 would be negligible (<0.1%).

No EPBC Act listed "endangered ecological communities" are present in the Project area.

Two "threatened" orchid species listed under the EPBC Act are widely distributed in the Project area. Cooktown Orchid is located in coastal and non-coastal vine forest, and mangrove edges. It was found within the proposed footprint of Dam C, and in the vicinity of a proposed access road crossing of an upper Norman Creek tributary. Chocolate Tea Tree Orchid is located in riparian gallery forest and Melaleuca dominated swamps particularly along major drainage lines and associated tributaries. It was found within the infrastructure corridor downstream of Dam C, and in the vicinity of proposed access road crossings of Winda Winda Creek and an upper Norman Creek tributary. The disturbance associated with the dam and other infrastructure represents a minor proportion of the habitat for these two orchids.

The threatened flora species are likely to be encountered in non-*Eucalyptus tetrodonta* vegetation communities which would not be directly affected by bauxite mining operations. The disturbance of sensitive non-*Eucalyptus tetrodonta* vegetation by mining would be avoided by the development of an environmental buffer system and the exclusion of mining from within the designated buffers and the non-*Eucalyptus tetrodonta* communities themselves.

Direct impacts on fauna habitats are linked to removal of vegetation to accommodate mining and Project infrastructure. Eight threatened fauna species (either EPBC Act listed or *Nature Conservation Act 1992* listed) have been confirmed as present in the Project area. Of these, two species are found within the proposed dam footprint. There is likely to be a short term impact on the breeding success of some pairs of Palm Cockatoos during construction of Dam C. However, other habitats are likely to support suitable nesting trees, and foraging habitat occurs elsewhere throughout the Project area. The loss of habitat for the Rufus Owl within the Dam C footprint is not insignificant in terms of habitat availability and other areas of suitable habitat occur throughout the Project area.

The Estuarine Crocodile (listed as "Vulnerable" under the *Nature Conservation Act 1992* and as a "migratory" species under the EPBC Act) is commonly encountered in the Weipa area including the freshwater swamps and creek systems within the Weipa mining leases. The tributaries that collectively form the Port Musgrave system and the Albatross Bay system surrounding Weipa (including the Embley and Hey estuaries adjacent to the Project area), have been identified as the two most significant Estuarine Crocodile habitats in Queensland. Overall the species is widespread in the Project area. One nest has been found within the footprint of Dam C on a freshwater tributary of Norman Creek. The Project is not expected to interfere with the total breeding effort of the species in the Project area.

Forty-four migratory bird species listed under the EPBC Act were identified as present or potentially present within the Project area. The majority of these species predominantly utilise habitats that would be located within environmental buffers and are not directly affected by mining. There are not anticipated to be any significant impacts on migratory birds resulting from the Project.

Impacts of habitat removal on the overall habitat landscape for fauna, and in particular faunal movement patterns, would be mitigated by retention of the environmental buffers, in particular a coastal margin vegetation buffer and by the retention of remnant vegetation.

Given the limited disturbance by infrastructure of non-*Eucalyptus tetrodonta* vegetation, the proposed environmental buffer system together with the retention of remnant vegetation, significant impacts on threatened flora and fauna species are unlikely.

RTA would implement fire, weed and feral animal management programs which would benefit threatened fauna in undisturbed areas by enhancing current habitat values.

Aquatic Ecology

The Project area sheds runoff from a centrally-located topographic high in all directions via numerous creeks and smaller, less defined drainage depressions. Aquatic ecosystems within the Project area also include swamps, lagoons, channels, lakes and estuaries. The systems are a mix of perennial and seasonal systems, some of which are interconnected with the groundwater system and have environmental values of national, state and regional significance.

There are three relatively large wetland aggregations partly or wholly contained within the Project area, including the lower Ward River. The lower Ward River within the Project area is included within the Archer Bay Aggregation which is a nationally significant wetland area listed in the Directory of Important Wetlands (DIWA).

These wetland systems provide areas of wetland habitat, productivity (carbon biomass), fish nursery, fisheries, nesting/feeding for migratory birds, aquatic refugia, habitat for threatened species and cultural significance.

The two main aquatic vegetation community types are riparian overstorey and aquatic macrophytes. Macrophytes are not common in the Project area due to shading by closed

riparian forests, nutrient poor water and leaf litter dominated substrates, and high discharge rates.

A total of 45 species of fish were recorded in the Project area during two field surveys. Six species of crustacean were recorded and locally populations were dense. A species of freshwater crab, *Austrothelphursa* sp., was recorded and assessed by the Queensland Museum as possibly a new species. One specimen of Mysid (Shrimp) crustacean belonging to the family Lepidomysida, a stygofauna, was identified by Queensland Museum staff and has not previously been recorded in Australia.

No "endangered", "vulnerable" or "near threatened" aquatic species listed under the *Nature Conservation Act 1992* or the EPBC Act were confirmed as present within the Project area.

Other than Dam C on a freshwater tributary of Norman Creek, the direct disturbance footprint of proposed mining and infrastructure development occurs primarily within terrestrial ecosystems. Implementation of an environmental buffer system would ensure riparian, wetland and estuarine habitats were buffered from direct impacts associated with vegetation clearing other than where they occur within narrow linear infrastructure crossing drainage lines, or within the proposed dam impoundment.

The primary impact on aquatic ecology arises from Dam C. Dam C may act as a fish barrier to those species that need to traverse upstream and downstream of the dam. Downstream of Dam C there is potential for changes to stream geomorphology, greater seasonal variability in channel hosted lagoons/pools, decreased abundance of freshwater macrophytes, altered timing of flow, potential water quality impacts if dam seepage occurs, and salinity changes at the estuary interface. Any such changes would be confined to the downstream reach of the Norman Creek freshwater tributary on which Dam C would be located.

Mitigation and monitoring measures to manage potential Project impacts include the following:

- Environmental flows would be released from Dam C to match the timing of inflows. Flow rates would be monitored upstream and downstream.
- Post-mining drainage paths would be reconfigured as far as practicable to match that of pre-mining. Hydrological monitoring would be undertaken in representative sub-catchments affected by mining.
- Drainage would be managed during mining operations to minimise sedimentation.
- Vegetation buffers would be established.
- A fishway structure of an appropriate size to allow those species that need to traverse between upstream and downstream of Dam C would be incorporated into the spillway to provide habitat connectivity.
- Seasonal salinity regimes in upper estuarine reaches and their relationship to surface base flows, groundwater inflows and reach habitats would be monitored.
- Water quality in receiving reaches and their relationship to ambient dissolved oxygen levels, soluble aluminium, iron and manganese concentrations would be monitored.
- Representative vegetation ecotonal boundaries would be mapped from aerial photography to detect any long-term (decadal) shift, and surface water would be monitored for salinity at monitoring points located in each of the major estuaries.
- Aquatic faunal communities in receiving reaches would be monitored periodically.

Air Quality

The Project area is undeveloped and remote. Potential sources of particulate emissions from the environment surrounding the proposed mine primarily comprise unsealed roads, smoke from bushfires, existing RTA mining activity north of the Embley River, and cattle station activities.

Air dispersion modelling was conducted to predict the ground level concentrations of particulates, nitrogen dioxide (NO_2), sulphur dioxide (SO_2) and concentrations of deposited dust at sensitive receptors close to the SoE Project area (Weipa, Napranum and Aurukun). The predicted concentrations at the nearest sensitive receptors all comply with the air quality objectives for particulates, NO_2 and SO_2 described in the *Environmental Protection (Air) Policy 2008* (Qld) (EPP (Air)). Predicted deposited dust concentrations were less than the maximum dust concentrations described in the DERM Guideline *Preparing an Environmental Management Overview Strategy (EMOS) for Non-standard Mining Projects.*

The predicted particulate levels (inclusive of background) at sensitive receptors were up to 27$\mu g/m^3$ for the 24-hour PM_{10} (respirable particulates less than 10 micrometres in diameter), compared to the proposed criterion of 50$\mu g/m^3$. Predicted fine particulate levels (inclusive of background) were up to 10$\mu g/m^3$ for the 24-hour $PM_{2.5}$ (respirable particulates less than 2.5 micrometres in diameter), compared to the proposed criterion of 25$\mu g/m^3$ and up to 2$\mu g/m^3$ for the annual $PM_{2.5}$ (compared to the proposed criterion of 8$\mu g/m^3$). Annual average total suspended particulate (TSP) levels were predicted to be up to 23$\mu g/m^3$ (compared to the proposed criterion of 90$\mu g/m^3$). Dust deposition levels were predicted to be up to 52mg/m^2/day (compared to the proposed criterion of 120mg/m^2/day).

Apart from conventional haul road watering and dust suppression sprays (e.g. truck dump chutes), no special mitigation measures are required.

Predicted NO_2 levels (inclusive of background levels) at sensitive receptors were up to 52 parts per billion (ppb) for the 1-hour NO_2 (compared to the proposed criterion of 120ppb) and up to 6ppb for the annual average NO_2 (compared to the proposed criterion of 30ppb). Predicted SO_2 levels (inclusive of background levels) were up to 3ppb for the 1-day SO_2 (compared to the proposed criterion of 80ppb) and up to 1.5ppb for the annual average SO_2 (compared to the proposed criterion of 20ppb).

An inventory of project greenhouse gas (GHG) emissions was prepared for the Project. The primary sources of GHG emissions include the on-site diesel-fired power station, heavy vehicle transport, and vegetation clearing prior to mining. The estimated total GHG emissions at 15Mdptpa, 30Mdptpa and 50Mdptpa production rates are 182kt CO_2-e (carbon dioxide equivalents), 319kt CO_2-e and 508kt CO_2-e per annum respectively. The estimated GHG emission intensity of the Project at the 15Mdptpa production rate is 0.0121t CO_2-e/t bauxite. This estimate includes the GHG emissions that would be generated as a result of the initial vegetation clearing for infrastructure. At higher mining rates there would be greater operational efficiency and the intensity declines to 0.0106t CO_2-e/t bauxite at 30Mdptpa, and to 0.0102t CO_2-e/t bauxite at 50Mdptpa. For comparative purposes, between 2007 and 2009 the GHG emission intensity of the current Andoom and East Weipa operations averaged 0.026t CO_2-e/t bauxite. Rio Tinto aims to progressively reduce the greenhouse gas emission intensity of its' operations and increase energy efficiency through efficient design considerations, GHG awareness training, efficient operation and maintenance of equipment, and regular auditing of energy efficiency.

Noise/Vibration

The residential areas along the Embley River, namely Napranum and the accommodation areas in Evans Landing, would be the nearest sensitive receptors to the Project area. The median current background ($L_{A90(1\ hour)}$) noise levels at the nearest sensitive receptors were found to be 41dB(A) during the day and 38dB(A) during the evening and night. The existing mining operations north of the Embley River contribute to the noise environment in Evans Landing and Napranum.

During the construction phase of the Project the most significant noise sources would be the construction of the proposed port, mine industrial area and the ferry and barge terminals. It is unlikely there would be significant impacts to sensitive human receptors from these activities due to the distance of these activities from residential receptors. For example, Napranum, Nanum and Weipa are approximately 4km from the closest mining areas and 40km from the Boyd infrastructure area and proposed port; Aurukun is approximately 15km from the closest mining areas and 35km from the Norman Creek infrastructure area. However, underwater noise generated by piling has the potential to affect marine animals. It is anticipated that the marine construction activity would temporarily deter most turtles and marine mammals from the immediate area. For precautionary purposes, it is proposed that an exclusion zone be established and monitored by an observer around pile driving activities and that a soft start approach be undertaken prior to normal pile driving. Normal pile driving would not be conducted while threatened marine fauna species are indentified within the nominated exclusion zone. The extent of the exclusion zone would be defined based on further literature review and quantitative analysis of the potential underwater noise impacts from pile driving relating to threatened marine fauna. The final extent of the exclusion zone would be defined in consultation with DSEWPaC.

The proposed noise level criteria for the Project have been derived taking into consideration the acoustic quality objectives for health and wellbeing as well as the control of background creep, described in the *Environmental Protection (Noise) Policy 2008* (Qld) (EPP (Noise)). Noise modelling was conducted for the 50Mdptpa production rate (which is likely to produce the highest noise levels) for typically adverse meteorological conditions. The modelling demonstrated that operational noise levels from mining and barge/ferry operations, including low frequency noise levels, at 50Mdptpa, are expected to comply with all proposed noise level objectives and criteria in Weipa, Napranum and Aurukun during the day, evening, night and night with wind.

The manufacturer's sound power level specifications for major equipment items would be considered when purchasing equipment. A noise monitoring campaign would be conducted after operation commences to validate the noise model. If actual noise levels exceed applicable noise limits, action would be taken to reduce noise levels.

Blasting is not proposed, therefore there would be no impact from blasting noise, ground vibration, or flyrock.

Cultural Heritage

The WCCCA is a registered Indigenous Land Use Agreement (ILUA) (QIA2001/002) under the *Native Title Act 1993* (Cwlth) between RTA, the State of Queensland and relevant Indigenous parties. The *Aboriginal Cultural Heritage Act 2003* (Qld) recognises ILUAs as a mechanism for managing cultural heritage as long as cultural heritage is included in the ILUA (as it is in the WCCCA). The WCCCA provides for a system of cultural heritage management over the Project area. This agreed process for identifying, assessing and managing places of cultural heritage significance satisfies the requirement of the *Aboriginal Cultural Heritage Act 2003* and meets Queensland legislative requirements for any new permits or approvals required for Project development works. The WCCCA requires RTA and Traditional Owners to establish mutually agreed plans for each commercial activity (including mining) that may have an impact upon Indigenous cultural heritage.

Under the auspices of the WCCCA, six cultural heritage surveys have been completed in the Project area. The areas surveyed included, but were not limited to, the proposed port, Boyd

and Norman Creek mine infrastructure areas and tailings storage facilities, the proposed barge/ferry terminal at Hey Point, the infrastructure corridor and Dam C. The surveys to date have documented archaeological sites totalling 538 scarred trees, 23 surface stone artefact scatters (with a total of 43 artefacts), and 111 shell middens. Previous anthropological fieldwork, undertaken prior to the six cultural heritage surveys, has identified 15 places of cultural significance to Traditional Owners (ethnographic sites). Many of the flora and fauna species in the area have significant cultural heritage value for Traditional Owners. These values have been discussed with Traditional Owners and documented in cultural heritage survey reports.

Results of archaeological surveys indicate that 82.5% of scarred trees, 88.4% of stone artefacts and 100% of shell middens and ethnographic sites are located outside of the infrastructure footprint and would not be affected by the Project. The remaining sites inside the footprint may be affected during construction of the Project. The results of archaeological surveys suggest that scarred trees are the site type mostly likely to be impacted by the proposed Project. Recorded shell middens are located outside of the areas for proposed facilities and future mining. Other site types are typically found in the riparian vegetation zone around watercourses, the coastline and significant vegetation such as thickets of vine forest. The majority of Project facilities are situated outside of this riparian vegetation zone. Measures to mitigate impacts on cultural heritage sites would be developed in consultation with Traditional Owners.

The majority of known places of cultural heritage significance are outside future mining areas, although access to some of these places may be affected by mine development. RTA would initiate discussions with the Western Cape Communities Coordinating Committee (WCCCC) and the Traditional Owners to establish separate heritage action plans for each location and incorporate these into the Community, Heritage and Environment Management Plan (CHEMP).

RTA would work with Traditional Owners and the relevant WCCCC sub-committee for the selection and appointment of consultants and development of the scope of ethno-botanical and ethno-faunal studies of the Project area. Information from such studies would be incorporated into management arrangements for the Project area. RTA would also evaluate options to work collaboratively to develop a knowledge database of flora and fauna species of cultural significance in the region.

Further management work would be undertaken, in consultation with Traditional Owners and in accordance with the WCCCA process, to fully assess the impact of the proposed Project on Indigenous cultural heritage and develop mitigation strategies where required. This would include progressive detailed surveys of all areas identified for future development.

Through consultation with Traditional Owners and the WCCCC SoE Sub-Committee, a scope and agreed timeframe for the development of a CHEMP is being prepared. The CHEMP would provide a long-term strategy for the management of land access, fire, flora and fauna, signage, weeds, environmental monitoring and further documentation of places of cultural heritage significance.

Searches of local government, state and national heritage registers and lists found there are no registered non-Indigenous heritage sites located within the Project area. Archaeological surveys have identified seven non-Indigenous heritage sites. The majority of these sites appear to be associated with early exploration drilling for bauxite, extending back to the 1950s and 1960s. The sites include a disused airstrip, sawn log crossings of creeks and remnants of drilling camps, and all have low local significance. The Project area as a whole has been assessed as being of moderate local significance, based on both the social significance of the landscape to the local Indigenous people (being part of the original Weipa Aboriginal Reserve), and the historic significance of the area to non-Indigenous and Indigenous people alike. Some house stumps from a small satellite Aboriginal mission near Hey Point were located in the 1990s but could not be relocated during a recent survey. This area is not with the Project area.

Neither the identified non-Indigenous heritage sites, nor the Project area as a whole, are assessed as being of state or national significance, or as being of sufficient significance to warrant protection or the constraint or restriction of any proposed activities.

In the event that previously unidentified cultural heritage sites were located within the Project area during the course of mining activity, a six-step unanticipated discovery process would be implemented.

Visual Values

The Project area is predominantly a homogenous, relatively-flat bauxite plateau landform covered by 25 to 35m high Darwin Stringybark woodlands and is mostly undisturbed, apart from vehicle tracks and lines cleared for exploration drilling. Bauxite cliffs from 7 to 20m high occur along various parts of the coastline and form an aesthetically prominent landscape.

The Project area is situated in a remote location and is not easily accessible from surrounding communities. There are no gazetted public roads that traverse the Project area south of the Embley River and hence no viewpoints accessible from gazetted public roads. There are no permanent residences in the Project area and the nearest communities are located away from the main Project components. Major Project components (e.g. the proposed port) are not visible from Traditional Owner outstations; however they may be visible while travelling en route to these areas.

The primary viewpoint of the Project is from coastal and estuarine waters. The Gulf of Carpentaria waters adjoining the Project area, and estuaries within the Project area, are used by professional, recreational and tour-guided fishing groups. Although the proposed port infrastructure would be directly visible from vessels using Gulf of Carpentaria waters the visual impacts are anticipated to be low, owing to the height of the natural cliffs and vegetation and the transitory nature of visits to the area.

Visual impacts of the stockpile and plant areas, as well as topographic changes associated with mining, are considered to be low due the setback distance from the coastline, the retainment of vegetation buffers and the lack of visual receptors.

Waste Management

The major sources of waste from the Project are:

- green waste from clearing of vegetation ahead of mining;
- dredged material from port and barge/ferry terminals;
- tailings from the beneficiation plant;
- general waste such as food scraps, paper, plastic, rags, cans and glass;
- regulated waste such as hydrocarbon waste, detergents, solvents, batteries and tyres;
- scrap metal;
- sewage effluent and sludge;
- ballast water; and
- ship waste.

The adopted waste strategy incorporates the waste minimisation hierarchy and would ensure appropriate waste monitoring, tracking and reporting.

Consideration would be given to the selective extraction of structural grade timber prior to mining, where practicable and where the timber can be beneficially used. Green waste would be pushed into windrows and burnt.

Tailings would be stored in tailings storage facilities constructed on mined areas near the Boyd and Norman Creek beneficiation plants. Geochemical analysis indicates the tailings are not hazardous. The tailings storage facility design is based upon the *Guidelines on Tailings Dam Design, Construction and Operations* by the Australian National Committee on Large Dams.

Colour-coded and labelled bins and storage areas would be used to segregate and collect general waste, recyclables and regulated waste. General waste would be collected regularly and transported for disposal at the licensed Weipa Waste Management Facility at Evans Landing (also known as the Evans Landing landfill). Regulated waste would be removed from site for appropriate treatment and/or disposal by a licensed regulated waste contractor.

The sewage treatment plants (STPs) would be designed and operated to treat water to meet Class A Recycled Water quality, as defined in Schedule 3D of the *Public Health Regulation 2005* (Qld). Treated effluent would be recycled on-site for process water, dust suppression, landscape watering or other uses that are appropriate for the quality of water produced. Sewage sludge drying pits would be capped and remediated at the end of the Project life.

All vessels owned and contracted by Rio Tinto would manage ballast water through a Ballast Water Management Plan which would comply with the Australian mandatory requirements and the *International Convention for the Control and Management of Ships' Ballast Water and Sediments*. RTA would complete baseline monitoring followed by three-monthly mussel larval monitoring in the vicinity the new port when overseas ships are utilised.

Ships would not generate substantial volumes of wastes at the site as most ships visiting the proposed port would have onboard incinerators. Waste from Australian vessels would be managed with the site's operational waste management system. Cans, bottles, ash from the incinerator, and any other inert waste may be removed from an overseas ship following inspection by AQIS officers and then disposed of at Evans Landing landfill. Most ships visiting the proposed port would have onboard STPs. Ships' sewage would be managed in accordance with the *Transport Operations (Marine Pollution) Act 1995* (Qld) and *Regulation 1995* which regulates the discharge of sewage in coastal waters. Where required, facilities would be provided to allow sewage to be pumped out for treatment. Ships would either be required to retain any oil-contaminated slops and washings on board or facilities would be provided to remove and treat oil-contaminated water.

A Dredge Management Plan, which would be developed and approved as part of a sea dumping permit, would be implemented to manage spoil disposal from dredging operations associated with the construction of the port and ferry/barge terminals.

Transport

Road access to the Weipa area is currently by way of the Peninsula Developmental Road (PDR). The road network in the vicinity of the Project is largely undeveloped, with vehicle access restricted to minor vehicular tracks. Current road access to the site is from the PDR via Aurukun Road, Beagle Camp Access Road, Pera Head Access Road, and Amban Access Road. The PDR is largely unsealed. The unsealed sections can be rough and corrugated, and during the wet season, the road is prone to closure. Aurukun Road connects the township of Aurukun with the PDR. It is largely unsealed and is subject to the same safety hazards as the PDR. Between Napranum and Weipa, the PDR is also known as Kerr Point Road and John Evans Drive and is a sealed two lane road. It is the main thoroughfare for employees travelling from Weipa to work at RTA's East Weipa operations.

Prior to construction of the barge and ferry terminals and new Mine Access Road, the main access to the site, including deliveries of aggregate from the Archer River Quarry, would be from the Peninsula Developmental Road (PDR) via Aurukun Road, Beagle Camp Access Road, Pera Head Access Road, and the Amban Access Road,. The predicted impact on the PDR and Kennedy Highway during this time is negligible. However, increases in traffic volume are predicted for roads with lower background levels, including a predicted 23% increase for the Aurukun Road. While this increase may seem significant, in absolute terms the total daily traffic, including that generated by the Project, is considered to remain at very low levels.

Once the new barge/ferry terminals and Mine Access Road are established, primary access to the site would be via the proposed barge/ferry terminals on the Embley and Hey Rivers. Once construction is completed and production commences, there would be limited pavement impact on the Aurukun Road, the PDR, and Kennedy Highway as it is unlikely that heavy vehicles would be using roads external to the site.

The following roads would experience an increase in pavement impacts of more than 5% during some stages of the Project:

- the PDR between the Archer River Quarry and the Aurukun Road turnoff during the delivery of aggregate;
- the PDR between Weipa and the Aurukun Road turnoff prior to construction of the barge/ferry terminals and Mine Access Road;
- Kerr point Road and John Evans Drive prior to construction of the barge/ferry terminals and Mine Access Road, and during operations at 50Mdptpa; and
- Aurukun Road between the PDR and the Access Road turnoff during the construction phase.

RTA proposes that the intersections for entry to the Hornibrook ferry terminal and Humbug barge terminal be upgraded prior to the commencement of operations.

Materials would be brought in via the Aurukun Road only when the road is declared open by the Police and Department of Transport (i.e. not during wet season closures). Heavy vehicle usage along the PDR to Weipa would also largely occur only during the dry season. RTA would repair any damage caused by Project-related traffic on these roads.

Bauxite shipments would commence from the proposed port once the Boyd beneficiation plant is commissioned. The shipment of bauxite through the Port of Weipa would reduce when mining operations cease at East Weipa. Deliveries of cargo and fuel would continue to the Port of Weipa. The volume of cargo and fuel deliveries are expected to increase 20% during the construction phase and more than double at 50Mdptpa, compared to the current volume of deliveries for the existing Weipa operations.

The proposed mooring area for ships is in an area of the Northern Prawn Fishery utilised by the commercial trawlers. The area is also utilised for recreational fishing. Fishing vessels are permitted to operate within mooring areas. Only a small proportion of available fishing ground would be temporarily unavailable while vessels are anchored in the area.

The Project would not require changes to airport or rail infrastructure at Weipa.

Consultation

The following groups and individuals were identified as stakeholders in this Project and were provided with the opportunity to participate in the consultation process:

- Federal, state and local government agencies and services providers including the Weipa Town Authority (WTA);
- Non-government organisations and local community groups;
- Traditional Owners and other Aboriginal groups;
- Industry, local business and service providers operating throughout the Western Cape region;
- Recreational and professional fishing groups;
- General public and residents of local communities in Aurukun, Napranum, Weipa and Mapoon;
- Regional pastoral lease holders and managers; and
- RTA and local contractor employees based on the Western Cape.

The following consultation tools were used:

- Project DVD for use during, and as follow-up to, individual and group briefings and during public displays;
- Project newsletters and feedback forms;

- Free-call number answered in Brisbane by SoE Project staff;
- Direct stakeholder contact (including telephone calls and face-to-face meetings);
- A webpage on the Rio Tinto Alcan website which provided information on the Project;
- RTA employee communications;
- Public information sessions and displays; and
- Advertisements to solicit public comment on the Draft Terms of Reference for the EIS.

The feedback provided during the consultation process was considered in the Project's social impact assessment (SIA) and the key issues raised during the consultation were considered during Project planning and design.

Across all stakeholder groups the issues and opportunities of greatest significance were:

- traffic/transport on the proposed new access road to the Project;
- land and sea management;
- community consultation and engagement;
- employment, training and educational opportunities;
- breakdown in community cohesion;
- water supply dam construction;
- opportunities for business development; and
- workforce arrangements.

In addition, there are a number of other issues which, while not key issues for local stakeholder groups as identified during the consultation meetings, are issues of importance to indirectly affected stakeholders such as State and Commonwealth government departments and agencies. These other issues of relevance to government stakeholders are:

- demographic changes;
- economic impacts on the local economy;
- housing and property values; and
- cumulative impacts.

These concerns have been addressed in the relevant EIS sections.

The EIS consultation and engagement program will continue throughout the EIS process. Prior to the commencement of construction a comprehensive stakeholder engagement plan for ongoing consultation and engagement will be developed. Interaction with stakeholders who have already been consulted as part of the Project planning phase will continue over the remainder of the EIS process and throughout the construction and operational phases. The WCCCC SoE Sub-Committee and the WCCCC will continue to provide the consultative mechanism for ongoing consultation and engagement with Traditional Owners.

Social Impact Assessment

The local communities that could be affected by the Project include the Aurukun, Mapoon, Napranum and Weipa communities. Extensive community consultation was undertaken as part of this EIS and this information provided the basis for the SIA. Mitigation and management strategies were developed for all issues identified during the SIA consultation.

The most significant concerns expressed were regarding the Mine Access Road (Hey River barge/ferry terminal to the Boyd infrastructure area) and the location of the barge/ferry terminal on the Hey River. The majority of stakeholder groups consulted were concerned about the disadvantages of public access to the Mine Access Road including issues of safety, unauthorised access to traditional lands south of the Embley River, the increased potential for

illegal alcohol transportation, and potential for environmental damage. RTA proposes to restrict access to the barge, ferry and Mine Access Road to persons and vehicles entering the Project area for the purpose of authorised mine-related business. Security measures would be implemented at each terminal.

Daily access and transport from Aurukun to the Project area by road, boat and/or air was raised as an opportunity to improve employment and business opportunities for residents of Aurukun. RTA is committed to facilitate the provision of access and transport for Traditional Owners living in Aurukun and working in the mine. RTA would work with the WCCCC Employment and Training Sub-Committee to identify opportunities for training and employment for residents of Aurukun and ways to provide appropriate access to the mine site. Traditional Owners indicated they would like to see opportunities exist for residents of Aurukun to be employed during both construction and operational phases.

Access to areas on ML7024 and ML6024 with cultural heritage and recreational significance, the protection of coastal and riparian landscapes, and management of land and sea areas were raised by the majority of stakeholders and were considered a high priority. RTA would continue to manage access for Traditional Owners to specific areas, including the three outstations in the Project area at Amban (False Pera Head), Waterfall (near Ina Creek) and Six Ti-Tree (just south of Waterfall). Amban, Waterfall and Six Ti-Tree are generally utilised in the dry season for varying periods. Access would be managed in accordance with RTA's obligations outlined within the WCCCA. This would be monitored on a regular basis in line with the mine plan development, safety requirements during construction and operational phases, and the needs of Traditional Owners of the Project area. RTA would cause as little disturbance as possible to Traditional Owner access and would work collaboratively with Traditional Owners and the relevant WCCCC sub-committee to develop a land access strategy. The strategy would aim to provide access for Traditional Owners both during active and non-active mining periods for areas including Hey Point, Boyd Bay, Pera Head, Amban/Norman Creek and Waterfall/Six Ti-Tree/Ina Creek. RTA is committed to working with Traditional Owners, WCCT and other key stakeholders to establish a program to support caring for land and sea, including assistance with the development and implementation of a ranger program and a permit system for the Project area to protect significant cultural heritage sites and environmental values, and allow controlled access for recreational purposes to the Project area.

RTA remains committed to the existing obligations under the WCCCA with regard to land and coastal management. In response to the issues raised by Traditional Owners, RTA recognises and supports the need for the joint development of a comprehensive CHEMP for the area of the mining lease south of the Embley River. A CHEMP would provide the framework for RTA and Traditional Owners to work together to manage the community, heritage and environmental values of the area covered by the mining lease south of the Embley River in the context of the WCCCA. Such a plan would aim to address, but not be limited to, land access, fire, flora, and fauna, signage, weeds, environmental monitoring and further documentation of places of cultural heritage significance. To address issues related to sea access, RTA would designate a safe passage underneath the proposed jetty for small recreational and charter boat users to prevent the need to travel around the wharf and jetty, in accordance with Maritime Safety Queensland requirements. Access to moorings at Boyd Bay would not be restricted.

Almost all stakeholder groups requested additional information and/or follow-up meetings and indicated the need for ongoing consultation by the Project team during studies and the construction phase. A comprehensive plan for ongoing consultation and engagement would be developed prior to the commencement of construction. This would ensure continuity of engagement with key stakeholders, including Traditional Owners and Western Cape communities, and provide mechanisms to seek further information, provide feedback and raise concerns related to the Project.

Mining is the principal driver of the Weipa economy and the mining workforce is the principal driver of Weipa's population. Based on 2006 census data, mine-related employees and contractors constituted 43% of the total employed workforce in Weipa and about 29% of the town's population of 3,096.

Throughout the consultation process, employment and training was raised by almost all stakeholder groups as an opportunity for the people of the region arising from the Project. Employment was a key consideration for Traditional Owners in particular. RTA would continue to work with the local communities to invest in employment and training to create a locally-based labour pool with the appropriate skill sets and knowledge to meet the particular employment needs of the Project. RTA would continue initiatives targeting pre-work development, employment and training for local Indigenous people. As part of the Project RTA would:

- continue to actively participate as a member of the Regional Partnership Heads of Agreement (RPA) Steering Committee, WCCCC and Ely Coordinating Committee to develop and implement pre-employment and job-readiness programs to support local Indigenous employment across the Western Cape region;
- develop and implement culturally-appropriate recruitment practices for positions at all levels and across various disciplines within the operations;
- develop and implement programs and services to support the retention of Indigenous employees including mentoring and employee and family support strategies that aim to address the root causes of socio-economic disadvantage;
- develop and implement long-term career planning strategies, including professional development and leadership programs for local Indigenous employees;
- in collaboration with Traditional Owners, continue to deliver cross-cultural awareness programs for all employees and contractors, including curriculum with specific reference with Wik and Wik Way traditional culture and values;
- proactively consider tenders for Project contracts that involve local Indigenous people and/or local Indigenous enterprises. This may include joint ventures, direct employment, training opportunities, equipment usage or cooperative arrangements with local Indigenous people and enterprises; and
- provide a supportive career development pathway for local Indigenous people and youth, including traineeships and apprenticeships across a range of disciplines during the construction and operational phases of the Project.

RTA also proposes to address any potential skills shortages and labour impacts in the region by working collaboratively with various State and Commonwealth Government agencies, regional stakeholders (including TAFE and other training and education providers) and job network provider to build a locally based skilled labour pool for construction and operational phases of the Project.

Law and order and alcohol and substance abuse were key issues raised during consultation meetings with a range of stakeholders. A number of mitigation strategies would be implemented to address these issues. A range of control measures to restrict unauthorised access to the mining lease would be implemented. RTA would implement strict policies for employees and contractors in relation to fitness for work, including alcohol and other drugs, with strict pre-employment medical programs and an ongoing random drug and alcohol testing regime. RTA would also continue to support the implementation of alcohol management plans for each community, with inclusion of this information in employee and contractor induction programs. Strategies to ensure an effective response to incidents and to raise awareness of regional law and order and alcohol management initiatives would be developed in consultation with RTA, the Queensland Police Service and other government agencies.

There was concern expressed by both Indigenous and non-Indigenous stakeholders that the construction of dams would potentially have a negative impact on sensitive environmental areas, areas of cultural heritage significance, and recreational fishing. RTA would consult with Traditional Owners to explore ways for ongoing involvement in environmental monitoring, biological surveys and management of Dam C during operations, and ongoing consultation with Traditional Owners would be undertaken to investigate potential post-mining land uses associated with Dam C. To minimise effects on fish populations RTA proposes to design the

dam spillway to allow fish passage in times of overflow, and environmental releases would occur from the dam to ensure the timing of flow downstream matches natural timing. It is not expected that there would be a significant impact on the downstream environment.

Wik and Wik Way Traditional Owners, shire councils, local businesses and service providers expressed strongly their view that they wish to take advantage of potential business opportunities available through the Project. In order to continue supporting the development of Indigenous businesses in the Western Cape, particularly as it relates to the Project, RTA would:

- continue to work collaboratively with key regional stakeholders, including the WCCT, Western Cape Chamber of Commerce and the Regional Partnership Steering Committee to identify and support the ongoing development of Indigenous businesses through the region;
- examine applicable contracts for local and Indigenous business opportunities, including the breakdown of larger contracts into smaller jobs to increase the potential opportunities for awarding contracts to local providers of goods and services;
- work collaboratively with the WCCT and Traditional Owners to identify and pursue all social, commercial and economic development opportunities associated with the Project;
- provide updates to the WCCT on the status of Indigenous business spending across the Weipa operations in line with RTA's existing reporting requirements for employment and training; and
- in collaboration with key local and regional stakeholders, identify opportunities to support and implement a range of business development programs and support services.

RTA, through its membership of the Chamber of Commerce, would continue to monitor the impact of its activities on local businesses and work with businesses to address concerns, where possible. Local businesses would be provided with relevant information on future opportunities that arise from RTA's proposed development activities.

A number of stakeholders were concerned about the construction camp having a "wet" mess (i.e. serving alcohol) and that, unless the canteen is tightly regulated, the illegal transport of alcohol into communities with alcohol bans could escalate. There was also concern workers may leave the camp and access areas with environmental and cultural significance and potentially cause damage to these locations. The wet mess would be licensed for the responsible service of alcohol to camp occupants only. The consumption of alcohol would be regulated and confined to the wet mess and designated areas within the camp. Any activities outside the camp would be controlled via a permit system developed in collaboration with Traditional Owners in order to minimise any potentially adverse impacts on the places of environmental and cultural heritage significance.

The Project's construction workforce would be accommodated in an on-site camp and negligible effect on the local housing market is expected. The population projections indicate that when production commences at SoE, Weipa would have a population of 3,500, marginally smaller than populations in 2007–2008 (4,000). At a SoE production rate of 30Mdptpa, when Andoom production is likely to have ceased, the overall operational workforce would decrease because the SoE Project has thicker bauxite reserves and shorter average haul distances and hence higher labour productivity than Andoom. At a SoE production rate of 30Mdptpa the Weipa population is projected to be about 3,300, slightly higher than it was in 2006. Future demands on infrastructure and government services are expected to be no higher than in recent years.

At 50Mdptpa, the population of Weipa is projected to be approximately 400 above the peak of 2007–2008. Such a population rise would require development of more residential land and housing, industrial land, and provision of expanded government services. RTA would work with Weipa Town Authority (WTA) to develop additional subdivisions as required to allow for the

construction of additional houses. RTA would assist WTA with industrial lot developments if required.

Economic Environment

Based on the results of economic modelling, the potential range of annual economic impacts during the construction and operation phases is estimated to be:

Construction Phase (for 15Mdptpa production capacity)

- Direct employment averages more than 300 per annum over three years;
- Indirect employment of approximately 179 in the local area, 395 in the FNQ region, 632 state-wide and 705 nationally;
- Direct financial contribution of $264 million locally, $527.9 million in the FNQ region, $989.9 million in Queensland and $1,319.8 million nationally;
- Indirect financial contribution of $201.7 million locally, $612.2 million in the FNQ region, $1,829.3 million in Queensland and $2,828.2 million nationally.

Operations Phase – 15Mdptpa production scenario

- Direct employment (including contractors) of approximately 500 in local region;
- Indirect employment of approximately 390 locally, 788 in the FNQ region, 1,170 state-wide and 1,771 nationally;
- Direct annual financial contribution of $575 million across the local, regional, Queensland and national economies;
- Indirect annual financial contribution of $96 million locally, $182 million in the FNQ region, $257 million in Queensland and $423 million nationally.

In addition to direct employment, opportunities are likely to arise as a result of the Project supporting existing local businesses and providing opportunities for new business development. A number of indigenous and non-indigenous business development, training and employment opportunities and mitigation strategies relating to strategies for local participation were identified through the SIA.

RTA is a party to the Regional Partnership Heads of Agreement, which includes a statement of intent by the parties to improve opportunities for business development employment and training of Indigenous people in the Western Cape region. RTA would continue to fulfil these commitments and monitor and evaluate progress of the various projects and activities and their impact on the local social-economic environment.

The WCCCA provides a range of benefits, including employment and training, and RTA's current obligations under the WCCCA related to the Weipa operations would also apply to the Project.

The disruption to the local economy by the construction and operation of the Project is likely to be minimal. Operations at the Project are purely a continuation of the mining practices currently being undertaken, and should have a negligible impact.

There has been no cattle production/agriculture in the Project area for many years and, as such, there would be no direct impact on agricultural land uses within the Project area. No adverse impacts are expected on surrounding land uses.

Health and Safety

Health and safety risks associated with the SoE Project have been identified through the use of a preliminary Project hazard analysis and risk assessment, and controls identified to manage these risks. The control strategies address legislative and Australian Standard requirements where applicable.

The risk profile for the proposed facilities is generally "low" or "moderate".

RTA would implement the existing CLASSIC Health Safety and Environment (HSE) Management System for the Project and the existing MarineSafe system at the proposed port. Both systems incorporate occupational health and safety standards that are currently in use at all Rio Tinto operations, and provide the basis for effective management of employee and contractor health and safety.

Hazard and Risk

The Project would utilise a number of substances (e.g. fuel and oils) that are regulated by the Australian Code for the Transport of Dangerous Goods by Road and Rail and are considered hazardous. The storage, handling and use of these substances would be in accordance with current Australian Standards and industry codes of practice.

The RTA risk management system has been developed in accordance with the Australian Standard for Risk Management (AS/NZS 4360:2004). The preliminary Project HSE risk register was compiled by Rio Tinto to identify potential hazards, accidents, spillages and abnormal events occurring during the Project. There were 13 "high", 54 "moderate", and 11 "low" risk scenarios identified. There were no critical risks.

Further detail on the "high" risk scenarios has been incorporated into the relevant sections of the EIS, including proposed prevention or mitigation measures.

There are no sensitive receptors, such as kindergartens, schools, hospitals, aged care facilities, residences, or commercial places close to the mining, processing or port areas. As such, there are no hazards identified for the Project that could impact public health values in the short or long term.

The existing Weipa operations maintain and implement, as required, a detailed Business Resilience and Recovery (BRR) Plan. The BRR Plan would be updated to include the Project area and updated regularly throughout each stage of the Project.

Cyclones are one of the highest risks to the Project, due to the frequency of their occurrence in the Gulf area and their potential severity. RTA's current Cyclone Emergency Procedure, which aims to minimise personal injury and damage to property, would be adapted to include the SoE Project.

Cumulative Impacts

Cumulative impacts are impacts that arise from the interrelationship of residual Project impacts and impacts of the SoE Project in combination with other current proposed mining projects.

In March 2007 the State of Queensland entered into a development agreement with the Aluminium Corporation of China Limited (Chalco) to develop the Aurukun Bauxite Project. Chalco was granted mineral development licence MDL 378 located immediately to the east of RTA's ML7024 (refer **Figure A**). A bauxite mine producing 6.5Mdptpa was proposed, with product to be transported by conveyor across ML 7024 for shipment from a new port located close to Boyd Point. The proponent proposed to accommodate a fly-in fly-out workforce on-site. In June 2010 the Queensland government announced that the development agreement had come to an end and there is currently uncertainty about the future development of the Aurukun Bauxite Project.

RTA liaised with Chalco during the planning phase for their proposed project to discuss any potential for co-location and/or sharing of certain infrastructure. Where possible, and subject to commercial agreement, RTA will seek to minimise environmental and property impacts in the

event that the Aurukun lease is developed in the future. Some impacts could potentially be mitigated by the following:

- establishment of a common infrastructure corridor for RTA's water pipeline, transmission line and overland conveyor (from the Norman Creek plant) and the Aurukun Bauxite Project's overland conveyor to the port; and
- co-location of port and stockpile facilities.

Cape Alumina Pty Ltd holds two Exploration Permit – Minerals (EPMs) over the Pisolite Hills resource area (EPM 14547 and EPM 15278 situated 50km north-east of Weipa), with an additional EPM to cover a barge loading facility (EPM 15984) (refer **Figure A**). The Pisolite Hills Project as originally proposed in 2008 would have nominally produced approximately five to seven Mdptpa of bauxite for 10 to 15 years. Product would have been trucked across ML 7024 to a barge-loading facility on the coast. RTA does not currently conduct mining activity or have infrastructure in the vicinity of the proposed haul road. A fly-in fly-out workforce was proposed, with accommodation to be provided in a camp on-site. In July 2010 Cape Alumina announced that the proposed Pisolite Hills Project was no longer viable due to the declaration of the Wenlock River Basin as a Wild River area.

Oresome Australia Pty Ltd is the proponent for the Urquhart Point Mineral Sands Project. The proposed project area is within mining lease application MLA 20669, north west of the SoE Project's Hey Point mining area (refer **Figure A**). The Urquhart Point Mineral Sands Project is located outside of the catchments affected by the SoE Project area. The proposed project would involve excavating sand ridges using slot mining, processing 700,000 to 800,000t of sand per annum to produce heavy mineral sands, and shipping approximately 50,000t of heavy mineral sands product per annum. The project life would be four to six years with a target commencement date of 2012.

There is potential for cumulative impacts to arise from residual impacts of the SoE Project in combination with impacts of other current possible future mining projects, in relation to surface water, groundwater, marine ecosystems, flora, aquatic ecosystems, roads, shipping and social impacts.

The proposed 6.5Mdptpa Aurukun Bauxite Project is within the catchment of the Ward River estuary. While there are uncertainties as to whether this project would proceed, the operation of both projects simultaneously could give rise to a cumulative impact on Ward River flows and catchment hydrology in the Ward River catchment. If the Aurukun Bauxite Project surface water demands were met from a dam on a tributary of the Ward River, the cumulative overall decline in mean annual discharge to the Ward River estuary would be very minor (<1%) and well within natural seasonal variation. Also, mining disturbance in the Ward River catchment would have a very minor change on the annual discharge from the overall Ward system (-0.6% at maximum mining impact; -1.2% post-closure).

Given the proposed mitigation strategies, in particular the environmental buffer system, there are unlikely to be significant cumulative impacts on aquatic ecosystems from impacts on catchment hydrology and river flows in the Ward River catchment.

Cumulative impacts on surface water quality in the lower Ward River system arising from activities associated with the Aurukun Bauxite Project and the SoE Project occurring simultaneously are expected to be low.

Abstraction of groundwater from the Gilbert River Formation and Garraway Beds artesian aquifers is to be investigated as a potential water supply source for the Aurukun Bauxite Project, which has the potential to cause cumulative impact on artesian aquifers in the region. Modelling results for the SoE Project indicate that abstraction rates could be increased by nearly 6GL above the proposed abstraction rate and still comply with RTA's current Water Licence conditions in relation to maximum relative drawdown.

The area of Darwin Stringybark (RE 3.5.2) that would be cleared by the Pisolite Hills Project and the Aurukun Bauxite Project is not publicly available but has been estimated. If all existing and proposed projects were fully developed, the subregional extent of RE 3.5.2 would be reduced to

approximately 89% of its former known distribution. The total clearing would not cause RE 3.5.2 to become regarded as "of concern" or "endangered" under the *Vegetation Management Act 1999*.

The reduction in spatial extent of non-Darwin Stringybark vegetation types within the Project area and the subsequent impacts on threatened flora occurring within these vegetation types, as a component of a possible larger cumulative reduction across the Cape York Bioregion (from other possible future projects), is anticipated to be minimal.

The PDR and a part of the Aurukun Road may receive a cumulative impact from both the SoE Project and the Aurukun Bauxite Project, if the Aurukun Bauxite Project were to proceed and both projects were to operate simultaneously. However, this is likely to occur only if the Aurukun Bauxite Project is in the construction or operational phase during the initial construction phase of the SoE Project. Cumulative impacts would be mitigated through repair or upgrade of the relevant part of the Aurukun Road.

If the Aurukun Bauxite Project constructed and operated an additional port facility near the proposed SoE Project port, the operation of two ports may result in cumulative impacts in terms of bulk carrier interactions and vessel interactions with commercial and recreational fishing vessels. The construction and operation of two ports may also have potential cumulative impacts on corals at Boyd Point, marine turtle nesting and the off-shore marine environment (depending on where the Aurukun Bauxite Project dredged spoil was disposed). Capacity may be provided at the SoE Project port for third parties, following agreement on suitable commercial terms. Such an arrangement would simplify the management of vessel movements compared to operating two ports and reduce cumulative impacts.

One matter raised consistently by stakeholders, in relation to cumulative impacts that would arise should more than one project proceed, was concern about the potential for the establishment of a road connection between the Project's Mine Access Road and the Aurukun Bauxite Project, thus facilitating the transport of illegal alcohol. A small number of stakeholders identified this as an opportunity for residents in Aurukun to obtain easier access to Weipa-based goods and services. There are also significant non-Project related cumulative impacts associated with current government services and programs currently being implemented in Aurukun. RTA would, by liaising with any other adjacent project proponents, endeavour to identify cumulative impacts and opportunities associated with employment, training and business development for the local communities. RTA would also seek to co-ordinate its' programs with others, including government programs and services currently being implemented in the region, and, where appropriate, would partner with the relevant Government agencies.

Environmental Management and Monitoring

Environmental protection commitments and proposed environmental authority conditions have been included in the relevant sections of the Environmental Management Plan (EM Plan).

The environmental monitoring for the SoE Project would include air quality, stream flow, surface water and groundwater quality, groundwater levels, noise, rehabilitation success, erosion, weeds, waste volume and type, sewage treatment plant water quality, community complaint records and cultural heritage assessments. The EM Plan outlines the Project's environmental monitoring program including monitoring sites, parameters and their frequency of measurement, and monitoring procedures and records.

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Environmental Impact Statement

for South of Embley Project

Section 1
Introduction

1 INTRODUCTION

RTA Weipa Pty Ltd (RTA) and its parent company Rio Tinto Aluminium Limited (formerly named Comalco Aluminium Limited) have collectively mined and shipped bauxite from the existing Weipa operation since 1963. Weipa is located on the western side of Cape York on the Gulf of Carpentaria in northern Queensland, approximately 600km north-west of Cairns (refer **Figure 1-1**). RTA holds mining lease (ML) 7024 (granted 1 January 1958) pursuant to the *Commonwealth Aluminium Corporation Limited Agreement Act 1957* (Qld) (Comalco Agreement Act), a Queensland "Special Agreement Act" and ML6024 (granted 25 July 1985) pursuant to the Comalco Agreement Act and *Mineral Resources Act 1989* (Qld).

RTA is currently mining the East Weipa and Andoom deposits located on ML7024 north of the Embley River. RTA is also mining from the adjacent Ely bauxite deposit (on ML7031) held by Alcan South Pacific Pty Ltd (acquired by Rio Tinto in 2007) under an agreement. Mined bauxite is trucked to one of two beneficiation plants located at Lorim Point and Andoom, respectively. Product bauxite is railed from Andoom to Lorim Point and conveyed to RTA's stockpiles prior to shipment from the Port of Weipa (refer **Figure 1-2**).

The northern bauxite reserves are gradually depleting, and with continuing demand for bauxite RTA has undertaken extensive drilling programs on ML7024. Significant bauxite reserves have been identified on the portion of ML7024 that lies south of the Embley River which could sustain a mining operation for about 40 years, depending on annual production rate.

Due to the Embley River estuary, development of the reserves south of the Embley River poses logistical challenges to the continued use of existing Weipa infrastructure. The proposed Project, referred to as the South of Embley (SoE) Project (or "the Project"), consists of the construction and operation of a bauxite mine and associated processing facilities, barge and ferry terminals and a port. The Project involves a staged increase in production up to 50 million dry product tonnes per annum (Mdptpa). The initial installed capacity is subject to ongoing feasibility studies but is likely to be either 15Mdptpa or 22.5Mdptpa. Actual production rates and the timing and size of capacity expansions would depend on market conditions.

This Environmental Impact Statement (EIS) has been prepared to identify potential environmental and social issues associated with the Project and set out proposed management measures.

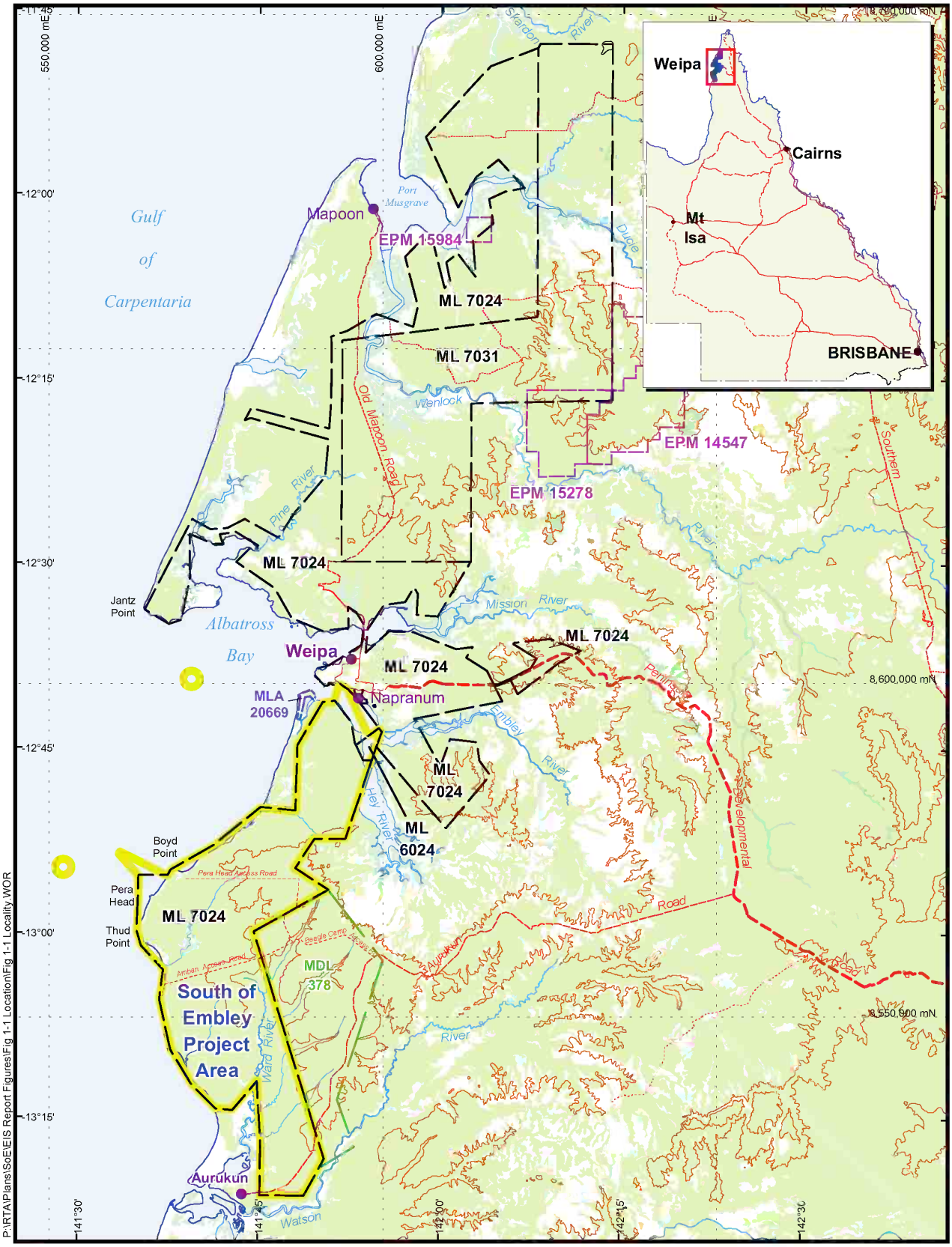
1.1 Project Proponent

The Project would be developed and operated by RTA Weipa Pty Ltd, which is a wholly-owned subsidiary of Rio Tinto Aluminium Limited. Both companies are in the Rio Tinto Alcan product group. Rio Tinto Alcan is one of five product groups operated by the global mining group, Rio Tinto. Rio Tinto Alcan supplies bauxite, alumina and primary aluminium to Australia, New Zealand and export markets. About 37% of Australia's total production of bauxite, 36% of its alumina and 40% of its primary aluminium is produced by Rio Tinto Alcan.

Rio Tinto Alcan's Australian head office for bauxite and alumina is based in Brisbane. Bauxite and alumina interests in Queensland include the existing Weipa mine and the Yarwun and Queensland Alumina Limited alumina refineries in Gladstone. In Queensland, Rio Tinto Alcan also operates the Boyne Smelters Limited aluminium smelter in Gladstone.

RTA Weipa Pty Ltd was registered under the *Corporations Act 2001* (Cth) in 2009 and the bauxite mining assets within ML 7024 and ML 6024 and some ancillary assets were transferred to RTA Weipa Pty Ltd from Rio Tinto Aluminium Limited effective 1 March 2011. The restructure is to replicate the position which exists through the vast majority of the Rio Tinto group (and resources companies generally) where, to provide for corporate and financial flexibility, separate operations are generally held in a special purpose vehicle.

A record of responsible environmental management has been exhibited during more than 40 years of mining bauxite in the Weipa region. Whilst improvement of environmental performance



P:\RTA\Plans\SoE\EIS Report Figures\Fig 1-1 Location\Fig 1-1 Locality.WOR

RTA Mining Lease boundary
South of Embley Project Area
Oresome Australia Pty Ltd Mineral Sands Project
Chalco Aurukun Bauxite Project
Cape Alumina Pty Ltd's Pisolite Hills Project
Township
Drainage
Road/track
50m Topographic contour

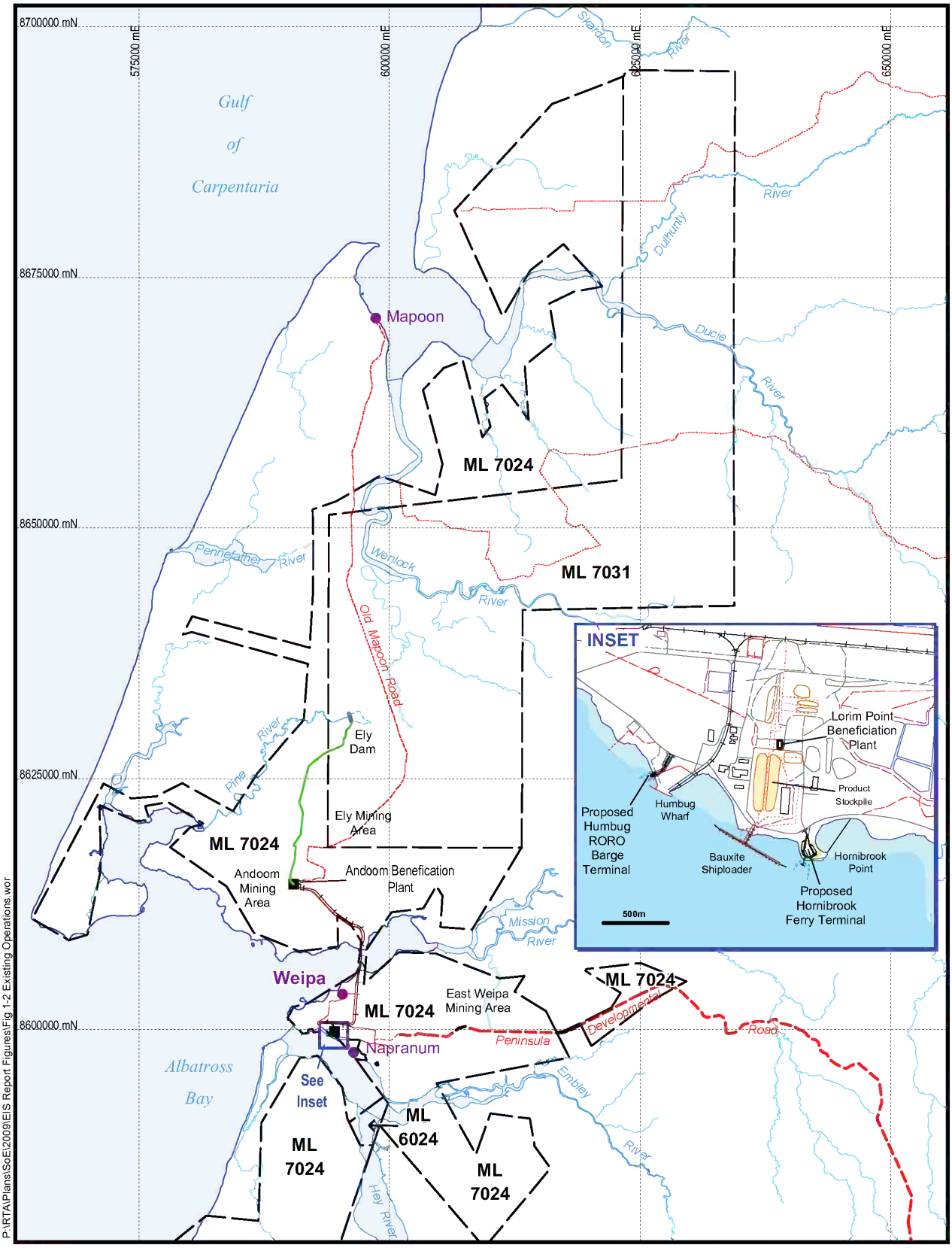
South of Embley Project

Fig. 1-1: Locality Map

N

10 0 10km

Datum/Projection: GDA94/MGA Zone 54 Date: 09/06/2011



P:\RTA\Plans\SoE\2009\EIS Report Figures\Fig 1-2 Existing Operations.wor

RTA Mining Lease boundary
Township
Drainage
Road/track
Product Bauxite Rail Line
Water Supply Pipeline
Beneficiation Plant

Rio Tinto Alcan

South of Embley Project

Fig. 1-2: Existing Facilities North of the Embley River

N

10 0 10km

Datum/Projection: GDA94/MGA Zone 54 Date: 06/12/2009

and outcomes continues, due enquiry indicates that RTA Weipa Pty Ltd, Rio Tinto Aluminium Limited and their Executive Officers have not been the subject of any proceedings under a Commonwealth or State law for the protection of the environment.

RTA has a Health, Safety and Environment Policy that includes commitments to minimise environmental impact and continually monitor and improve the way the company works (refer **Appendix 1A**). As described in **Section 1.9.6**, mining and mining-related activities on ML7024 at Weipa have transitional authorisation under section 616B of the *Environmental Protection Act 1994* (Qld) (EP Act) relating to "Special Agreement Act" mines. RTA has commenced the process to transition to an environmental authority (mining activities) (EA) under the EP Act with respect to ML7024 and ML6024, by way of an application and Environmental Management Plan submitted in February 2010. The grant of application of the EA is pending, however it is anticipated that the conditions are likely to require the current RTA Weipa operations to prepare or significantly revise and submit the following management plans as a minimum:

- Land Use Management Plan;
- Rehabilitation Management Plan;
- Erosion and Sediment Control Plan;
- Water Management Plan; and
- Waste Management Plan.

Following the Coordinator General's assessment of the SoE Project EIS, an application would be made to amend the EA in respect to any requirements particular to the SoE Project, such that the Department of Environment and Resource Management (DERM) may issue the required amended EA under the EP Act for operations on ML7024 and ML6024. Subsequently, the required management plans would be either reviewed to ensure adequacy for the SoE Project or new management plans developed and implemented for the SoE Project, incorporating any relevant conditions of consent.

The primary contact for the Project is detailed below:

Manager—South of Embley Project
Rio Tinto Aluminium Limited
GPO Box 153, Brisbane Qld 4001
Telephone 1800 308 938 (freecall)
Facsimile + 61 7 3328 6990
Email external.affairs@riotinto.com

1.2 Project Description

The Project involves the construction and operation of a bauxite mine and associated processing and port facilities to be located near Boyd Point on the western side of Cape York Peninsula. Boyd Point is approximately 40km south-west of Weipa and 40km north of Aurukun, with the closest mining areas being 4km from Napranum, 15km from Aurukun, and 50km from the nearest cattle station homesteads. The Project area would be predominantly located on a portion of ML7024 south of the Embley River, on ML6024, on certain Strategic Port Land within the Port of Weipa, and offshore dredging and disposal areas (refer **Figure 1-1**).

The Project consists of the following components:

- **bauxite mining** – involving the clearing, salvage of topsoil, stripping of overburden, extraction of up to 50Mdptpa of bauxite, replacement of topsoil and revegetation. Mined areas would be progressively rehabilitated. Refer to **Section 2.4** for a detailed description;
- **bauxite processing** – crude bauxite would be transported using a network of internal haul roads to one of two beneficiation plants (Boyd beneficiation plant, followed by a second plant at Norman Creek). A beneficiation plant separates the bauxite and waste materials through screening, crushing, washing and dewatering. Chemicals are not

used in the process, only water. Fine waste materials would be discharged to tailings storage facilities. Refer to **Section 2.5** for a detailed description;

- **product bauxite stockpiles** – product stockpiles and a stacker-reclaimer would be established adjacent to the port facilities (refer to **Section 2.5.3**);

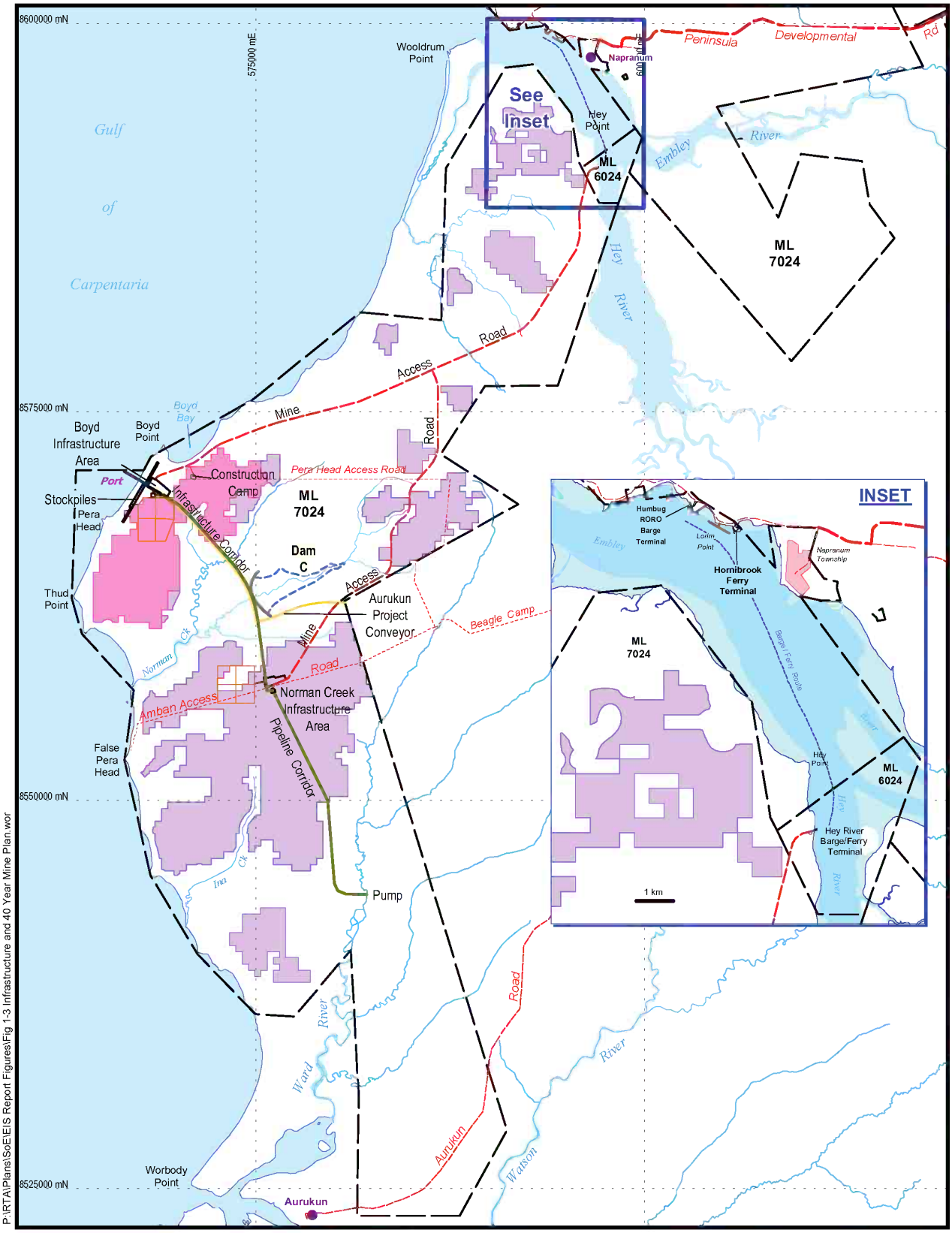
- **port and ship-loading facilities** – involving the construction and operation of a new port, ship-loading and tug mooring facilities between Boyd Point and Pera Head. Works would include a jetty, berths, ship-loader and dredging of berth pockets and departure areas. Protected moorings for tugs to use during inclement weather would also be constructed alongside the existing Lorim Point east wharf. The initial phase of the new port would have a capacity of 30Mdptpa, increasing to a maximum design capacity of 63Mdptpa when demand requires. The design capacity allows for third parties following agreement on suitable commercial terms. The construction of these facilities will result in the disposal of approximately 6,500,000m^3 of dredged material to sea for the initial phase of the port. Refer to **Section 2.6** for a detailed description;
- **ancillary infrastructure** – involving the construction and operation of a diesel-fuelled power station, workshops, warehouse, administration facilities, package sewage treatment plant, general waste disposal and diesel storage facilities. Refer to **Section 2.7** for a detailed description;
- **water infrastructure** – involving the construction of a water supply dam on a freshwater tributary of Norman Creek (Dam C), with the later construction of a water pumping station on the Ward River, plus pipelines and up to 12 artesian bores. Refer to **Section 2.7.3** for a detailed description;
- **temporary on-site camp for the construction phase** – involving the construction of a facility with up to 630 beds. The existing Evans Landing camp (located on ML7024) would also be used during the construction phase as required. During the operations phase employees would be housed in the existing Weipa community and commute to site on a daily basis via ferry and a new mine access road. Refer to **Section 2.7.1** for a detailed description; and
- **barge and ferry facilities** – involving the construction and operation of a new ferry terminal at Hornibrook Point, a roll on/roll off (RORO) barge facility at Humbug Wharf, and a new barge/ferry terminal on the western bank of the Hey River. These would be used to transport workforce, materials and equipment between Weipa and the Project. Dredged material derived from the construction of these facilities would also be disposed at sea. Refer to **Section 2.7.2** for a detailed description.

The main infrastructure components are illustrated in **Figure 1-3** and **Figure 1-4** and a detailed project description is set out in **Section 2**. The land parcels and tenure within the Project area, including Strategic Port Land, are summarised in **Table 2-1** and shown in **Figure 2-1**.

1.3 Project Rationale

RTA plans to develop a new bauxite mine capable of producing up to 50Mdptpa along an incremental expansion pathway. The EIS has been prepared to assess the impacts of several different levels of production along this pathway: a minimum rate of 15Mdptpa, a maximum rate of 50Mdptpa, and a nominal intermediate rate of 30Mdptpa. However, the actual rates and the timing of production increases are subject to market conditions. The initial production rate is subject to ongoing feasibility studies but is likely to be either 15Mdptpa or 22.5Mdptpa.

The initial phase of mining operations would involve production to substitute depleted East Weipa economic reserves as well as developing third party markets. Production capacity would expand to replace Andoom production once those economic reserves are depleted. Production capacity would thereafter be expanded to 50Mdptpa when market conditions are suitable. The



P:\RTA\Plans\SoE\EIS Report Figures\Fig 1-3 Infrastructure and 40 Year Mine Plan.wor

RTA Mining Lease boundary
Township
Road/track
Freshwater dam
Tailings storage facility
Barge / Ferry route
Mining Years 1 -13
Mining Years 14 - 40

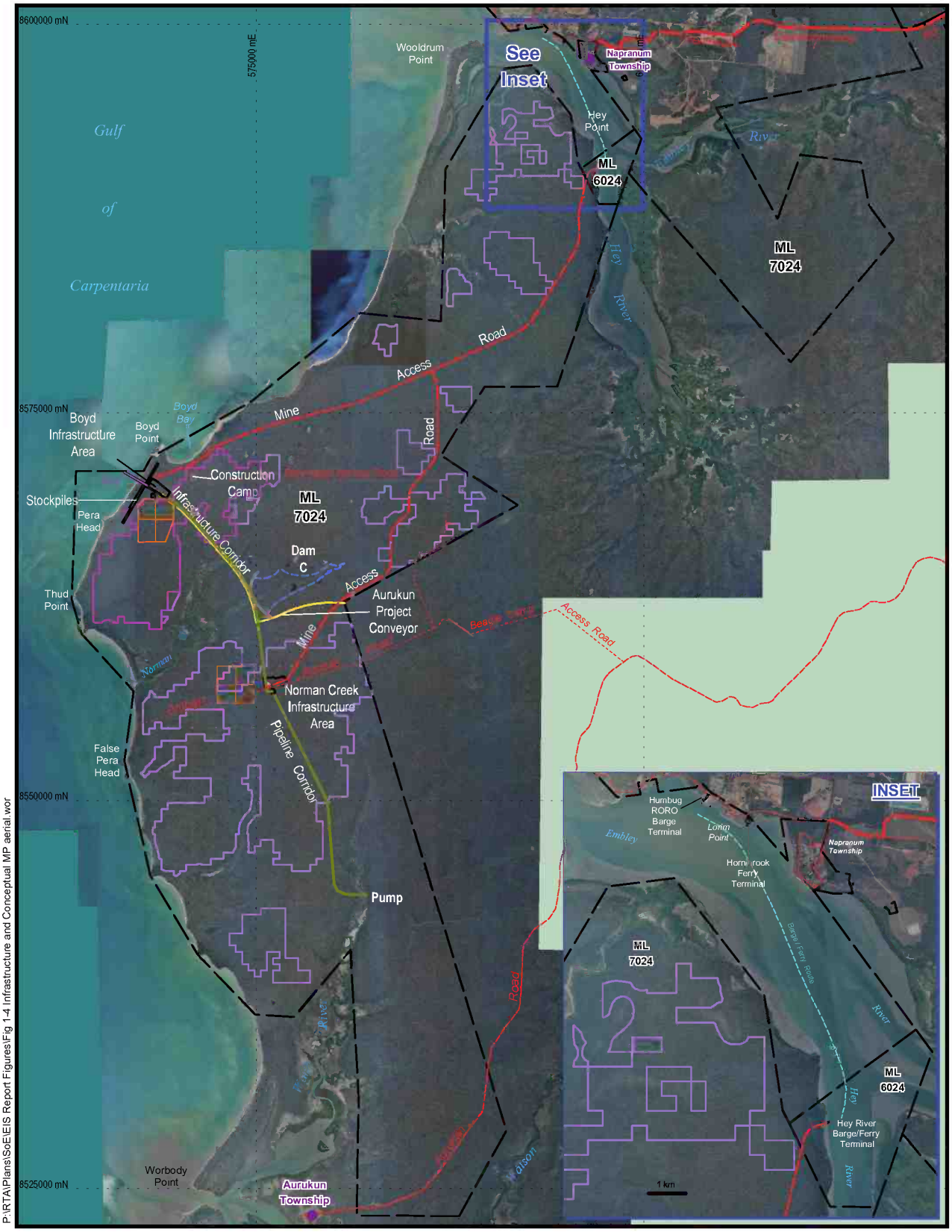
South of Embley Project

Fig. 1-3: Infrastructure and Conceptual 40 Year Mine Plan

N

5 0 5km

Datum/Projection: GDA94/MGA Zone 54 Date: 17/02/2011



P:\RTA\Plans\SoE\EIS Report Figures\Fig 1-4 Infrastructure and Conceptual MP aerial.wor

RTA Mining Lease boundary
Township
Road/track
Freshwater dam
Tailings storage facility
Barge / Ferry route
Mining Years 1 -13
Mining Years 14 - 40

South of Embley Project

Fig. 1-4: Infrastructure and Conceptual Mine Plan (Aerial Photo)

N

5 0 5km

Datum/Projection: GDA94/MGA Zone 54 Date: 17/02/2011

Project has bauxite reserves capable of sustaining a mine life of approximately 40 years, depending on annual production rate. The indicative production schedule used in the EIS is presented in Table 1-1, however, it should be noted that the timing and size of production increases are subject to market conditions.

Table 1-1 Indicative Production Scenario for EIS

	SoE Production					
	Construction			Minimum rate	Intermediate rate	Maximum rate
Mining Centre / Year*	-1#	-2	-3	1-13	14+	Subject to market
East Weipa (production)	✓			x	x	x
Andoom (production)	✓			✓	x	x
SoE (Mdptpa)	x			15	30	50

* Years and production rates are nominal and subject to change due to market conditions, construction timetables and available economic reserves.

Nominal start date for construction in early 2012, subject to receipt of relevant environmental approvals and Rio Tinto's internal project approvals.

The key objectives of the Project are to:

- extend the life of RTA's mining operations in Weipa beyond depletion of East Weipa and Andoom reserves;
- maintain continuity of bauxite supply to Gladstone refineries and third parties;
- enable increased bauxite production in the Weipa region in response to the rising world demand for this product and to enhance RTA's competitiveness as a bauxite producer;
- continue mining-related employment in the Western Cape region;
- maintain Weipa as the main residential and commercial support base for the Project;
- operate the mine in a manner that has an acceptable impact on surrounding communities and the environment;
- develop and operate the Project in compliance with all relevant statutory requirements; and
- continue to maintain an open and honest relationship with stakeholders.

Extensive resource definition investigations and environmental surveys have taken place in the Project area. It is anticipated that construction would commence in early 2012, following receipt of relevant environmental approvals and Rio Tinto's internal project approvals. The initial construction phase is expected to take approximately three years. The estimated capital cost to establish 15Mdptpa capacity would be approximately $1,450 million. The final cost is subject to completion of feasibility studies.

1.4 Relationship to Other Projects

In March 2007 the State of Queensland entered into a development agreement with the Aluminium Corporation of China Limited (Chalco) to develop the Aurukun Bauxite Project. Chalco was granted mineral development licence (MDL) 378 located immediately to the east of RTA's ML7024 (refer **Figure 1-1**). A bauxite mine producing 6.5Mdptpa was proposed, with product transported by conveyor across ML7024 for shipment from a new port located close to Boyd Point. The proponent proposed to accommodate a fly-in fly-out workforce on-site. In June 2010 the Queensland Government announced that the development agreement had come to an end and there is currently some uncertainty about the future development of the Aurukun Bauxite Project.

RTA liaised with Chalco during the planning phase for their proposed project to discuss any potential for co-location and/or sharing of certain infrastructure. Where possible, and subject to commercial agreement, RTA will seek to minimise environmental and property impacts in the event that the Aurukun lease is developed in the future. Some impacts could potentially be mitigated by the following:

- establishment of a common infrastructure corridor for RTA's water pipeline, transmission line and overland conveyor (from the Norman Creek plant) and the Aurukun Project's overland conveyor to the port (refer **Figure 1-3**); and
- co-location of port and stockpile facilities.

The SoE Project's water supply and power supply are designed to be independent of any other project.

Cape Alumina Pty Ltd holds two granted Exploration Permit – Minerals (EPMs) over the Pisolite Hills resource area (EPM14547 and EPM15278 situated 50km north-east of Weipa), with an additional EPM to cover a barge loading facility (EPM15984) (refer **Figure 1-1**). The Pisolite Hills project as originally proposed in 2008 would have nominally produced five to seven Mdptpa of bauxite for 10 to 15 years. Product would have been trucked across ML7024 to a barge-loading facility on the coast. RTA does not currently have mining activity or infrastructure in the vicinity of the proposed haul road. A fly-in fly-out workforce was proposed, with accommodation to be provided in a camp on-site. In July 2010 Cape Alumina announced the proposed Pisolite Hills project was no longer viable due to the declaration of the Wenlock River Basin as a Wild River area.

The potential cumulative impact from bauxite mining of clearing of regional ecosystems is assessed in **Section 7.9.1**. The potential cumulative impact from water supply infrastructure and potential cumulative impacts to catchment hydrology from bauxite mining is assessed in **Section 5.2.3** and **Section 5.2.4** respectively.

The Project is not expected to give rise to any consequential impacts that require assessment under the *Environmental Protection and Biodiversity Conservation Act 1999* (Cwlth) (EPBC Act).

1.5 Socio-economic Costs and Benefits

The Project is located in the Western Cape Region, which includes the Aurukun, Mapoon, Napranum and Weipa communities. Extensive community consultation was undertaken as part of this EIS and this information provided the basis for the social impact assessment.

Mining is the principal driver of the Weipa economy and the mining workforce is the principal driver of Weipa's population. Based on 2006 census data mine-related employees and contractors constituted 43% of the total employed workforce in Weipa and about 29% of the town's population of 3,096.

The Project's construction workforce would be accommodated in an on-site camp and negligible affects on the local housing market are expected (refer **Section 17.4.9**).

At a Project production rate of 15Mdptpa, RTA's overall workforce (including Andoom) would be marginally smaller than in 2007–2008 and Weipa would have a population of about 3,500, down from just over 4,000 reached in 2007–2008 (refer **Section 16.2.1**). At a production rate of 30Mdptpa, the overall workforce would reduce slightly (due to greater productivity in SoE operations compared to Andoom operations) and Weipa's population is projected to be about 3,330. Future demands on infrastructure and government services are expected to be no higher than in recent years.

SoE mine production would be capable of increasing above 50Mdptpa when market conditions are suitable. Under the 50Mdptpa production scenario, the population of Weipa is projected to be approximately 400 above the peak of 2007–2008. Such a population rise would require development of more residential land and housing, and provision of expanded government services.

The area south of the Embley River is primarily the traditional lands of the Wik and Wik Way people. RTA's existing operations are relatively remote from this area and from Aurukun, the nearest community. The Project would bring development activities much closer to the Traditional Owners and their country. RTA would continue to work with Traditional Owners to facilitate access to country, subject to mine safety requirements. RTA would also continue existing employment, training and business development programs and tailor them to the needs of the Project and community. The potential social impacts of the Project, both adverse and beneficial, and proposed mitigation measures are discussed in **Section 16.**

The economic impacts of the Project are evaluated in **Section 17** and summarised below:

Construction Phase (for 15Mdptpa production capacity)

- Direct employment averages more than 300 people per annum over three years;
- Indirect employment of approximately 179 people in the local area, 395 people in the Far North Queensland (FNQ) region, 632 people state-wide and 705 people nationally;
- Direct financial contribution of $264 million locally, $527.9 million in the FNQ region, $989.9 million in Queensland and $1,319.8 million nationally;
- Indirect financial contribution of $201.7 million locally, $612.2 million in the FNQ region, $1,829.3 million in Queensland and $2,828.2 million nationally.

Operations Phase – 15Mdpta production scenario

- Direct employment (including contractors) of approximately 500 people in local region;
- Indirect employment of approximately 390 people locally, 788 people in the FNQ region, 1,170 people state-wide and 1,771 people nationally;
- Direct annual financial contribution of $575 million across the local, regional, Queensland and national economies;
- Indirect annual financial contribution of $96 million locally, $182 million in the FNQ region, $257 million in Queensland and $423 million nationally.

1.6 Project Alternatives

RTA has been undertaking studies to optimise the Project design. A number of options have been considered, including:

- beneficiation plant location;
- port and stockpile location;
- workforce housing;
- barge and ferry terminal locations;
- power supply;
- beneficiation plant technology
- water demand management;
- water supply;
- initial tailings storage facility establishment; and
- disposal of dredged material.

The option of not proceeding with the Project is not financially feasible as the bauxite reserves will be depleted in RTA's current mining areas leading to the progressive closure of the Weipa mine. Without an alternative source, the Gladstone alumina refineries will lose a viable, ongoing source of bauxite and the town of Weipa will lose a major financial contributor.

The Project is not sterilising other resource opportunities nor displacing existing agricultural or forestry enterprises. **Section 3.7.1** discusses pre-mine land use suitability.

The alternatives considered for major project components are described below.

1.6.1 Beneficiation Plant Location

The continued use of the Lorim Point beneficiation plant (refer Figure 1-2) to process ore mined from the SoE orebodies was evaluated. This option would require the crude ore to be transported on average more than 50km by conveyor or rail to the existing Lorim Point beneficiation plant, including over a 3.5km bridge spanning the Embley River estuary. Irrespective of the transport method selected, the cost of this system, including bridging the Embley River, proved to be cost prohibitive.

1.6.2 Port and Stockpile Location

The port and stockpile alternatives evaluated were:

- use of existing facilities at Lorim Point (northern bank of Embley River, refer **Figure 1-2**); and
- establishment of a new port between Boyd Point and Pera Head (refer **Figure 1-3**).

The use of the existing Lorim Point stockpiles and ship-loader would require all crude ore or product bauxite to be transported on average more than 50km by conveyor or rail to the existing Lorim Point beneficiation plant, over a 3.5km bridge spanning the Embley River estuary.

Irrespective of the transport method selected, or whether the ore was beneficiated at a new SoE-located plant or the existing Lorim Point plant, the cost of this approach (including bridging the Embley River) proved to be cost prohibitive. It should be noted that the new port has been designed to accommodate vessels of up to 185,000 deadweight tonnage (dwt). Dredging of berth pockets and departure areas and sea disposal of dredge material would be required to accommodate these vessels at the new port. The existing Port of Weipa facilities are limited to smaller ships up to 255m in length, 12.3m draft, and 85,000dwt (PCQ 2010). If the existing port were to be upgraded to accommodate the larger vessels, then dredging in the Embley estuary and subsequent disposal of dredged material would also be required.

The proposed new port would be much closer to the centroid of bauxite reserves (refer **Figure 1-3**) and hence would reduce energy usage as it minimises the overall land transportation distance of crude ore and product.

The location of the proposed Port between Pera Head and Boyd point has the closest access to deep water along the coastline south of the Embley River and therefore minimises the required dredge volume.

Two port vessel capacity options were evaluated – a port capable of accepting bulk carrier vessels up to: (a) 185,000dwt and 18.1m draft; and (b) 90,000 dwt and 12.8m draft. The larger vessel capacity option has been selected in order to maximise access to markets. For the purposes of evaluation studies, it has conservatively been assumed that vessel departures are unrestricted by tides and hence the depth of dredging required has been matched to this assumption.

The 185,000dwt vessel option, compared to the smaller vessel option, would require an increased dredge footprint (1,460,062m^2 compared to 135,000m^2), dredge depth, dredge volume (6,500,000m^3 compared to 250,000m^3) and dredging duration. The 185,000dwt vessel option would be likely to have the potential for greater impact on threatened and migratory marine fauna and the Commonwealth marine environment, as a result of the increased dredging. However, the use of larger vessels means that there would be fewer vessel movements during operations and more energy efficient transport of ore (i.e. less diesel used and emissions of greenhouse gases by ships). Neither vessel option would be likely to have a significant impact on threatened and migratory marine fauna and the Commonwealth marine environment.

1.6.3 Workforce Housing

The alternatives evaluated for the operation's workforce accommodation were:

- use existing residences in Weipa/Napranum (refer **Figure 1-2**) and commute daily to the Project site; and
- establish new workforce-only accommodation on-site with a drive-in drive-out and/or fly-in fly-out roster arrangement.

The continued use of Weipa/Napranum was selected as it maximised the use of the existing housing stock and community facilities and services, and minimised change to the social fabric of these communities. The mine's operational workforce would be bussed to and from work daily (refer to **Section 2.7.2**).

The construction workforce would be largely accommodated in a temporary construction camp located on ML7024 near Boyd Bay (refer **Figure 1-3**). This workforce would be predominantly sourced from eastern Australia and would fly-in and fly-out of Weipa when not on roster. The proposed temporary construction camp has been located in a mineralised area that would be later mined. There would be insufficient existing housing in Weipa/Napranum to accommodate the full construction workforce, therefore, additional temporary accommodation would need to be constructed in Weipa/Napranum which may also result in disturbance of existing flora and fauna habitat. Overall, the construction of temporary accommodation near Boyd Bay compared to Weipa/Napranum, would be likely to have similar potential impacts on threatened and migratory fauna and threatened flora. However, the provision of temporary worker-only accommodation on-site would minimise daily travel times and avoid locating a temporary construction workforce within an established township. Neither option would be likely to have a significant impact on threatened and migratory fauna and threatened flora.

The transport infrastructure options evaluated for the movement of personnel to and from site were:

- sealed road from Weipa to the Project site via the Peninsula Developmental Road (PDR) and the Amban Access Road;
- bridge over the Embley River to link Weipa to the Mine Access Road;
- barge carrying both passengers and vehicles to link to the Mine Access Road; and
- passenger ferry to link to the Mine Access Road.

The first option was not feasible due to excessive daily commute travel times. The second option is the least economically feasible due to the high cost of bridging the 3.5km wide Embley River estuary. The passenger ferry was selected in preference to the barge as it minimises travel time and hence reduces the risk of fatigue.

The barge and ferry terminals would be likely to have less potential impact on threatened and migratory fauna and threatened flora compared to the bridge, which would require additional vegetation clearing and piling. None of the options would be likely to have a significant impact on threatened and migratory marine fauna and the Commonwealth marine environment.

1.6.4 Location of Barge and Ferry Terminals

The operational workforce would commute to the site daily by driving to the Hornibrook ferry terminal on the north side of the Embley River, where they would leave their vehicles and catch a ferry to the Hey River barge/ferry terminal, from where they would be bussed to site. Freight and equipment would be transported via barge from the Humbug barge terminal on the north side of the Embley River to the Hey River barge/ferry terminal (refer **Figure 1-3**). The trucks would then drive off the barge and travel by the sealed on-lease Mine Access Road to the site.

Three locations for barge and ferry terminals were considered on the northern side of the Embley River. These included an area adjacent to the existing Evans Landing wharf, an area adjacent to the existing Humbug Wharf, and Hornibrook Point. The location at Evans Landing

was unsuitable due to the potential for significant interference with existing commercial and recreational boating and also to increased ferry travel time.

The Humbug barge terminal would be located adjacent to the existing Humbug Wharf, which is where the regular barge service from Cairns docks. Large machinery and supplies arriving by barge from Cairns can be transported to the Project without traversing public roads. Use of public roads would be required if the barge terminal was located at Hornibrook Point.

It is proposed to locate the ferry terminal at Hornibrook Point as this has the shortest route and hence the shortest travel time to the Hey River barge/ferry terminal. This location also has the advantage of reducing interactions with vessels that support the existing operation.

The potential impacts on threatened and migratory marine and estuarine fauna would be similar for all terminal locations. None of the options are likely to have a significant impact on threatened and migratory marine fauna and the Commonwealth marine environment.

1.6.5 Power Supply

The following power supply alternatives were evaluated:

- generate power at Weipa by expanding the existing diesel-fired station and installing a high voltage transmission line to the Boyd infrastructure area; and
- generate power on-site using diesel-fired generators.

The first alternative is the least reliable and least feasible, in part because the 3.5km wide Embley River estuary would have to be traversed by a high voltage line. In addition to the higher capital cost, line losses along the length of the 50km overhead power line would result in a less efficient operating system. As a result, on-site generation is proposed.

Alternative energy supplies such as biomass, wind, solar and wave were considered. Wave power was not technically viable. Wind and solar sources were not able to supply guaranteed minimum base load power. Biomass was not technically viable for low base load demand situations (e.g. beneficiation plant not running, ship loaders not running).

The option of installing a 50km overhead power line is likely to have a greater potential impact on flora and fauna habitat, compared to generating power on site, because additional vegetation clearing would be required. Neither of the options would be likely to have a significant impact on threatened and migratory fauna and threatened flora.

1.6.6 Bauxite Beneficiation Technology

Geological characterisation of the SoE orebody has shown that the greatest economic benefit can be obtained from the crude bauxite if the high-silica fine material (nominally <0.6mm) associated with the crude ore is removed. The silica in fines consumes caustic soda at the alumina refinery and caustic consumption is the primary cost driver in the bauxite and alumina production chain.

The following bauxite beneficiation (processing) technologies for removing fines were evaluated:

- dry beneficiation; and
- wet beneficiation.

Crude bauxite in the ground is a mixture of bauxite bearing pisolites (pea-shaped particles) locked in a matrix of finer materials including fine bauxite and clay. Energy is needed to break up the crude ore into pisolites and fine matrix material. A dry screening process would break up some of the large lumps but would not remove fine material adhering to pisolites. A substantial quantity of pisolites would also remain trapped in the matrix material and be rejected as oversize material by a dry screening plant, further eroding the value of the ore body. Comalco (now RTA) has previously investigated mobile in-pit dry beneficiation but found the plant was burdened with many technical problems which could not be effectively solved.

In a wet beneficiation plant the crude bauxite is soaked with water to break-up lumps and this "pre-conditioned" ore is then washed over a screen to remove the fines. The amount of water needed to wash the fines from the bauxite pisolites varies depending on the quantity and type of fines. A "high dispersion energy" plant uses more water than a "low dispersion energy" plant.

Wet beneficiation is an efficient and reliable technology that has been proven throughout the world and it has been adopted for the Project. As much crude ore as is practicable would be beneficiated in "low dispersion energy" plants. This would reduce overall water usage. Some ore from the Norman Creek mining area would need to be beneficiated in a "high dispersion energy" plant. Mining of this ore would be delayed until a "high dispersion energy" unit is added to the initial "low dispersion energy" plant at Norman Creek (refer **Section 2.5.1**).

1.6.7 Water Demand Management

The options evaluated for reducing and stabilising water demand for operations were:

- type of beneficiation plant;
- staging of significant plant expansions;
- product yield assumptions; and
- recycling of water within the beneficiation plant.

The design of the "low dispersion energy" beneficiation plants has incorporated materials handling and layout features that enable as much crude ore as is practicable to be beneficiated in these plants, thus reducing overall water usage. The plant design enables water in the circuit to be reused throughout the plant.

Tailings water recycling (refer **Section 2.7.3**) is crucial to reduce the proportion of water required from alternative sources. The recycling of water from tailings storage facilities commences once the floor of the tailings storage facility has been sealed through the deposition of fine tailings particles. The sealing takes two to three years during which time alternate water sources are required. The planned significant lifts in bauxite production rate are staged to follow the establishment of the recycled tailings water stream in order to eliminate high peaks in water demand.

The beneficiation process separates crude ore into product, oversized waste and tailings. Due to the characteristics of the ore body, these proportions would constantly vary and consequently the product yield would also vary. The Boyd beneficiation plant water usage is determined by the proportion coming from tailings recycling. The overall water demand has been based on the average yield of the ore body rather than minimum yield. In order to stabilise water demand, short term mine plans may need to be varied so that high or low yielding ore is mined to meet overall production plans.

The use of thickened tailings was also evaluated but not adopted. The same amount of water is used within the bauxite processing circuit regardless of whether there is a thickened or an unthickened tailings system. With a thickened tailings system, water is removed from the tailings stream for recycling before tailings are pumped in paste form to the tailings storage facility; it is difficult to recover additional water reliably from a thickened tailings storage facility. With an unthickened tailings system, all the recycled water is recovered from the tailings disposal facility. Overall, the effective water recovery is similar for both types of tailings systems; however, a thickened tailings system also requires the use of chemical flocculants and greatly increases the energy needed to pump the thickened tailings to the disposal area.

1.6.8 Water Supply

A wide range of options were considered to meet the forecast demands for water over the anticipated range of production rates up to 50Mdptpa.

Following a preliminary evaluation, the following supply options were not adopted on the basis of a combination of cost, sustainability, reliability and technical considerations:

- pumping water via pipeline from Weipa;

- desalinisation; and
- sole reliance on an artesian borefield.

Unlike the Weipa Peninsula, the Project area does not have a high-yielding shallow aquifer. The principal sources of supply are therefore restricted to recycled water from tailings storage facilities, surface water from streams, and deep artesian groundwater. The wide range of supply combinations utilising various proportions of these sources was investigated. Surface water supply options encompassed both dams and direct pumping from flowing streams. Nine dam site options in the Norman Creek catchment were evaluated, along with two in the Ina Creek catchment and four in the Ward River catchment. Following consideration of cost, sustainability, reliability, local community concerns, and the environment, the following principal supply sources have been adopted:

- Production rate less than 30Mdptpa – tailings water recycle, water supply dam (Dam C), and artesian; and
- Production rate 30Mdptpa to 50Mdptpa – tailings water recycle, water supply dam (Dam C), direct pumping from the Ward River, and artesian.

The water supply dam (Dam C) would have a maximum storage capacity of 29GL and could be constructed in either in two stages or a single stage (refer **Figure 1-3** for location). The dam would be constructed in a single stage should expansion of production above 15Mdptpa be anticipated to occur quickly, or should an initial production capacity of 22.5Mdptpa be adopted. This is the subject of ongoing feasibility studies. This EIS has assessed the impact of the dam at minimum, intermediate and maximum production rates of 15, 30 and 50Mdptpa respectively.

One water supply sub-option considered involved constructing a smaller single stage of Dam C only and constructing a second dam on the Ward River. This sub-option involved a greater total area of disturbance and was not the preferred approach of Traditional Owners and has not been adopted.

The various water supply sources are quantified in **Section 5.2.1**.

The selected option of constructing one dam is likely to have less potential impact on threatened and migratory fauna and threatened flora, compared to the sub-option of constructing two dams, because one dam would require less vegetation clearing.

1.6.9 Initial Tailings Storage Facility Establishment

Two locations were considered for the construction of an initial tailings storage facility to serve the Boyd beneficiation plant. The first was located on a non-mineralised area to the north of the plant and the second on a mineralised area to the south. The first dam alternative would be simpler and quicker to establish since the second would require pre-mining and crude ore stockpiling if ore was not to be sterilised. However, the second location to the south (refer **Figure 1-3**) was selected in order to reduce the overall out-of-pit footprint of disturbance by about 200ha.

Construction of the initial tailings storage facility to the south of the Boyd beneficiation plant is likely to have less potential impact on threatened and migratory fauna and threatened flora.

1.6.10 Volume of Dredged Material

Two key design factors influence the volume of marine sediment required to be dredged:

- the length of the jetty and wharf structure; and
- limitation of vessel departure times.

The length of the port jetty and dredge channel has been optimised taking into consideration the trade-off between increasing the jetty length versus dredging volumes. In the case of the proposed port, constructing a longer jetty would not substantially reduce the dredging volumes. The depth increases rapidly over the first 500m from shore (between the shore and the berth pocket) and then increases more gradually (refer **Figure 6-39**). For example if the jetty length was to increase by 40% then the dredge volume would only decrease by approximately 10%.

As designed, the approach jetty is 568m (from the top of the cliffs), and dredging commences at the berth pocket (refer **Figure 2-6**). Constructing a longer jetty would significantly increase the cost of construction without significantly reducing environmental impact.

Similarly, at the ferry and barge terminals, a sheet pile structure is proposed to optimise access to deeper water at the Hey River terminal, which minimises disturbance to mangroves in this area.

The high cost of dredging provides a financial incentive to reduce dredge volumes as much as possible. Dredge volumes at the Port could be reduced through limiting vessel departure times to high tide so that ships require less than -20.2m draft from lowest astronomical tide (LAT). However, this would limit the port capacity. A feasibility study is currently being undertaken to determine the economic feasibility of limiting vessel departure time. For the purposes of the environmental impact statement, it has conservatively been assumed that vessel departures are unrestricted by tides and hence the depth of dredging and associated impact assessment has been matched to this assumption (-20.2m LAT).

Dredge volumes have also been minimised at the ferry and barge terminals as much as practicable. The passenger ferry would be required to operate on all tides in order to transport workers at shift change. However, the volume of dredging for the ferry and barge terminals has been optimised by taking into consideration vessels with the lowest draft practical for the service conditions and optimising the approach and departure paths for the vessels.

1.6.11 Disposal of Dredged Material

Several alternatives for disposal of sediments from dredging were considered. The following alternatives were not adopted based primarily on environmental, material suitability, construction needs and economic viability:

- re-use for beach nourishment and land creation;
- off-site recycling;
- removal of hazardous constituents for beneficial re-use;
- disposal on land;
- placement of the material from the port area at the existing Albatross Bay Spoil Ground.

The re-use of material for beach nourishment is not considered appropriate given that the beach area is a known nesting area for marine turtles. Placement of dredged material on the beach would impact turtles' ability to nest and may reduce viability of nests through constant inundation of water through dewatering. Peer-reviewed literature documents negative impacts on turtles from beach nourishment activities. Using the material for land creation is considered inconsistent with the use of the area by turtles for nesting. There is no need to create more land for the development of the SoE Project.

The material to be dredged is not suitable for construction material. The material from the Port area is comprised of a relatively thin layer of sandy silts on at the surface overlying stiff clays and underlying siltstone, whilst the material from the barge and ferry terminals is comprised primarily of silty-clays. Material beneficial for offsite recycling typically requires relatively clean sands.

There are no hazardous constituents to be removed because the material is clean. Further, beneficial re-use opportunities do not exist.

If the material was pumped ashore, the dewatering process could adversely affect a shallow, low-yield aquifer via infiltration of saline seepage through the porous coastal soils. The shallow aquifer currently sustains baseflow in surface streams in the area. This water has very low salinity levels. Saline seepage from the marine sediment could adversely impact water quality. The disposal of dredged spoil to land would require construction of a containment facility to store the material. At the Hey River location, the construction of such a facility would require the removal of coastal vegetation. At Humbug Wharf and Hornibrook Point, the construction of

a containment facility would sterilise the site for a prohibitive period prior to development of the onshore terminal infrastructure, further the silty-clay dominated sediments would not be suitable for engineered use, especially in supporting heavy machinery. Awaiting construction of the containment facility would prevent commencement of dredging activities for some months, subsequently delaying the construction of the port, barge and ferry facilities. These facilities are on the critical path for construction of the Project. The revegetation of an elevated emplacement of marine sediments would pose difficulties and would be likely to require long-term maintenance.

Placement of the spoil from the port area at the Albatross Bay spoil ground would require the material to be barged about twice the distance than to the proposed new spoil ground. This would require at least three hopper dump barges and contractors' dredging spreads do not typically extend to that number of barges, particularly in such a remote area. If a suitable contractor was found then the costs would be significantly greater. If three hopper dump barges could not be secured, the dredging and sea disposal timeline would increase, potentially extending persistence of turbid conditions.

Ocean disposal of marine sediments in a marine environment provides a lower environmental risk than land disposal, due to:

- using the material for beach nourishment or land disposal is inconsistent with the use of the area by marine turtles;
- disposal on land could adversely affect water quality in the shallow aquifer; and
- revegetation of marine sediments would pose difficulties.

Both land and sea disposal have negligible risk to human health.

Sea dumping of the dredge material is being proposed based on the lack of suitable alternatives for the volume of material to be disposed and the clean nature of the material.

1.7 Environmental Impact Assessment Process

1.7.1 Purpose of the EIS

This Environmental Impact Statement has been prepared to meet the assessment requirements for the Project under the *State Development and Public Works Organisation Act 1971* (Qld) (SDPWO Act), the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act) and the *Environment Protection (Sea Dumping) Act 1981* (Cth) (Sea Dumping Act).

The EIS has been prepared to inform decision-makers, affected parties, interest groups and the public about potential environmental and social issues relating to the development and operation of the Project, and how these issues would be managed. The content of the EIS reflects the Terms of Reference (ToR) issued by the Queensland Coordinator-General (CG) and the EIS Guidelines issued by the Commonwealth Minister for Sustainability, Environment, Water, Population and Communities (the Minister).

This document will be made publicly available for comment and submissions will be sought from individuals and organisations. The EIS process allows for community consultation and ensures environmental protection by comprehensive consideration of potential impacts and management strategies. The Department of Employment, Economic Development and Innovation (DEEDI) is responsible for coordinating the impact assessment process under the auspices of the CG. The Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) fulfils a similar role for the Minister.

1.7.2 Objectives of the EIS

The objective of the EIS process is to ensure all impacts, direct and indirect – in particular environmental, social and economic impacts – are fully examined and addressed. The EIS aims to be a comprehensive document that provides:

- public information regarding the project, alternatives and preferred solutions; the existing environment and values that it would affect both on and off the site; the impacts that may occur; and the measures to be taken to mitigate all adverse impacts; and
- a definitive statement of measures or actions to be undertaken to mitigate any adverse impacts occurring during construction, operation and following decommissioning of the project. This is achieved by the inclusion of a draft Environmental Management Plan (EM Plan) (refer **Section 21**) in the EIS, which describes acceptable impacts and environmental management strategies designed to meet specific performance criteria.

The EIS relates to the entire life of the Project including construction, operation and decommissioning. The EIS enables reasonable economic and technically achievable conditions to be developed to ensure the impact of the Project is within acceptable levels. The level of analysis and detail in this document reflects the level of significance of particular impacts.

1.7.3 EIS Process

Summary of Parallel EIS Processes

The Project is to be assessed under two separate but parallel EIS processes under State and Federal environmental law. Further detail on the relevant processes is provided below.

The EIS addresses both the State Terms of Reference (**Appendix 1B**) and Commonwealth Tailored Guidelines (**Appendix 1C**) and it will be advertised for public and advisory agency comment:

- as a final EIS for the purposes of section 33(1) of the SDPWO Act; and
- as a draft EIS for the purposes of section 103(1)(c) of the EPBC Act.

For administrative and public convenience, all submissions on the EIS are to be lodged with DEEDI (for State EIS purposes and on behalf of the project proponent for Commonwealth EIS purposes). All submissions will then be copied and forwarded to RTA and DSEWPaC to meet requirements under the SDWPO Act and the EPBC Act. Further detail on the public submission process is provided in **Section 1.8**.

Additions to this EIS which are required as a result of public submissions will be made as appendices so that all relevant matters relating to both EIS assessment processes are contained within the one document.

Queensland EIS Process

On 13 June 2008, RTA lodged an Initial Advice Statement (IAS) and a request for "significant project" declaration with the CG. The IAS provides an outline of the proposed project, including the project rationale and its potential impacts. The IAS was subsequently updated on 3 November 2008.

The Project was declared a "significant project" for which an EIS is required pursuant to section 26(1)(a) of the *State Development and Public Works Organisation Act 1971* (Qld) (SDPWO Act) on 21 November 2008, by the CG. The declaration initiates the statutory environmental impact assessment procedure under Part 4 of the SDPWO Act

Matters considered by the CG in making this declaration included information contained in the IAS, relevant planning schemes and policy frameworks, infrastructure impacts, employment opportunities, environmental effects, complexity of local, State and Commonwealth Government requirements, level of investment and the project's strategic significance.

Draft Terms of Reference (ToR) were prepared and advertised for public and advisory agency comment on 16 January 2009. The CG was required to have regard to all comments received before issuing a final ToR in April 2009 (refer **Appendix 1B**). This EIS was prepared in response to the final ToR and applies to the whole of the Project. A table providing cross-references from the ToR to the EIS is presented in **Appendix 1D**.

If the CG is satisfied that the EIS responds to the ToR, this EIS may be advertised for public comment. The CG must consider all properly made submissions and any other submissions that he accepts about the EIS and any other material the CG considers is relevant to the Project.

If further information is requested by the CG, a "Supplementary EIS" will be prepared by RTA to cover outstanding matters. A final decision on the overall acceptability of the Project will be made on the basis of the information provided in the EIS and the Supplementary EIS.

At the completion of the EIS phase, the CG must prepare a report evaluating the EIS (CG's Report). The CG Report will evaluate the environmental effects of the project and any associated mitigation measures. The CG's Report will be publicly available.

The CG's Report does not authorise the commencement of work associated with the Project. Instead it sets the framework within which other State approvals are to be sought and the conditions that are to be granted. Of significance for the Project:

- the CG Report may state conditions for any draft environmental authority (mining lease) under the EP Act; and
- if the Project involves development requiring an application for a development approval under the *Sustainable Planning Act 2009* (Qld) (SP Act), the CG Report may, under section 39 of SDPWO Act, state for the assessment manager one or more of the following:
    - the conditions that must attach to the development approval;
    - that the development approval must be for part only of the development; and/or
    - that the approval must be preliminary approval only.

Alternatively, the report must state for the assessment manager:

- that there are no conditions or requirements for the project; or
- that the application for development approval be refused.

There is no legislative requirement for the CG's Report to be provided to the Minister to assist in his assessment of the Project under the EPBC Act, as the Bilateral Agreement between the State of Queensland and the Commonwealth does not apply.

Commonwealth EIS Process

RTA referred the Project to the Minister for a decision as to whether the project constituted a controlled action under the provisions of the EPBC Act. On 2 October 2008, the Project was declared a "controlled action" (Referral No. 2008/4435) and was to be assessed under the Bilateral Agreement with Queensland using the EIS Process under Part 4 of the SDPWO Act.

However, following a change to the proposed port design to accommodate larger bulk carriers, RTA withdrew Referral No. 2008/4435 and submitted a new referral to the Minister. On 29 October 2010, the Project was declared a "controlled action" for which an EIS was required (Referral No. 2010/5642), and the relevant controlling provisions were:

- listed threatened species and communities (sections 18 and 18A of the EPBC Act);
- listed migratory species (sections 20 and 20A of the EPBC Act); and
- Commonwealth marine areas (sections 23 and 24A of the EPBC Act).

The change to the Project and the inclusion of Commonwealth marine areas as a controlling provision meant that the Bilateral Agreement could no longer apply. Instead, the relevant EIS process is under Part 8 of the EPBC Act. As such, the Project will be subject to two different and separate EIS processes.

Tailored Guidelines were issued by the Minister to RTA (refer **Appendix 1C**), and these set the framework for how the EIS is to address the potential significant impacts of the Project on Matters of National Environmental Significance (MNES). A stand-alone report addressing these matters is

provided as **Section 22** of this EIS. A table providing cross-references to the Tailored Guidelines is provided in **Section 22 Table 38**.

If the Minister is satisfied that the draft EIS responds to the Tailored Guidelines, this EIS may be advertised for public comment as a "draft EIS". At the end of the submission period, RTA will finalise the "draft EIS", taking account of and summarising comments received within the submission period, and stating how such comments are addressed in the "final EIS". As soon as practicable after finalising the "draft EIS", RTA is to provide the finalised EIS to the Minister and will cause the finalised EIS to be published.

The Secretary of the Commonwealth Department of Sustainability, Environment, Water, Population and Communities, will review the EIS material on behalf of the Minister. The Secretary must then prepare and give to the Minister a Recommendation Report relating to the action, which states whether the taking of the action should be approved, and if so, the conditions that should be attached to the approval.

The Minister then has period of 40 business days (beginning on the first business day after the Minister receives the finalised EIS), in which to decide whether the Project should be approved.

The final approval decision of the Minister and associated conditions would be publicly notified by placing it on the DSEWPaC website.

1.7.4 Structure of the EIS

The EIS is structured as follows:

- **Executive Summary** – a comprehensive restatement of the Project's purpose, scope, methods, results, conclusions, findings and recommendations, i.e. a consolidation of the principal points of the EIS;
- **Section 1** provides an introduction to the Project and summarises applicable legislation, approvals and objectives for the Project;
- **Section 2** provides a detailed Project Description;
- **Section 3 to Section 19** covers the various elements of the environment, describing the existing environment and addressing the potential impacts of the Project and the mitigation strategies proposed to limit the impacts to acceptable levels;
- **Section 20** describes potential cumulative environmental impacts that may arise from construction and operation of the SoE Project, including those that arise from the interrelationship of residual Project impacts and in combination with other proposed mining projects;
- **Section 21** presents a draft EM Plan for the mine that describes management strategies to achieve acceptable environmental conditions and makes commitments about how impacts would be managed;
- **Section 22** presents a stand-alone EPBC Assessment Report to present MNES and a table of cross references showing where the various EIS Guidelines requirements are addressed in the EIS are presented in Table 38 of that report;
- additional parts of the EIS contain References, a Glossary, Abbreviations and Units, and Appendices;
- a copy of the Queensland ToR and the Commonwealth EIS Guidelines are presented in **Appendix 1B** and **Appendix 1C** respectively. A table of cross references showing where the various Queensland ToR requirements are addressed in the EIS are presented in **Appendix 1D**;
- details of the EIS study team are provided in **Appendix 1E**; and
- a summary of the proponent commitments is provided in **Appendix 1F**.

1.8 Public Consultation Process and Submissions

Prior to the commencement of consultation, a scoping study was undertaken to identify the key stakeholders who may be directly or indirectly affected by the Project (refer **Section 15.1.1**). A range of consultation tools have been utilised to facilitate engagement with the general public and specific stakeholders (refer **Section 15.1.2**).

Throughout the preparation of the EIS document members of the public and other interested parties have been encouraged to participate in the process by providing their input into public consultation programs. Newsletters providing information about the Project and promoting communication with the EIS team have been widely circulated in the Weipa region. A wide range of stakeholder meetings has been held. Responses from all parties have been considered in the design of environmental and social plans and strategies. The community consultation process and issues raised are described in **Section 15.2.**

DEEDI, on behalf of RTA and DSEWPaC, will advertise the release of the EIS for advisory agency and public review and comment. The document will be placed on display at nominated locations for a period to be specified by the Commonwealth Minister and Queensland Coordinator General, of at least 20 business days.

RTA will make CD ROM copies of the EIS available free to interested persons upon request. The EIS will be available in hard copy format for purchase from RTA. Persons with special needs (e.g. visually impaired, English as a second language) can contact RTA to make arrangement to access the information in the EIS.

The EIS will be available on the RTA web site for interested parties to view and download if required:

http://www.riotintoalcan.com/ENG/whatweproduce/1812_south_of_embley_project.asp

Information on the EIS and the assessment processes for the State and Commonwealth governments will also be available on the respective websites:

http://www.dlgp.qld.gov.au/projects/mining-and-mineral-processing/bauxite-and-aluminium/south-of-the-embley-project.html

http://www.environment.gov.au/cgi-bin/epbc/epbc_ap.pl?name=current_referral_detail&proposal_id=5642

Any person, group or organisation may make a written submission about the EIS to the DEEDI. Such submissions do not have to relate to the whole of the Project and may relate to any aspect or section of the document. EIS submissions must be made in writing and submitted to the DEEDI within the designated comment period.

All submissions, comments and enquiries for the purposes of the SDPWO Act or EPBC Act should be addressed to:

EIS Project Manager—South of Embley Project
Significant Projects Coordination
Department of Employment, Economic Development and Innovation
PO Box 15009, Brisbane City East Qld 4002

Telephone	+ 61 7 3224 8351
Facsimile	+ 61 7 3225 8282
Email	SOE@deedi.qld.gov.au

http://www.deedi.qld.gov.au (under the Coordinator-General tab)

Both the State and Commonwealth will have access to all submissions.

RTA will respond to each submission as an addendum to this EIS. The addendum will in effect represent a "Supplementary EIS" under the SDPWO Act and a "Final EIS" under the EPBC Act.

1.9 Legislative Framework and Project Approvals

In addition to the approval of the EIS under the SDPWO Act and approval of the "controlled action" under the EPBC Act (refer **Section 1.9.2**), the Project will require a number of other approvals, permits and licences for various components of the development (refer **Table 1-2**).

Table 1-2 Project Approvals, Permits and Licences

Permit/Approval/Licence	Legislation	Authority	Comments
Project Wide			
Environmental Impact Statement	*State Development and Public Works Act 1971* (Qld) (SDPWO Act)	Department of Employment, Economic Development and Innovation (DEEDI)	Coordinator-General declared "a significant project for which an EIS is required" 21 November 2008.
Controlled Action Approval	*Environment Protection and Biodiversity Conservation Act 1999* (Cwlth) (EPBC Act)	Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC)	Project was declared a "controlled action" on 29 October 2010. Required if project has, will have or is likely to have a significant impact on matters of national environmental significance.
Environmental Authority	*Environmental Protection Act 1994* (Qld) (EP Act)	Department of Environment and Natural Resources (DERM)	Covers mining and associated activities as per operational and environmental requirements of an environmental authority (mining activities).
Humbug and Hornibrook Terminals, Tug Berths			
Barge and ferry terminals – development approval	*Sustainable Planning Act 2009* (Qld) (SP Act)	North Queensland Bulk Ports (NQBP) (assessment manager)	Required for operational works on land and operational works in the tidal areas of NQBP Strategic Port Land (DERM is a concurrence agency for operational works in tidal waters).
Commonwealth sea dumping permit (for dredged spoil)	*Environmental Protection (Sea Dumping) Act 1981* (Cwlth)	DSEWPaC	Required for dredging and disposal of spoil at existing Albatross Bay spoil ground in Commonwealth waters.
Removal of marine plants – development approval for operational works	SP Act and *Fisheries Act 1994* (Qld)	DEEDI	Required if marine plants found to be present and required to be removed. Part of combined development application to NQBP (above) although DEEDI would be concurrence agency for assessment.
Hey River Terminal			
Commonwealth sea dumping permit (for dredged spoil)	*Environmental Protection (Sea Dumping) Act 1981* (Cwlth)	DSEWPaC	Required for dredging and disposal of spoil at existing Albatross Bay spoil ground in Commonwealth waters.
Port			
Port	*Commonwealth Aluminium Corporation Limited Agreement Act 1957* (Qld) (Comalco Agreement Act)		Harbour works are authorised under the Comalco Agreement Act, which includes dredging in tidal waters for the port on ML7024. Development approval under SP Act is not required.
Approach channel dredging	*SP Act*	DERM	Required for operational works in tidal waters outside ML7024. DERM is lead agency for operational works in tidal waters.
Commonwealth sea dumping permit (for dredged spoil)	*Environmental Protection (Sea Dumping) Act 1981* (Cwlth)	DSEWPaC	Required for dredging and disposal of spoil at proposed new spoil ground in Commonwealth waters.
SoE Mine Facilities			
Licence to take water (surface water)	Comalco Agreement Act and *Water Act 2000*	DERM	Pre-existing rights to take water for the Project are held under the Comalco Agreement Act and preserved under section 1037A of the *Water Act*

Permit/Approval/Licence	Legislation	Authority	Comments
	(Qld)		*2000*.
Water storage dam – development approval	Comalco Agreement Act and *Water Act 2000*	DERM	Pre-existing rights to build dams for the Project are held under the Comalco Agreement Act and preserved under the *Water Act 2000*.
Waterway barrier (fish barrier) works approval – development approval for operational works	SP Act and *Fisheries Act 1994* (Qld)	DEEDI	Required for a dam or water crossing that inhibits fish movement.
Failure impact assessment (of dams)	*Water Supply (Safety and Reliability) Act 2008* (Qld)	DERM	Required for dams with a wall height >8m in height and storage capacity of >500ML. Dam C water storage dam shall require failure impact assessment.
Licence to take water (sub-artesian)	*Water Act 2000*	DERM	Required if taking sub-artesian water in declared sub-artesian area under section 1046 of the *Water Act 2000*. A declared sub-artesian area exists. Use of sub-artesian water is not currently planned.
Licence to take water (artesian)	*Water Act 2000*	DERM	The Comalco Agreement Act permits 12 artesian bores under section 32(b) (or more with Minister's consent). A licence to take artesian water is still required.
Development approvals for artesian bores	SP Act and *Water Act 2000*	DERM	Required for installation of artesian groundwater bores.

1.9.1 State Development and Public Works Organisation Act 1971 (Qld)

The Project has been declared a "significant project" for which an EIS was required pursuant to section 26(1)(a) of the SDPWO Act. The application of the SDPWO Act is described in **Section 1.7.3**.

1.9.2 Environment Protection and Biodiversity Conservation Act 1999 (Cwlth)

The EPBC Act prescribes the Commonwealth's role in environmental assessment, biodiversity conservation and the management of protected matters. The Act identifies eight MNES and makes it an offence to take any action that has, or is likely to have, a significant impact on any of those matters, unless it is approved by the Minister. Such an action is a "controlled action". It is an offence to undertake a controlled action without the approval of the Commonwealth Minister responsible for the EPBC Act.

The Project was declared a controlled action on 29 October 2010 and the controlling provisions were:

- sections 18 and 18A (listed threatened species and communities);
- sections 20 and 20A (listed migratory species); and
- sections 23 and 24 (Commonwealth marine areas).

As a consequence of this decision, the Project requires approval under the EPBC Act. The Commonwealth has determined an EIS under the EPBC Act is required. The Minister issued *Tailored Guidelines for the preparation of the Draft Environmental Impact Statement* (the 'Tailored Guidelines') on 21 December 2010. This EIS has been prepared to meet both the Commonwealth and State EIS requirements.

The Tailored Guidelines specifically requires a stand-alone report addressing potential impacts of the Project on MNES. An EPBC Act assessment report has been prepared to satisfy this requirement, and is presented in **Section 22**. This report describes the proposed action in relation to MNES, the affected environment relevant to the controlling provisions, an assessment of impacts on MNES, and mitigation measures and summarises conclusions.

In addition, section 160 of the EPBC Act requires that Commonwealth agencies seek advice from the Minister before granting certain authorisations under other Acts. A permit under the Commonwealth *Environment Protection (Sea Dumping) Act 1981* to dispose of dredged material at sea is such an authorisation (refer **Section 1.9.3**).

The EPBC Act has the effect of allowing the Minister to require assessment of the sea dumping application as though it was a controlled action under Part 8 of the Act. In order to avoid duplication of assessment processes and to ensure that all relevant information is considered at once, DSEWPaC has requested that sufficient information be provided in this EIS to support the application for a Sea Dumping Permit for dredging and disposal associated with Stage 1 capital dredging at the proposed Port and capital dredging for the barge and ferry terminals. This information can be predominantly found in Sections 6 and 22 of this EIS.

1.9.3 Environment Protection (Sea Dumping) Act 1981 (Cwlth)

The *Environment Protection (Sea Dumping) Act 1981* (Sea Dumping Act) regulates the loading and dumping of waste and other matter in the sea. The loading and dumping of spoil from dredging operations in Commonwealth waters is regulated by the Act and such disposal requires a permit.

A permit will be required for the loading and disposal of dredged spoil from the proposed port to a proposed new spoil ground west of Boyd Point. A permit will also be required for loading and disposal of dredged spoil from the Humbug barge terminal, Hornibrook ferry terminal and Hey River barge/ferry terminal at the existing Albatross Bay spoil ground.

The assessment to support the application for a Sea Dumping Permit for dredging and disposal associated with Stage 1 capital dredging at the Port and capital dredging associated with the ferry and barge terminals is predominantly included in this EIS. A sea dumping permit has been applied for and the framework for the Dredge Management Plan drafted (refer **Section 6.10**). Detailed sediment characterisation reports have been provided separately to DSEWPaC and the data is summarised in Section 6 of the EIS. The Tailored Guidelines required the following guidelines to be utilised in preparation of that

- *National Assessment Guidelines for Dredging* (Commonwealth of Australia 2009)
- Annex 2 1996 Protocol to the Convention on the prevention of marine pollution by dumping of wastes and other matter 1972 (the London Protocol); and
- Waste Specific Guidelines for Assessment of Dredged Material. International Maritime Organisation

A detailed description and characterization of the sediment proposed to be dredged, the proposed disposal site, and assessment of the potential effects of disposal of dredged material, in accordance with the above guidelines, are presented in **Section 6** and summarised in **Section 22** (EPBC Assessment Report) of this EIS. Alternative options for disposal of dredged material are presented in **Section 1.6.10**.

Future capital dredging and disposal for Stage 2 of the Port (which would occur subject to market demand) and maintenance dredging and disposal associated with both the Port and the ferry and barge terminals, would be subject to obtaining a subsequent sea dumping permits.

1.9.4 Agreement Acts

RTA is the holder of ML7024 granted on 1 January 1958 pursuant to the Comalco Agreement Act, a Queensland "Special Agreement Act". ML6024 (granted 25 July 1985 and affirmed 26 August 2002) was granted pursuant to the Comalco Agreement Act and the *Mineral Resources Act 1989* for the purposes of providing transport access to ML7024. The current term of ML7024 and ML6024 runs until 31 December 2041; however, there is a right of renewal until 31 December 2062.

The Comalco Agreement Act confers certain rights and obligations relating to the development of bauxite resources, including provisions relating to the taking of water and harbour works (refer **Table 1-2**).

Rio Tinto is also the holder of ML7031 pursuant to the *Alcan Queensland Pty Limited Act 1965* (Qld) (which is also a "Special Agreement Act"). While RTA mines ore from ML7031 (known as the Ely mining lease), activities on ML7031 are not the subject of the Project.

Although the Comalco Agreement Act and the *Alcan Queensland Pty Limited Act 1965* are similar in many ways, there is no relationship from a tenure perspective.

1.9.5 Mineral Resources Act 1989 (Qld)

RTA does not require any new mining leases in addition to ML7024 and ML6024 in order to develop the Project.

1.9.6 Environmental Protection Act 1994 (Qld)

Mining and mining-related activities on ML7024 at Weipa have transitional authorisation under section 616B of the EP Act relating to "Special Agreement Act" mines. RTA has commenced the process to transition to an environmental authority (mining activities) under the EP Act with respect to ML7024 and ML6024. An application will be made to amend the environmental authority (mining activities) in respect to any requirements particular to the Project. To the extent of those amendments, the amendment application is likely to trigger the requirement for an EIS for the Project. The EIS under the SDPWO Act will satisfy such a requirement for an EIS.

The environmental authority (mining activities) will authorise mining and mining-related activities throughout ML7024 and ML6024, not just in relation to the Project area. These activities shall include the following environmentally relevant activities under the *Environment Protection Regulation 2008* (Qld)*:*

- 8. Chemical storage (petroleum product storage);
- 14. Electricity generation;
- 15. Fuel burning (heavy mobile equipment);
- 16. Extractive and screening activities (includes dredging);
- 21. Motor vehicle workshop operation;
- 31. Mineral processing;
- 43. Concrete batching;
- 50. Bulk material handling;
- 56. Regulated waste storage;
- 60. Waste disposal;
- 63. Sewage treatment; and
- 64. Water treatment.

In determining the conditions of the environmental authority, DERM shall have given regard to the provisions of the:

- Existing environmental authority (mining activities) authorisations on ML7024 and ML6024;
- *Environmental Protection (Water) Policy 2009* (Qld)*;*
- *Environmental Protection (Air) Policy 2008* (Qld)*;*
- *Environmental Protection (Noise) Policy 2008* (Qld)*;* and
- *Environmental Protection (Waste Management) Policy 2000* (Qld).

1.9.7 Sustainable Planning Act 2009 (Qld)

The SP Act and the *Sustainable Planning Regulation 2009* (Qld) (SP Regulation) establish the framework for planning and development assessment in Queensland, including the Integrated Development Assessment System (IDAS). Under Schedule 4 of the SP Regulation, mining and mining-related development is exempt from assessment against a planning scheme. However, certain Project development activities regulated by the SP Act and other natural resource

management legislation will be assessable development against Schedule 3 of the SP Regulation. These include:

- Removing marine plants (*Fisheries Act 1994*);
- Constructing a waterway barrier (*Fisheries Act 1994*);
- Operational works in tidal waters (SP Act); and
- Operational works to take artesian water (*Water Act 2000*).

The clearing of native vegetation for mining and mining-related activities is not assessable development under Schedule 3.

1.9.8 Land Act 1994 (Qld)

The *Land Act 1994* regulates land dealings relating to non-freehold land leases and permits to occupy and to the opening and closing of road reserves. The Project may require leases or modification to leases in respect of land presently held by North Queensland Bulk Ports (NQBP) for those barge and ferry terminals not located on ML7024 or ML6024. There are no proposed openings or closings of road reserves.

1.9.9 Native Title Act 1993 (Cwlth)

RTA has valid mining leases (ML7024 granted 1 January 1958) and ML6024 (granted 25 July 1985 and affirmed 26 August 2002) under the *Native Title Act 1993.*

The Western Cape Communities Co-existence Agreement (WCCCA) is a registered Indigenous Land Use Agreement (ILUA) (QIA2001/002) under the *Native Title Act 1993* between RTA, the State of Queensland and relevant Aboriginal parties.

The WCCCA recognises and respects the rights of Traditional Owners and allows for consultation over future development of mining operations. The WCCCA recognises RTA's entitlement and powers to develop the mining leases (ML7024, ML6024), property rights and other rights or interests granted under the Comalco Agreement Act. RTA will continue to engage with the Traditional Owners under the provisions of the WCCCA.

Where any proposed activities are outside the ILUA area, to the extent that native title has not been extinguished in relation to those areas, RTA will comply with the applicable process under the *Native Title Act 1993*. RTA does not expect this to arise.

The Federal Court of Australia determined on 29 July 2009 (*Wik and Wik Way Native Title Claim Group v State of Queensland [2009]* FCA 789) that the Wik and Wik Way people have native title over the land covered by the Project area. The native title rights and interests are subject to RTA's rights under the Agreement Act, WCCCA and the terms of the mining leases.

1.9.10 Aboriginal Cultural Heritage Act 2003 (Qld)

The *Aboriginal Cultural Heritage Act 2003* protects Aboriginal and Torres Strait Islander cultural heritage through imposing a duty of care for all persons to take reasonable and practical measures to avoid harming aboriginal cultural heritage. The Act empowers Traditional Owners to be directly involved in the assessment and management of their own cultural heritage.

The WCCCA provides for a system of cultural heritage management over the area covered by the ILUA. This area includes all land and waters on ML7024 and ML6024. Due to the operation of s86 of the *Aboriginal Cultural Heritage Act 2003,* this agreed cultural heritage management system satisfies the requirement of the Act and the cultural heritage assessment for granting of any new permits or approvals pursuant to an EIS that are required for development works on land or waters within the ILUA area.

1.9.11 Queensland Heritage Act 1992 (Qld)

The *Queensland Heritage Act 1992* provides for the conservation and protection of places and items of historical and/or non-indigenous cultural heritage, i.e. all places that derive from the post-settlement history of Queensland. Under this Act, places and items must be entered into a Queensland Heritage Register in order to be protected.

Where any project impacts on an item entered on the register , all aspects of development

which affects the registered interest require a development approval under IDAS. There are no registered items within the Project area.

1.9.12 Cape York Peninsula Heritage Act 2007 (Qld)

The *Cape York Peninsula Heritage Act 2007* provides for the declaration of Areas of International Conservation Significance. There have been no declarations of Areas of International Conservation Significance within the Cape York Peninsula region.

1.9.13 Water Act 2000 (Qld)

The *Water Act 2000* regulates the use of surface waters and groundwater and the interference with watercourses lakes or springs. Pre-existing rights to build weirs or dams and take surface water for the Project are held under section 1037A of the *Water Act 2000* due to the Comalco Agreement Act.

It is proposed to take water from the Great Artesian Basin and a licence to take artesian water will be required. The *Comalco Agreement Act* permits 12 artesian bores under section 32(b) (or more with the Minister's consent). RTA has an existing artesian water licence for 9GL per annum which allows abstraction from bores located on ML7024. RTA proposes to apply to increase the artesian allocation to a five-year moving average of 12GL per annum, with a peak abstraction of 15GL in any one year. A declared sub-artesian area (section 1046) exists in the Project area, however, the taking of sub-artesian water is not proposed.

Certain watercourses would be crossed by roads, pipelines and conveyors. Riverine Protection Permits are required for any activities that destroy riparian vegetation, or excavate or place material in a watercourse to the extent that such activities are not authorised under an environmental authority (mining activities) or the *Water Regulation 2002* (Qld).

The Cape York Peninsula Moratorium Area has been declared under the *Water Act 2000*. It covers most of northern Cape York, including the Project area south of Boyd Point. The Moratorium restricts the type and volume of new water licences that can be issued under the *Water Act 2000* for the taking of surface and sub-artesian water. The Moratorium recognises and does not affect the existing rights under the Comalco Agreement Act.

1.9.14 Water Supply (Safety and Reliability) Act 2008 (Qld)

The *Water Supply (Safety & Reliability) Act 2008* provides a framework to regulate "referable" dams. In general terms, a dam that is more than 8m high and meets certain storage capacity criteria requires a failure impact assessment. If a dam has a category 1 or 2 failure impact rating and the assessment is accepted by the chief executive administering the Act, the dam is classified as "referable" and is an assessable development under Schedule 3 of the SP Regulation. Dam C shall require failure impact assessment.

1.9.15 Wild Rivers Act 2005 (Qld)

There are currently no rivers in the Project area that are nominated or declared under the *Wild Rivers Act 2005.* The State Government has previously announced an intention to nominate the Watson River as a wild river under the Act. The Watson River is located south of the southern boundary of ML7024 and while part of the river's catchment is within ML7024 (refer **Figure 1-1**), the proposed footprint of the Project is outside the physical catchment/basin boundary of the Watson River. Pursuant to section 17 of the Act, rights and entitlements that pre-date the introduction of the Act are not affected by a wild river nomination or declaration.

1.9.16 Fisheries Act 1994 (Qld)

Approval is required under the *Fisheries Act 1994* to remove or destroy marine plants (such as mangroves and seagrass). Such activity is assessable development under Schedule 3 of the SP Regulation. An approval is likely to be required to remove some mangroves at the proposed Hey River barge/ferry terminal.

Approval is required under the *Fisheries Act 1994* to construct a waterway barrier that obstructs fish movement. Such operational works are assessable development under Schedule 3 of the SP

Regulation. An approval shall be required to construct the water storage dam on a freshwater tributary of Norman Creek (Dam C).

The Department of Employment, Economic Development and Innovation (DEEDI) (formerly the Department of Primary Industries and Fisheries) is proposing to declare parts of Albatross Bay (i.e. Pine River Bay) a Fish Habitat Area (FHA) under the *Fisheries Act 1994* (Qld). DEEDI has nearly concluded its public consultation and expects that the FHA will be declared in mid 2011.

The proposed Pine River Bay Fish Habitat Area is to the north of Weipa and the Embley River and is not adjacent to the Project area.

1.9.17 Coastal Protection and Management Act 1995 (Qld)

The objective of the *Coastal Protection and Management Act 1995* includes providing for the protection, conservation, rehabilitation and management of the coastal areas including resources and biological diversity. The Act provides for the preparation of State and coastal management plans which describe how the coastal zones are to be managed. Certain works carried out in these zones can be assessable development under IDAS.

The Act also provides for coastal management districts to be declared. Coastal management districts are either:

- declared through a regional coastal management plan as being a coastal management district; or
- by virtue of transitional provisions within the Act, declared to be those coastal management control districts and erosion prone areas previously declared under the Beach Protection Act 1968 (Qld).

The Project area falls within the northernmost part of the Gulf of Carpentaria Coast district. A regional coastal management plan has yet to be prepared for this district.

The Aurukun Shire Erosion Prone Areas plan SC4077A includes all land within approximately 50km of the coast between the Embley and Holroyd Rivers. However, all land within ML7024 and ML6024 are excised from plan SC4077A.

1.9.18 Vegetation Management Act 1999 (Qld)

The *Vegetation Management Act 1999* regulates the clearing of remnant native vegetation. Clearing of native vegetation for mining and mining-related activities is not assessable development under Schedule 3 and 24 of the SP Regulation. It is not proposed to clear native vegetation outside of ML7024 and ML6024.

1.9.19 Nature Conservation Act 1992 (Qld)

The *Nature Conservation Act 1992* and the *Nature Conservation (Wildlife) Regulation 2006* (Qld) regulate the taking or destruction, without authorisation, of certain listed flora and fauna species. The taking or destruction of wildlife in the course of authorised works associated with mining and mine related development on mining leases is allowed.

1.9.20 Land Protection (Pest and Stock Route Management) Act 2002 (Qld)

The *Land Protection (Pest and Stock Route Management) Act 2002* provides a framework for the management of weeds, pest animals and the stock route network.

As the holder of ML6024 and ML7024, RTA is under an obligation to take reasonable steps to keep the land and watercourses on-lease free from certain classes of declared pests.

There are no stock routes in the Project area.

1.9.21 Transport Infrastructure Act 1994 (Qld)

The *Transport Infrastructure Act 1994* provides for the management of transport infrastructure systems, including the state road network, rail, air services and ports managed by designated port authorities. RTA's proposed Project would not require transport infrastructure that requires regulation under this Act.

1.9.22 Transport Operations (Marine Pollution) Act 1995 (Qld)

The purpose of the *Transport Operations (Marine Pollution) Act 1995* is to protect Queensland's marine and coastal environment by minimising deliberate and negligent discharges of ship-sourced pollutants into coastal waters. Vessels using the proposed port near Boyd Point, the barge, and the ferry would be subject to this Act.

1.9.23 Transport Operations (Marine Safety) Act 1994 (Qld)

The purpose of the *Transport Operations (Marine Safety) Act 1994* is to regulate the maritime industry to ensure maritime safety while ensuring that operational issues are efficiently managed. Vessels using the proposed port near Boyd Point, the barge, and the ferry would be subject to this Act.

1.9.24 Civil Aviation Regulations 1988 and Civil Aviation Safety Regulations 1988 (Qld)

The purpose of the Act, the *Civil Aviation Regulations 1988* and *Civil Aviation Safety Regulations 1988*, is to provide a regulatory framework for maintaining, enhancing and promoting the safety of civil aviation. The Weipa airport is a certified aerodrome for the purposes of the *Civil Aviation Safety Regulations 1988*. The Project does not include any change to the operation of the existing Weipa airport or require the construction of a new airport.

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Environmental Impact Statement

for South of Embley Project

Section 2

Project Description

2 PROJECT DESCRIPTION

This section describes the location of the Project components and a description of each component from the construction phase through to operations and decommissioning.

2.1 Overview of the Project

The key components of the Project are shown on **Figure 1-3**. The Project involves a staged increase in production up to 50 million dry product tonnes per annum (Mdptpa). The initial production capacity is subject to ongoing feasibility studies but is likely to be either 15Mdptpa or 22.5Mdptpa. Actual production rates and the timing and size of capacity expansions would depend on market conditions (refer **Table 1-1** for an indicative schedule).

The initial construction phase is expected to take approximately three years. The estimated capital cost to establish 15Mdptpa capacity would be approximately $1,450 million (final cost is subject to feasibility studies). The peak construction workforce is expected to be approximately 630, with an average of 310 full-time equivalent jobs over the three years.

The anticipated mine life is approximately 40 years, depending on production rate. The SoE mine would directly employ a workforce of 500 at 15Mdptpa, 760 at 30Mdptpa and 1,020 at 50Mdptpa.

2.2 Location and Tenure

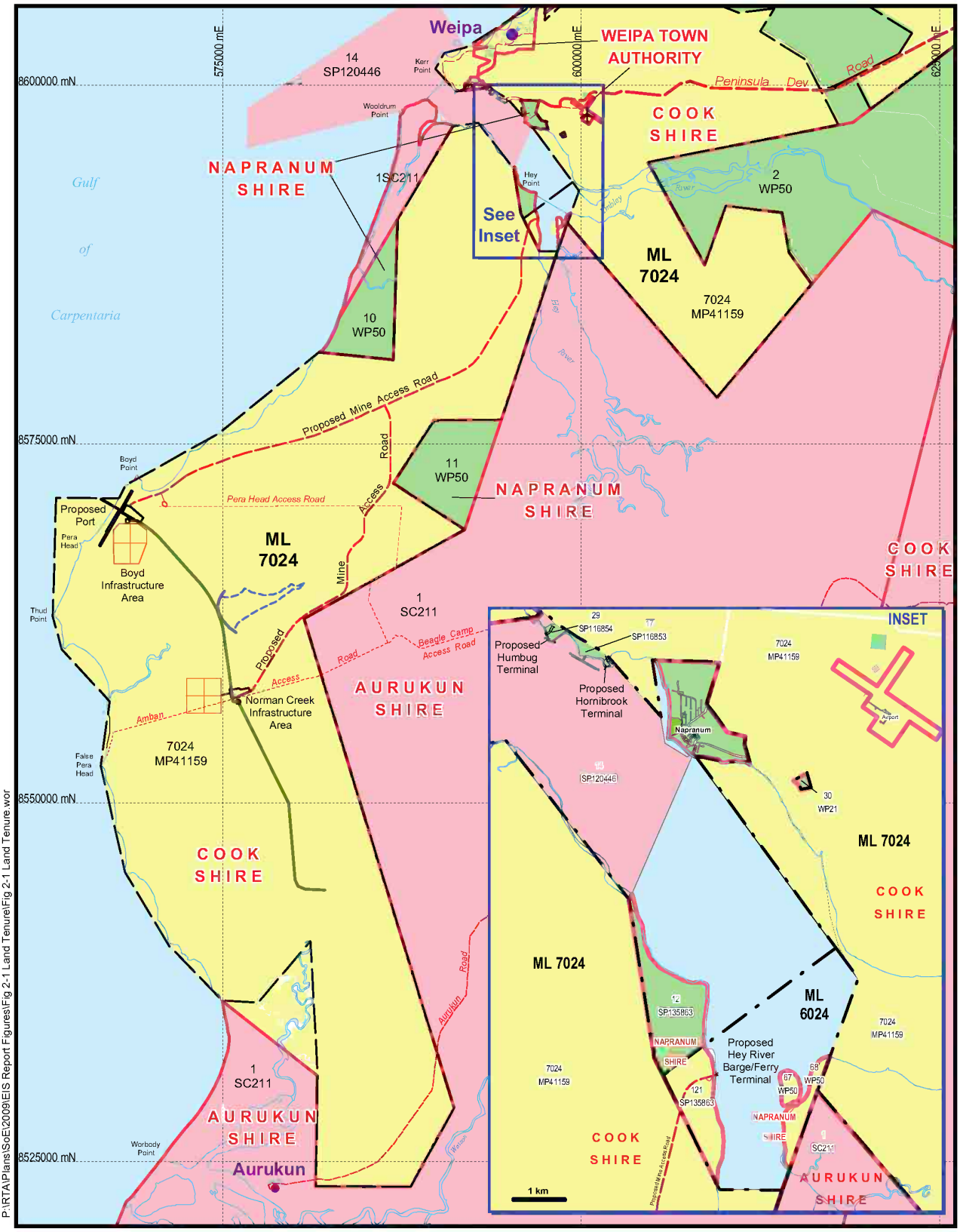
The Project is situated on the western side of Cape York on the Gulf of Carpentaria (refer **Figure 1-1**, and **Figure 14-1)**. The Project area is predominantly located on the portion of ML7024 that is south of the Embley River and on ML6024. In addition, a ferry terminal would be located at Hornibrook Point and a barge terminal at Humbug Point. Both locations are on Strategic Port Land administered by the North Queensland Bulk Ports Corporation Limited (NQBP) and both are within the Port of Weipa. The Port of Weipa limits are shown in **Figure 2-9**. Dredging for the proposed Port and the ferry and barge terminals would be undertaken in offshore areas and the material disposed of in offshore disposal grounds (refer **Figures 2-3 to 2-7** and **Figure 2-9**). The land parcels and tenure within the Project area and adjacent properties, including Strategic Port Land, are summarised in **Table 2-1** and shown in **Figure 2-1**.

The northern end of ML7024 is bounded by the Embley and Hey Rivers and the southern end lies north of the Watson River. The Gulf of Carpentaria abuts the western boundary of ML7024, which extends over submerged land between Thud and Boyd Points. The eastern side of ML7024 adjoins mineral development licence (MDL) 378 granted to Aluminium Corporation of China Limited (Chalco) in 2007. The gross extent of the portions of ML7024 and ML6024 south of the Embley River is approximately 106,000ha.

Mining activities would take place on ML7024. A barge/ferry terminal would be located on the Hey River on ML6024. A new port facility would be constructed on ML7024 south of Boyd Point for shipment of bauxite product. A portion of the port's dredged departure channel would extend westward beyond the boundary of ML7024. The proposed port is located outside the Port of Weipa port limits.

Two mine infrastructure areas would be established in stages. The Boyd infrastructure area would be located near Boyd Point, approximately 40km south-west of Weipa and 40km north of Aurukun. Later, the Norman Creek infrastructure area would be established approximately 15km south-east of the Boyd infrastructure area.

Current access to the Project is from the Peninsula Developmental Road (PDR) via the Aurukun Road, Beagle Camp Access Road, Pera Head Access Road, and the Amban Access Road, which traverse MDL378. Once the barge/ferry terminals are constructed, access would be via barge/ferry to the Hey River Terminal and an "on-lease" mine access road to the Boyd infrastructure area.



P:\RTA\Plans\SoE\2009\EIS Report Figures\Fig 2-1 Land Tenure\Fig 2-1 Land Tenure.wor

RTA Mining Lease boundary
Shire Boundary
Weipa Airport
Road/track

Tenure

Freehold
Lands Lease
State Land

Rio Tinto Alcan

South of Embley Project

Fig. 2-1: Land Tenure and Local Government Boundaries

N

5 0 5km

Datum/Projection: GDA94/MGA Zone 54 Date: 09/06/2010

There are no reserves, stock routes, easements or public road reserves within the Project area.

No additional land tenures would be required for the Project.

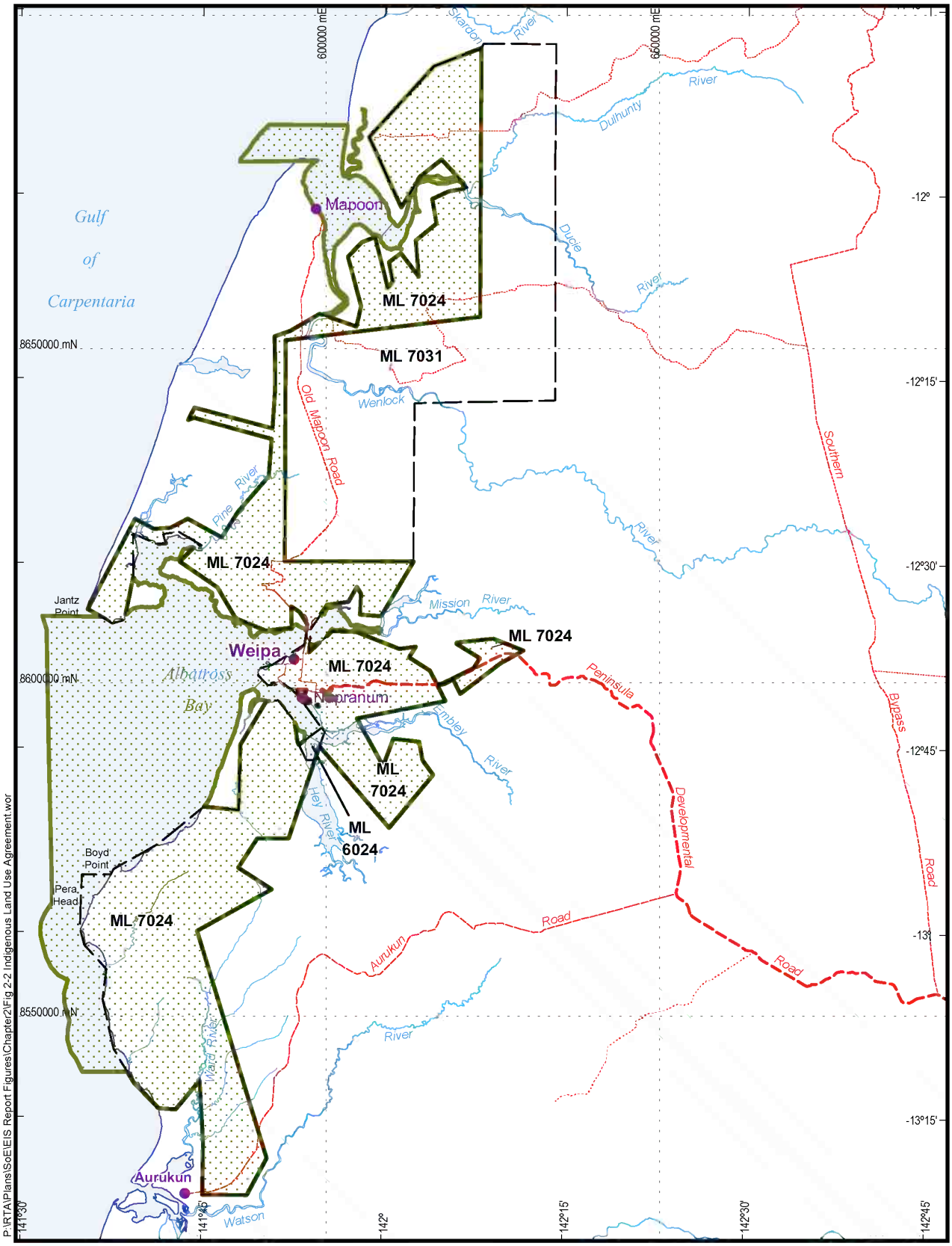
ML7024 lies within the Cook Shire Local Government Area and ML6024 lies within the Napranum Aboriginal Shire.

The Federal Court of Australia determined on 29 July 2009 (FCA 789) that the Wik and Wik Way people have Native Title over the land covered by the SoE Project area. The Western Cape Communities Co-existence Agreement (WCCCA) is a registered Indigenous Land Use Agreement (ILUA) (QIA2001/002) under the *Native Title Act 1993* (Cwlth) between RTA, the State of Queensland and relevant Aboriginal parties. The area covered by the ILUA includes all of ML7024 and ML6024 and is shown in **Figure 2-2**. Where any proposed activities are outside the ILUA area, to the extent that Native Title has not been extinguished in relation to those areas, RTA would comply with the applicable process under the *Native Title Act 1993*. RTA does not expect this to arise.

The location of areas proposed to be mined in years 1–13 and in years 14–40 area shown on **Figure 1-3.** The infrastructure associated with mining has been located so as not to sterilise bauxite reserves.

Table 2-1 Land Parcels and Tenure

Aspect	Mining Tenement	Land Parcel	Background Tenure	Ownership
Mine, Port and Infrastructure	ML7024 (RTA)	Lot 7024 MP41159	State land	The State of Queensland
Hey River barge/ferry terminal	ML6024 (RTA)	Lot 121 SP135863	State land	The State of Queensland
		Lot 67 WP50	State land	The State of Queensland
		Lot 68 WP50	State land	The State of Queensland
Humbug Barge Terminal	Not applicable. Located within Strategic Port Land.	Lot 29 SP116854	Freehold	North Queensland Bulk Ports Corporation Limited
		Lot 14 SP120446	Perpetual Lease	North Queensland Bulk Ports Corporation Limited
Hornibrook Ferry Terminal	Not applicable. Located within Strategic Port Land.	Lot 17 SP116853	Freehold	North Queensland Bulk Ports Corporation Limited
		Lot 14 SP120446	Perpetual Lease	North Queensland Bulk Ports Corporation Limited
Adjacent Properties	MDL378	1 SC211	DOGIT	Deed of grant in trust to Aurukun Aboriginal Council
	Not Applicable	11 WP50	Freehold	Napranum Aboriginal Shire Council
		10 WP50	Freehold	Napranum Aboriginal Shire Council
		Lot 15 SP116851	Perpetual Lease	North Queensland Bulk Ports Corporation Limited
		2 SP161882	State Land	The State of Queensland



P:\RTA\Plans\SoE\EIS Report Figures\Chapter2\Fig 2-2 Indigenous Land Use Agreement.wor

RTA Mining Lease boundary

Indigenous Land Use Agreement QIA 2001/002 (also known as Western Cape Communities Co-existence Agreement) Area

Township

Drainage

Road/track

South of Embley Project

Fig. 2-2: Indigenous Land Use Agreement Area

N

10 0 10km

Datum/Projection: GDA94/MGA Zone 54 Date: 01/04/2011

2.3 Construction

Initial construction of the Project is anticipated to commence in 2012 following receipt of relevant environmental approvals and Rio Tinto's internal project approvals and take three years. There may be opportunities to shorten the construction phase, possibly by up to 12 months depending on availability of certain contractors, equipment and labour.

The EIS has been prepared to assess the impact of several different levels of production: a minimum rate of 15Mdptpa, a maximum rate of 50Mdptpa, and a nominal intermediate rate of 30Mdptpa. However, the actual rates and the timing of production increases would depend on market conditions. Similarly, the timing and extent of associated construction activities is subject to market conditions. For the purposes of the EIS, the construction activities have been described for (a) a minimum initial production rate 15Mdptpa, (b) an expansion to 30Mdptpa, and (c) a further expansion to 50Mdptpa. While there is flexibility to undertake smaller or larger production increments depending on circumstances, the EIS has assessed these construction scenarios for the Project:

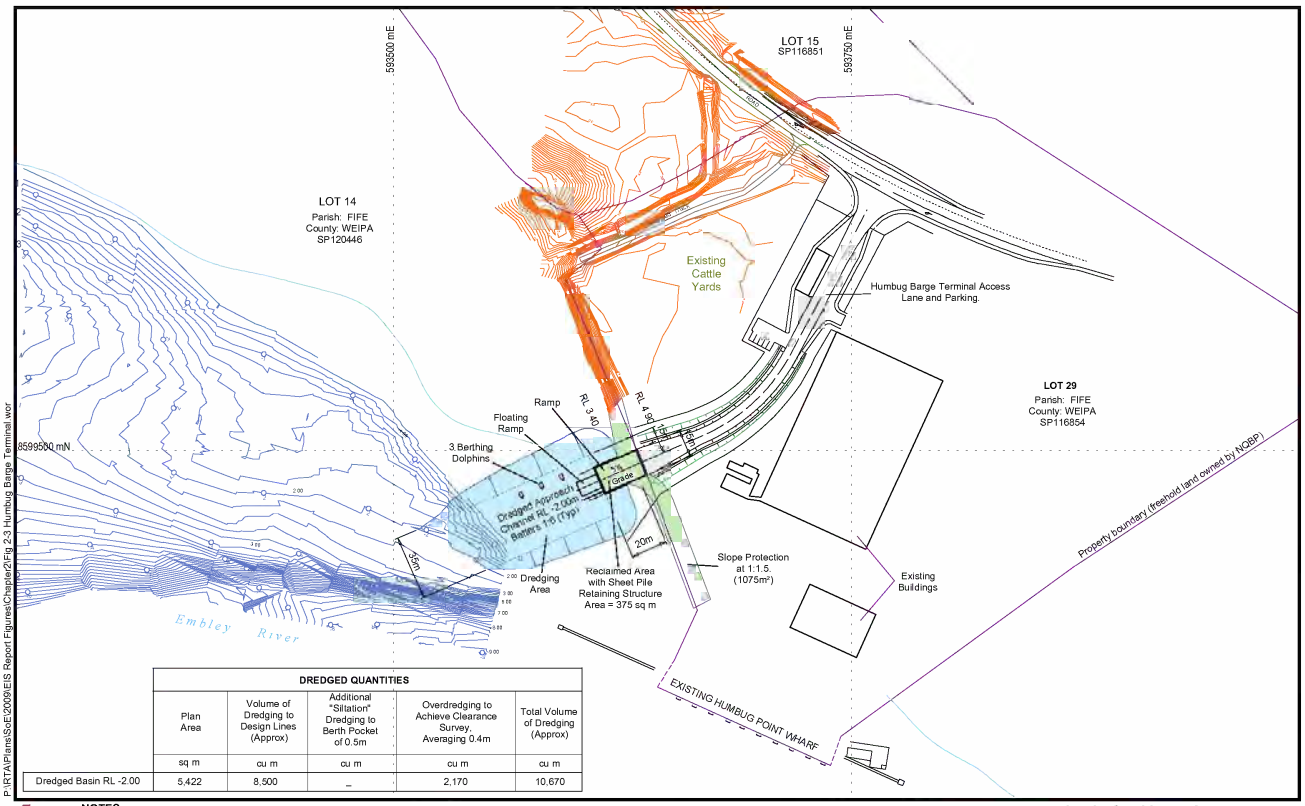
1. Construction of mine, beneficiation plant, port and associated infrastructure with a production capacity of 15Mdptpa;
2. Construction of second beneficiation plant, expansion of associated infrastructure and increase in mine production to 30Mdptpa;
3. Expansion of beneficiation capacity, port and associated infrastructure and increase in mine production to 50Mdptpa.

Note that the initial production capacity is subject to ongoing feasibility studies and would be either 15Mdptpa or 22.5Mdptpa (see **Section 1.3**). Wherever practicable and required, construction activities would be undertaken 24-hours a day. The high rainfall experienced in the wet season may restrict vehicle movements and thus curtail some construction activities in wetter months. All structures would be designed and constructed to the relevant cyclone loading specified in Australian Standards *AS1170 Structural Design Actions Infrastructure*.

2.3.1 15Mdptpa Production Capacity

The design and construction of the 15Mdptpa mine is estimated to take approximately three years. The initial priority would be to provide site access, power, telecommunications, water supply and accommodation for the construction workforce. The following works would be undertaken in the first year:

- Humbug barge terminal – construction of roll-on roll-off (RORO) facility, including floating ramp, mooring dolphins, access lane and vehicle parking. Approximately 10,700m^3 of material would be dredged and disposed of at the existing Albatross Bay spoil ground (refer **Section 6.5.2** for further information on dredging). A small area (about 400m^2) would be reclaimed behind a sheet pile wall (refer **Section 3.9.1** for further information on fill material). The location of the terminal is shown on **Figure 1.3** and the terminal layout is shown in **Figure 2-3.**
- Hornibrook ferry terminal – construction of vehicle parking, covered waiting area and walkway, pontoon and floating ramp. Approximately 19,000m^3 of material would be dredged and disposed of at the existing Albatross Bay spoil ground (refer **Section 6.5.2** for further information on dredging). An area of about 1,900m^2 would be reclaimed and supported by rock revetment and/or sheet piles (refer **Section 3.9.2** for further information on fill material). The location of the terminal is shown on **Figure 1-3** and the terminal layout is shown in **Figure 2-4**.



DREDGED QUANTITIES					
	Plan Area	Volume of Dredging to Design Lines (Approx)	Additional "Siltation" Dredging to Berth Pocket of 0.5m	Overdredging to Achieve Clearance Survey, Averaging 0.4m	Total Volume of Dredging (Approx)
	sq m	cu m	cu m	cu m	cu m
Dredged Basin RL -2.00	5,422	8,500	_	2,170	10,670

P:\RTA\Plans\SoE\2009\EIS Report Figures\Chapter2\Fig 2-3 Humbug Barge Terminal.wor

Rio Tinto Alcan

NOTES

1. VERTICAL DATUM:
   Depths are in metres and are reduced to Chart Datum (CD).
   Which is approximately the level of lowest Astronomical Tide (LAT).
   CD (LAT) is 1.752m below AHD.
2. HORIZONTAL DATUM:
   Coordinates are to MGA/GDA94 Zone 54

Reclaimed area
Dredged area

Data Source: SKM Drawing SDK-2230-0017

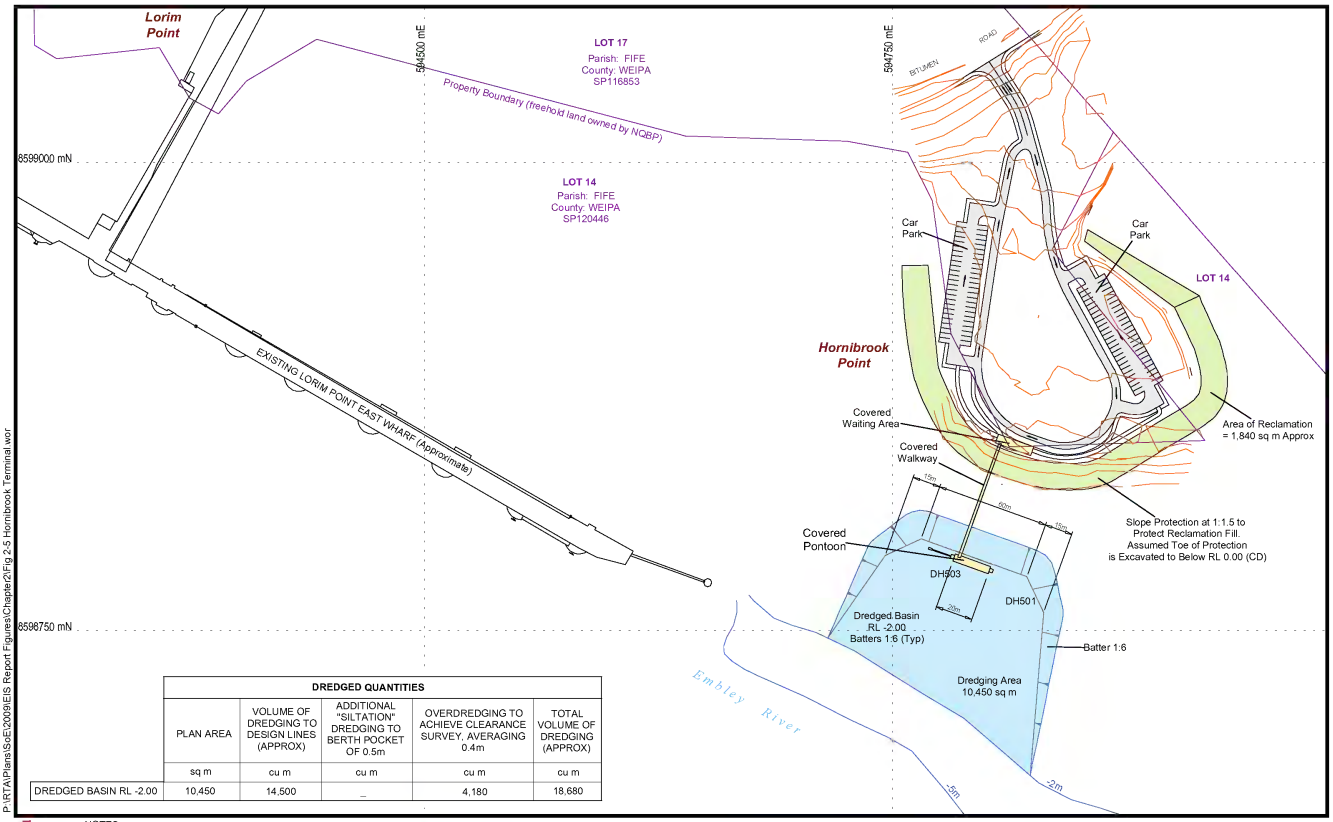
N

0 50m

South of Embley Project

Fig. 2-3: Humbug Barge Terminal

Datum/Projection: GDA94/MGA Zone 54 Date: 15/07/2010



DREDGED QUANTITIES					
	PLAN AREA	VOLUME OF DREDGING TO DESIGN LINES (APPROX)	ADDITIONAL "SILTATION" DREDGING TO BERTH POCKET OF 0.5m	OVERDREDGING TO ACHIEVE CLEARANCE SURVEY, AVERAGING 0.4m	TOTAL VOLUME OF DREDGING (APPROX)
	sq m	cu m	cu m	cu m	cu m
DREDGED BASIN RL -2.00	10,450	14,500	_	4,180	18,680

P:\RTA\Plans\SoE\2009\EIS Report Figures\Chapter2\Fig 2-5 Hornibrook Terminal.wor

NOTES

1. VERTICAL DATUM:
   Depths are in metres and are reduced to Chart Datum (CD) which is approximately the level of Lowest Astronomical Tide (LAT). CD (LAT) is 1.752m below AHD.
2. HORIZONTAL DATUM:
   Coordinates are to MGA/GDA94 Zone 54

Reclaimed area

Dredged area

Data Source: SKM Drawing SDK-2230-0016

N

0 50m

South of Embley Project

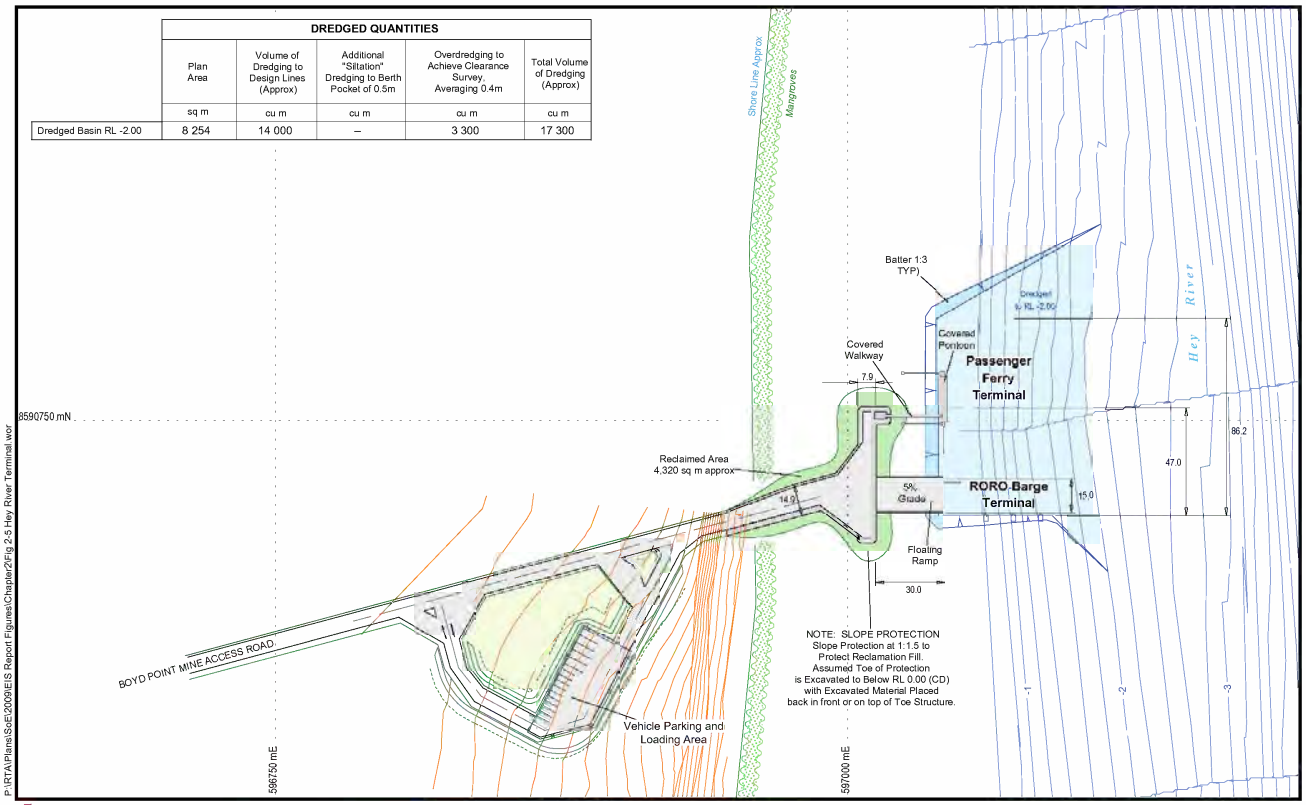
Fig. 2-4: Hornibrook Ferry Terminal

Datum/Projection: GDA94/MGA Zone 54 Date: 15/07/2010

- Hey River barge terminal – construction of Roll-On Roll-Off facility, vehicle parking, covered waiting area and walkway, pontoon and floating ramp for ferry terminal. Approximately 17,300m^3 of material would be dredged and disposed of at the existing Albatross Bay spoil ground (refer **Section 6.5.2** for further information on dredging). An area of about 4,400m^2 would be reclaimed and supported by rock revetment and/or sheet piles (refer **Section 3.9.3** for further information on fill material). A thin band of mangroves would need to be cleared. The location of the terminal is shown on **Figure 1-3** and the terminal layout is shown in **Figure 2-5.**
- Construction of all-weather sealed 38km Mine Access Road from the Hey River Terminal to Boyd infrastructure area (refer **Figure 1-3** and **Section 2.7.2**).
- A temporary camp (up to 630 beds) to accommodate construction workforce at the Boyd infrastructure area (refer **Figure 1-3**). The existing Evans Landing camp, which has been previously used for construction projects north of the Embley River, would also be utilised as required. A mobile construction camp may be used during construction of the Mine Access Road and an accommodation barge may be used during dredging for the Port.
- Temporary concrete batch plant and temporary construction fuel storage facility.
- Dredging for a new port located between Boyd Point and Pera Head (refer **Figure 1-3** for location and **Figure 2-6** for port layout). Approximately 6,500,000m^3 of material would be dredged and disposed of at a new offshore spoil ground located approximately 17km west of Boyd Point (refer **Section 6.5.1** for further information on spoil disposal).
- Commencement of construction of port and ship-loading facilities. The port would include an approach jetty and two berths totalling 900m in length and a fair-weather mooring point along the jetty for tugs. Tugs would return to Weipa in bad weather to protected moorings to be constructed alongside the existing Lorim Point east wharf. A 1.2km conveyor would transport bauxite from the product stockpile to the ship loader. The port would be built with an initial capacity of 30Mdptpa. The location of the proposed port is shown in **Figure 1-3** and the layout of the proposed port is shown in **Figure 2-6**.
- Commencement of construction of mine support infrastructure at the Boyd infrastructure area (refer **Figure 1-3** for location and **Figure 2-7** for the Boyd infrastructure area detail), including a 15.4MW diesel-fuelled power station, fuel storage, workshops, warehouse, administration facilities, and package sewage treatment plant.

The following works would be commenced in the second year and completed in the third year:

- Water storage dam (Dam C) on a freshwater tributary of Norman Creek (refer **Figure 1-3**) and associated pipeline. Under the 15Mdptpa scenario, Dam C would have an initial capacity of 10.9GL, a wall height (at spillway) of 8m and wall length of approximately 2,550m. The surface area at full supply level would be approximately 3.6km^2. Note that the dam would be constructed in a single stage (capacity of 29.0GL) should expansion of production above 15Mdptpa occur quickly, or should an initial production rate of 22.5Mdptpa be adopted (see **Section 1.6.8**). This is the subject of ongoing feasibility studies.
- Installation of four artesian bores.
- Beneficiation plant and stockpile facilities at the Boyd infrastructure area near the port (refer to **Figure 2-7**). Plant would include: a primary and secondary crushing station with the option of a tertiary crushing station if required, 4.7km of conveyors, stacker and reclaimer, and 680,000dpt stockpile.



P:\RTA\Plans\SoE2009\EIS Report Figures\Chapter2\Fig 2-5 Hey River Terminal.wor

Rio Tinto Alcan

NOTES:

Vertical Datum:
Depths are in metres and are reduced to chart datum (CD) which is approximately the level of lowest astronomical tide (LAT).
CD (LAT) is 1.508m below AHD.

Reclaimed area

Dredged area

Data Source: SKM Drawing SDK-2220-00072

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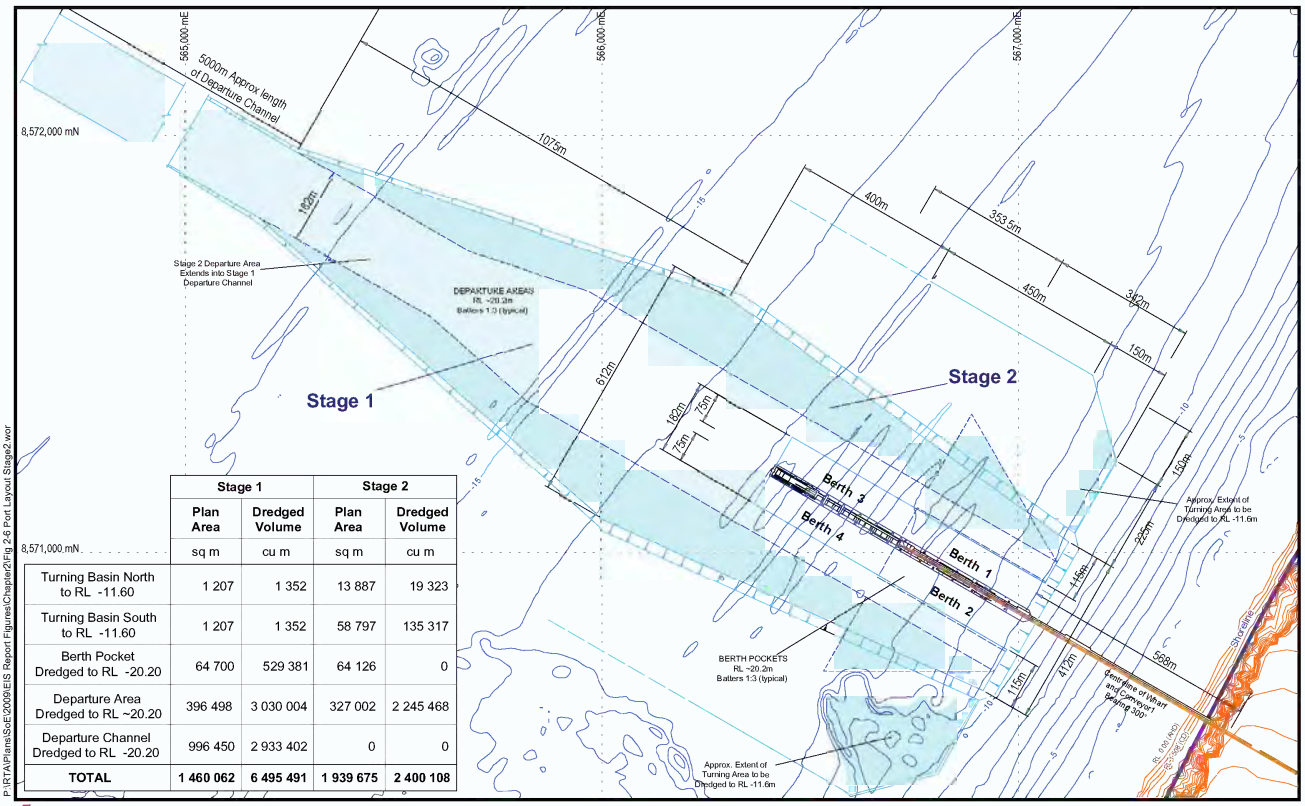
0 50m

South of Embley Project

Fig. 2-5: Hey River Barge/Ferry Terminal

Datum/Projection: GDA94/MGA Zone 54 Date: 15/07/2010



	Stage 1		Stage 2	
	Plan Area	Dredged Volume	Plan Area	Dredged Volume
	sq m	cu m	sq m	cu m
Turning Basin North to RL -11.60	1 207	1 352	13 887	19 323
Turning Basin South to RL -11.60	1 207	1 352	58 797	135 317
Berth Pocket Dredged to RL -20.20	64 700	529 381	64 126	0
Departure Area Dredged to RL ~20.20	396 498	3 030 004	327 002	2 245 468
Departure Channel Dredged to RL -20.20	996 450	2 933 402	0	0
TOTAL	**1 460 062**	**6 495 491**	**1 939 675**	**2 400 108**

P:\RTA\Plans\SoE2009\EIS Report Figures\Chapter2\Fig 2-6 Port Layout Stage2.wor

NOTES:
Vertical Datum:
Depths are in metres and are reduced to chart datum (CD) which is approximately the level of lowest astronomical tide (LAT).
CD (LAT) is 1.508m below AHD.

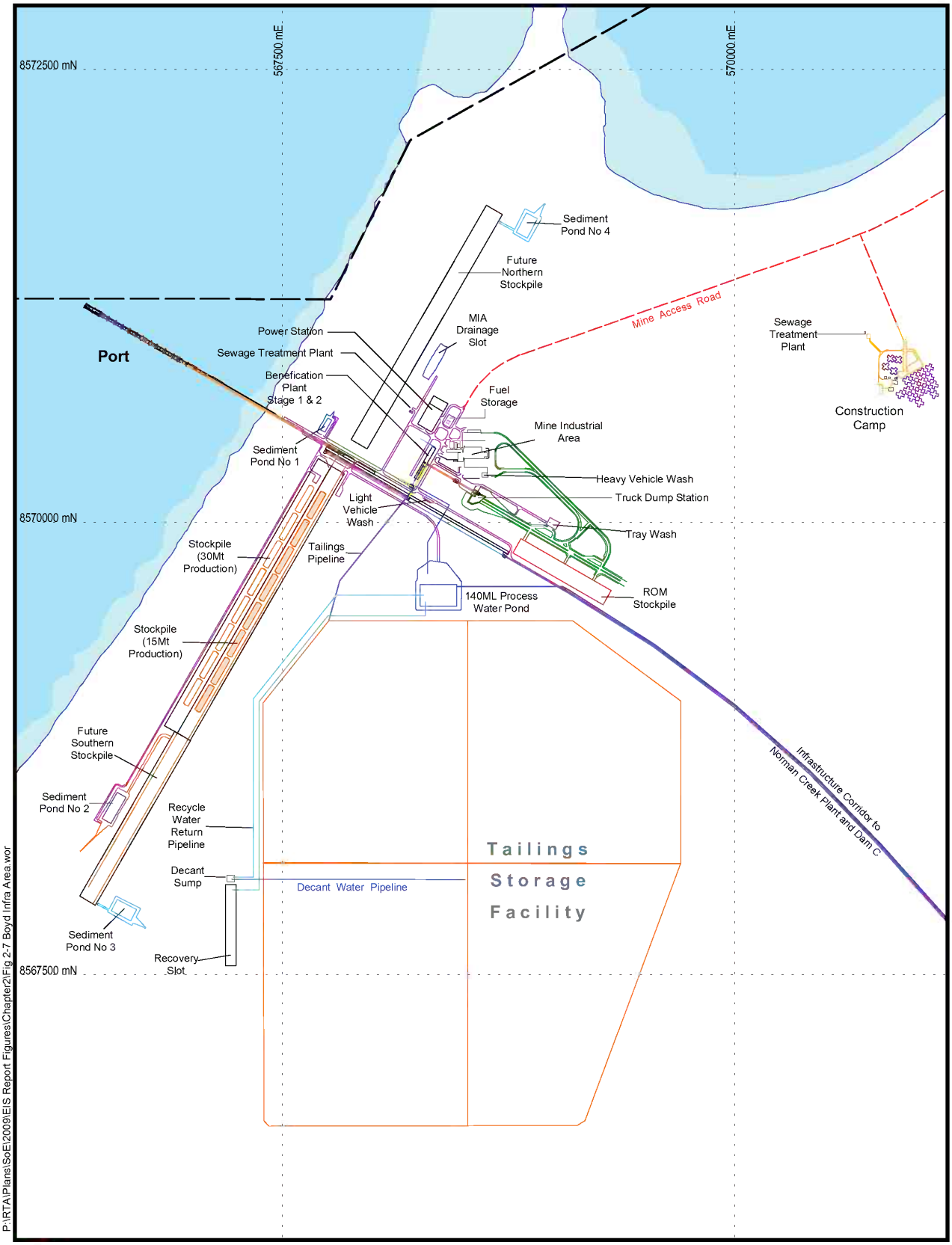
Data from SKM Drawing SOK-2231-00002 M.dxf

0 100 200 300m

South of Embley Project

Fig. 2-6: Port Layout

Datum/Projection: GDA94/MGA Zone 54 Date: 01/04/2011


8572500 mN
567500 mE
570000 mE
8570000 mN
8567500 mN
Sediment Pond No 4
Future Northern Stockpile
MIA Drainage Slot
Power Station
Sewage Treatment Plant
Benefication Plant Stage 1 & 2
Port
Mine Access Road
Sewage Treatment Plant
Construction Camp
Fuel Storage
Mine Industrial Area
Sediment Pond No 1
Heavy Vehicle Wash
Truck Dump Station
Light Vehicle Wash
Tray Wash
Stockpile (30Mt Production)
Tailings Pipeline
140ML Process Water Pond
ROM Stockpile
Stockpile (15Mt Production)
Future Southern Stockpile
Infrastructure Corridor to Norman Creek Plant and Dam C
Sediment Pond No 2
Recycle Water Return Pipeline
Tailings Storage Facility
Decant Sump
Decant Water Pipeline
Sediment Pond No 3
Recovery Slot
Lease boundary
P:\RTA\Plans\SoE\2009\EIS Report Figures\Chapter2\Fig 2-7 Boyd Infra Area.wor
South of Embley Project
Fig. 2-7: Boyd Infrastructure Area
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Datum/Projection: GDA94/MGA Zone 54
Date: 01/04/2011

- Mining of bauxite from within parts of the footprint of the proposed tailings storage facility located south of the Boyd beneficiation plant (refer **Figure 2-7**), and stockpiling of ore for later processing. Construction of the initial cells of the tailings storage facility.

Construction of the wharf and jetty would utilise pre-assembled modules for the deck structure to reduce the site labour component where practical. The construction plan allows for the yard machines (stacker, reclaimer and ship loader) arriving in large pre-assembled modules transported via heavy lift ships.

Construction of the port would start with dredging of the berth pocket followed by driving the piles supporting the wharf and jetty structures as well as the separate berthing and mooring structures. Piles may be driven by a piling rig mounted on a jack-up barge to improve access to inshore shallow areas. Prefabricated headstocks would be lifted and welded in position to the piles. Placement of the prefabricated wharf and jetty decks is anticipated to be by heavy lift cranes mounted on barges or by a heavy lift vessel delivering the deck units. The jetty and wharf deck structures would have conveyor galleries and services pre-assembled to the extent practical to minimise work over water. Small bore piping conveyor belting and electrical cabling would be site run.

The Boyd beneficiation plant and the administration and maintenance infrastructure would be erected on-site using conventional construction methods. Construction materials and equipment would be trucked to site initially via the PDR and existing Access Roads (refer **Figure 1-3**) until barge facilities have been constructed at the Hey River barge/ferry terminal (approximately six months into the construction period). During this initial phase, some equipment and materials required for the commencement of construction may be brought ashore by barge between Boyd Point and Pera Head, and at Hey Point. Transportation of materials to the Project site is discussed further in **Section 14**.

Approximately 35,800m^3 of aggregate, 15,000m^3 of concrete and 8,000t of steel would be required for construction. Approximately 4,900,000m^3 of cut and fill earthworks would be undertaken in order to level ground surfaces for facilities and to construct a water storage dam, tailings storage facility and truck dump station. Ground levelling would typically not require more than 0.5m excavation, but may reach 2m for the southern end of the product stockpile area. Construction areas are generally the higher elevations in the landscape dominated by deep reddish massive gradational soil with aluminous concretions. Excavation to a depth of several metres would be required for the water storage dam and tailings storage facility. Material excavated would comprise subsoil, low quality bauxite/clay mix, kaolin clay and ironstone. This excavated material is suitable for construction of infrastructure, including dams (refer **Section 5.2.3** for details of dam construction). Topsoil from construction areas would be stripped and stockpiled for later use in rehabilitation of infrastructure areas.

Water for construction purposes would be obtained from Norman Creek until such time as the permanent water supply facilities are built. The indicative number and type of construction equipment is shown in **Table 2-2**.

Table 2-2 Construction Equipment

Equipment	Quantity
Trucks (100t)	12
Trucks (50t)	3
Loaders	4
Scrapers	6
Graders	4
Water cart	3
Dozer	4
Crane	4
Concrete truck	3
Light vehicles	50

2.3.2 30Mdptpa Production Capacity

The expanded 30Mdptpa production capacity scenario would be attained once mining at Andoom ceases.

A second mine infrastructure area would be established at the Norman Creek mining area (refer **Figure 1-3**).

At a 30Mdptpa production capacity scenario, the following additional works would be required:

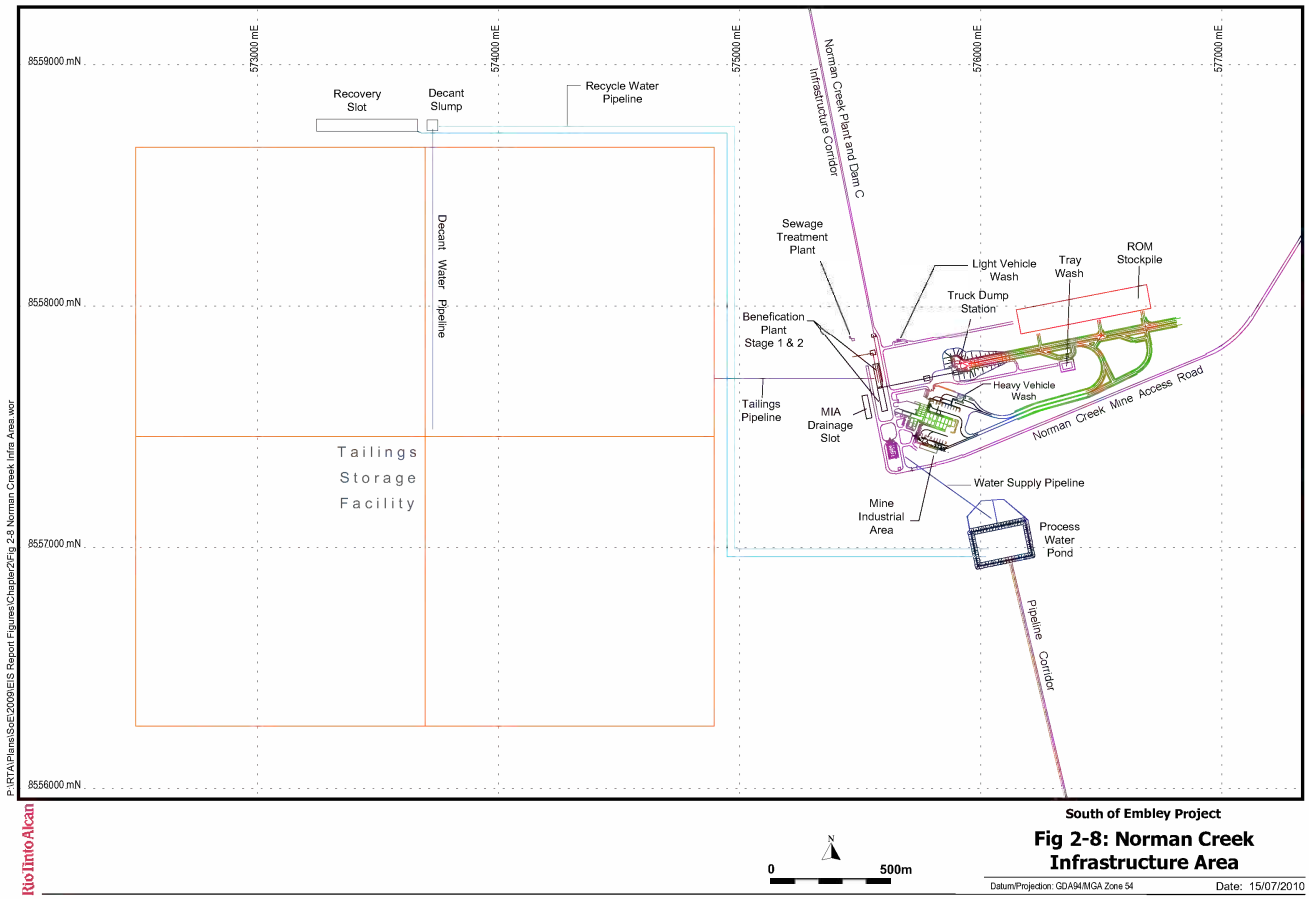
- 24km sealed Norman Creek Mine Access Road (constructed as a spur from the existing Mine Access Road) (refer **Figure 1-3**).
- Dam C (refer **Figure 1-3**) would have a capacity of 29.0GL, through a raise in height (at spillway) of the existing wall from 8m to 12m (if not initially built at this capacity). The wall length would be approximately 3,850m and the surface area at full supply would be approximately 6.5km^2.
- Water pumping station on the Ward River (refer **Figure 1-3**) and associated 16km pipeline and power line. The annual volume of water pumped from the Ward River would be capped at 1% of mean annual river flow at the pump station (2.67GL).
- Three artesian bores.
- Primary crusher and beneficiation plant with 15Mdptpa capacity at the Norman Creek infrastructure area (refer **Figure 2-8**).
- 15km overland conveyor to the port product stockpiles (refer **Figure 1-3**). The port stockpile capacity would be increased to 1.26Mdpt.
- High voltage power line extension from Dam C to the Norman Creek infrastructure area.
- Associated infrastructure at the Norman Creek infrastructure area including fuel storage, workshops, warehouse, administration facilities and package sewage treatment plant (refer **Figure 2-8**).
- Tailings storage facility located in the vicinity of the Norman Creek beneficiation plant (refer **Figure 2-8**). This would be preceded by mining of bauxite from within parts of the footprint of the proposed tailings storage facility and stockpiling of ore for later processing.
- Power station expansion at the Boyd infrastructure area to 29MW.

The port does not need to be expanded until production exceeds 30Mdptpa.

2.3.3 50Mdptpa Production Capacity

50Mdptpa production capacity would be attained when market conditions allow. At a 50Mdptpa capacity scenario, the following additional infrastructure would be required:

- Expansion of beneficiation plant capacity at Norman Creek and/or Boyd infrastructure areas to an aggregate of 50Mdptpa. The size of the increment in capacity at either plant would depend on feasibility studies at the time. For the purposes of the EIS, both plants are assumed to have 25Mdptpa capacity.
- Installation of five artesian bores.
- Expansion of the power station at the Boyd infrastructure area to 54MW.
- Expansion of the port product stockpile capacity to 2.55Mdpt.
- Extension of the wharf to accommodate two extra berths at the port. To accommodate the extra berths and departure areas, approximately 2,400,000m^3 of material would be dredged and disposed of at the offshore spoil ground located approximately 17km west of Boyd Point.


573000 mE
574000 mE
575000 mE
576000 mE
577000 mE
8559000 mN
8558000 mN
8557000 mN
8556000 mN
Recovery Slot
Decant Slump
Recycle Water Pipeline
Decant Water Pipeline
Tailings Storage Facility
Norman Creek Plant and Dam C Infrastructure Corridor
Sewage Treatment Plant
Light Vehicle Wash
Tray Wash
ROM Stockpile
Truck Dump Station
Benefication Plant Stage 1 & 2
Heavy Vehicle Wash
Tailings Pipeline
MIA Drainage Slot
Norman Creek Mine Access Road
Water Supply Pipeline
Mine Industrial Area
Process Water Pond
Pipeline Corridor
P:\RTA\Plans\SoE2009\EIS Report Figures\Chapter2\Fig 2-8 Norman Creek Infra Area wor
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South of Embley Project
Fig 2-8: Norman Creek Infrastructure Area
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Datum/Projection: GDA94/MGA Zone 54
Date: 15/07/2010

2.4 Bauxite Mining

2.4.1 Ore Reserves

Ore reserves are reported in accordance with the *Australasian Code for Reporting of Exploration Results, Mineral Resources and Ore Reserves* (known as the JORC Code) as required by the Australian Securities Exchange (ASX). As of 31 December 2010 a total of 1,602 million tonnes of bauxite reserves with a 53% grade have been reported within RTA's Weipa mining leases, with a considerable proportion of the reserve within the portion of ML7024 south of the Embley River.

Exploration activities are ongoing throughout the Project area and involve prospecting, the establishment of access tracks, drilling, test pits, use of instruments and equipment for mineral detection, sampling and digging to extract test material and ore samples to determine mineral content, land clearance, and trucking of ore and test samples extracted. Resource evaluation would be ongoing throughout the life of the mine to better define the bauxite reserves.

2.4.2 Mine Development and Schedule

The Project currently has bauxite reserves that could sustain a mine life of about 40 years, depending on annual production rate. Mine life also depends on the extent to which mineable reserves may change in the future subject to resource evaluation and economic factors.

The conceptual 40-year mine plan is shown in **Figure 1-3**. Mining would commence in the Boyd Point – Pera Head area, and would later be extended to the Norman Creek area. **Figure 1-3** shows the areas to be mined in years 1–13 (i.e. at a production rate of 15Mdptpa) and in years 14–40 (i.e. at a production rate of 30Mdptpa and above).

The areas to be mined comprise *Eucalyptus tetrodonta* woodlands on bauxite plateaus. Approximately 5,300ha of woodland would be cleared for mining over years 1–13 and 21,980ha over years 14–40. The areas and the conservation status of vegetation to be cleared during the construction and operation phases of the Project, as well as mitigation measures, are discussed in **Section 7.9**.

Vegetation would be cleared by bulldozers, following the wet season when the ground is sufficiently moist to allow tree roots to pull clear of the ground rather than breaking. Consideration would be given to the selective extraction of structural-grade timber in the Project area prior to mining, where practicable and where the timber can be beneficially used. The cleared vegetation would be pushed into windrows and burnt.

Approximately 60cm of soil would be salvaged and returned by scraper or haul truck directly to mined-out areas undergoing rehabilitation, where possible, or stockpiled for later respreading. The overburden above the bauxite would then be removed by front-end loader and returned to mined-out pits by trucks.

2.4.3 Mining Equipment and Methods

The top of the bauxite strata is generally less than 1m below the natural ground surface. The average ore thickness across the Project area is approximately 3.4m.

A shallow open pit would be developed whereby bauxite would be mined by front-end loader or excavator. Bauxite is relatively easy to dig and does not require blasting. The ore would be loaded into 180t dump trucks and transported via dedicated haul roads to a truck dump station adjacent to the beneficiation plant.

A list of the mining equipment used at 15, 30 and 50Mdptpa production rates is presented in **Table 9.3**.

2.4.4 Final Landform

After overburden and soil are returned to mined-out pits the final landform would be at a lower elevation than the original landform due to the removal of the bauxite, but the overall slope of the landform would be similar. Where mining leaves batters on the edges of the pit, these

would be recontoured to a maximum slope of 20% (1 in 5). The final landform would not have any out-of-pit dumps of excavated waste material or soil.

2.5 Bauxite Processing (Beneficiation)

Product-grade bauxite is processed by beneficiation, a process where oversized particles are removed by screening and fine particles are removed by washing. After beneficiation, product bauxite would be stockpiled prior to shipping from the proposed port.

The beneficiation process generates tailings, which are pumped to a tailings storage facility where water is decanted and recycled back to the plant. Each stage of the process is discussed below. The indicative layout of the Boyd and Norman Creek beneficiation plants is shown in **Figure 2-7** and **Figure 2-8** respectively.

2.5.1 Beneficiation Plant

Crude ore is transported to a truck dump station and dumped into a hopper. The ore is then sized to <300mm in a primary crusher and then <90mm in a secondary crusher. Ore is then conveyed to the beneficiation plant. The plant function is to disperse the crushed crude bauxite by using water and separate oversize tramp and high-silica fines fractions from the product bauxite fractions, and then to dewater the product bauxite. No chemicals are used in the beneficiation process. The oversize rejects would report to a tertiary crusher for blending with the product stream or be conveyed directly to a rejects stockpile for subsequent disposal. The high-silica fines fractions would report to a tailings storage facility via the tailings pumping system. The dewatered product bauxite would report to the product stockpiles.

In the plant, crushed ore and dispersion water is fed to single-deck scalping screens. Water sprays over the scalping screen decks complete the dispersion of the crude ore. The decks of the scalping screens classify and separate oversize rejects (+25mm) from the crude bauxite feed. The underflow slurry (–25mm) from each scalping screen flows by gravity onto a dedicated product screen for final classification and dewatering of the product (+0.6mm). The product from all screens collects on the product conveyor and the underflow from the product screens would flow by gravity to tailings sumps.

The oversize material from the scalping screens would be conveyed to a nominal 4,000t stockpile adjacent to the plant. A larger 100,000t oversize stockpile would be located between the plant and the tailings storage facility. This material would be reprocessed, used for construction (e.g. roads, tailings storage facility walls) or returned to mined-out pits.

The beneficiation plant building structure would support the scalping and product screens, and outgoing conveyors. Elevated concrete frames would support the scalping screens. Ground level steel beams located over the below-grade screen-underflow sumps would support the scalping screens. Steelwork supports would provide all other supports and access-ways in the building structure. Stair towers would provide access at each end of the beneficiation plant to allow two points of egress. A concrete apron slab would drain area sumps.

The initial Boyd and Norman Creek beneficiation plants would be similar "low dispersion energy" plants designed to process approximately 3,400 wet crude tonnes per hour and each plant would use approximately 1t of water to produce 1t of product bauxite. Each plant would be designed so it can be expanded in the future. Approximately 40% of the crude ore in the Norman Creek mining area has elevated fines content that may require "high dispersion energy" beneficiation. This ore would be processed through a "high dispersion energy" module that would be added to the existing plant. This module would use approximately 1.9t of water to produce 1t of product bauxite.

Approximately 35% of the water used in the beneficiation plants would be recycled from tailings storage facilities. Overall bauxite product recovery from crude ore would average approximately 70%.

2.5.2 Tailings

Beneficiation produces tailings consisting of water, fine bauxite pisolites, sands and clays. Approximately 0.4Mt of tailings is produced for every 1Mdpt of product bauxite. Depending on the source of crude ore, the geotechnical classification of tailings ranges from a sandy silt with clay to a clayey silt. Bauxite tailings are benign, contain no added chemicals and are not classed as hazardous under the DERM criteria for *Determining Dams Containing Hazardous Wastes* (refer **Section 13.3.4**).

The tailings would be pumped in slurry form (30% solids by weight) from a tailings sump at the beneficiation plant to a tailings storage facility. The tailings storage facilities are "turkey's nest" dams where tailings are discharged from the perimeter wall into cells within the dam. The tailings solids would beach and suspended solids would settle out and water would be decanted and pumped back to the beneficiation plant for reuse in processing. The tailings storage facilities are divided into cells to facilitate the cycling of tailings perimeter deposition within a cell, and between cells, to enhance formation of a broad tailings beach adjacent to the perimeter walls that dries quickly to a consistent density over its full depth. Tailings storage facility walls would be raised in lifts of approximately 3m using an upstream raising technique (refer **Section 13.3.4**).

The tailings storage facility for the Boyd and Norman Creek beneficiation plants would be located close to the plants and each would have four cells which would be constructed and commissioned over several years. Prior to construction of each cell, the bauxite from within each cell would be mined and fed into the plant if it is operating, or stockpiled for later processing if not. This approach would avoid sterilization of economic bauxite reserves and reduce the extent of clearing of vegetation. The Boyd tailings storage facility would have a capacity of approximately 182Mt, cover an area of approximately 580ha and be about 22m high upon completion. The Norman Creek tailings storage facility would have a capacity of approximately 204Mt, cover an area of approximately 580ha and be about 25m high upon completion. These tailings storage facilities would have sufficient capacity for the 40-year mine plan.

2.5.3 Product Stockpiles

Product bauxite from the beneficiation plants would be conveyed to a stacking feed conveyor which supplies a travelling luffing and slewing stacker which deposits bauxite onto a stockpile pad. The stacker would stack product into a range of discrete stockpiles varying in product quality. The stacker would operate at a nominal rate of 2,500dptph. A bucket wheel reclaimer would reclaim selected stockpile material at a nominal rate of 9,000dptph and feed this onto a reclaim conveyor, which in turn feeds a load-out conveyor to the wharf.

The stockpile area would be expanded in stages as production increases. Should ore from neighbouring mines operated by others be shipped through the proposed port, such ore would be conveyed by others across ML7024 to the stockpile area. Allowance has been made in the stockpile layout to enable additional stockpile capacity to be added adjacent to RTA's facilities to accommodate product from third parties following agreement on suitable commercial terms.

At a production rate of 15Mdptpa, the stockpile capacity would be 680,000dpt and it would occupy 17ha. At a production rate of 30Mdptpa, the stockpile capacity would be 1.36Mdpt and it would occupy 34ha. At an RTA production rate of 50Mdptpa, and assuming 13Mdptpa production from third parties as well, the stockpile capacity would be 2.55Mdpt and it would occupy 59ha.

The fully-developed product stockpile layout, including provision for third parties, is shown in **Figure 2-7.** The extension of the stockpiles to the north of the beneficiation plant would require an additional stacker and reclaimer.

2.6 Port Facility and Shipping

RTA proposes to construct and operate port facilities located between Boyd Point and Pera Head. Works would include an approach jetty, wharf, berths, ship-loader and dredging of berth pockets and departure areas. The proposed port is located outside the Port of Weipa port limits.

Initially, RTA proposes to construct and operate a port capable of shipping 30Mdptpa. The first stage of the Port would enable replacement of bauxite exports from the existing Port of Weipa Lorim Point wharf in the Embley River as bauxite reserves at East Weipa and, later, Andoom are depleted. The port would be designed to permit future expansion to ship up to 63Mdptpa. Capacity may be provided for third parties following agreement on suitable commercial terms.

2.6.1 Facility details

The port would include an approach jetty approximately 568m long and, initially, a 342m wharf with two berths. A further two berths would be added when production rises above 30Mdptpa. The four-berth wharf would be approximately 696m long. The berths consist of an "I" berth aligned perpendicular to the shoreline (at 300 degrees). The port would be capable of accepting bulk carrier vessels of up to 185,000 dead weight tonnage and 18.1m draft. Separate berths would be provided for tugs and line boats. Separate berthing and mooring dolphins are provided which isolate ship berthing loads from the main wharf structure. The port is also equipped with the appropriate navigational aids.

The approach jetty would support the product load-out conveyor and a vehicle access roadway from the Boyd infrastructure area. The wharf supports a rail-mounted travelling luffing and slewing ship loader capable of loading at a rate of 9,000t/hr. Ships would not be refuelled at the proposed port. The port layout is shown in **Figure 2-6.**

Initially, approximately 6,500,000m^3 of marine sediments would be dredged to establish the berth pockets and departure areas over a period of about 300 days. For the purposes of evaluation studies, it has conservatively been assumed that vessel departures are unrestricted by tides and hence the depth of dredging required has been matched to this assumption. The dredging would be carried out by a cutter suction dredger re-depositing material on the sea bottom and retrieved by a trailing suction hopper dredge (TSHD). Dredged spoil would be transported by the TSHD to a new offshore spoil disposal ground located approximately 17km west of Boyd Point (refer **Figure 2-9** for location). Initially, annual maintenance dredging of approximately 890,000m^3 is expected to be required to maintain under keel clearance for ships. Once the wharf is extended, an extra 280,000m^3 of maintenance dredging would be required annually equating to annual maintenance dredging of the port of approximately 1,170,000m^3.

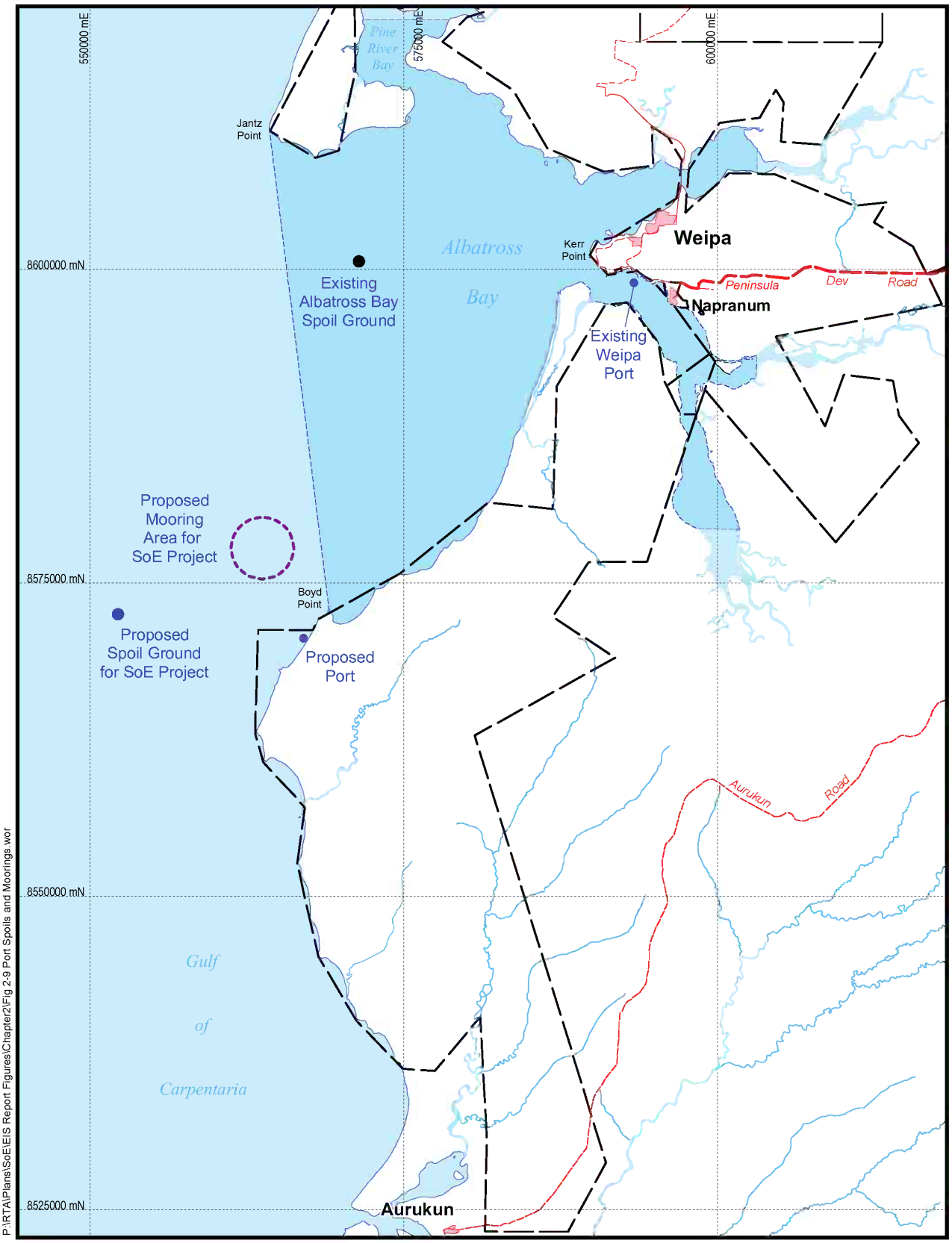
When the wharf is extended in a second stage to expand its capacity to at least 50Mdptpa, a further 2,400,000m^3 of dredged spoil would be generated and disposed of at the same offshore spoil ground.

Dredging and spoil disposal would be conducted 24 hours a day, seven days a week. Further details of the proposed dredging and spoil disposal are presented in **Section 6.5.1**.

2.6.2 Shipping

When a ship arrives near the port and has to wait to berth, it would generally anchor in an offshore mooring area in water approximately 20m deep (refer **Figure 2-9**). However, some ships may be able to anchor in waters between 20 and 14m deep and therefore the specific location of the anchorage areas would be subject to the approval of the operator of the Port, who would direct ships according to conditions at the time through the shipping agent.

The Port would be designed for continuous hours of operation. When the port is ready to receive a ship, tug boats would assist to manoeuvre the ship safely and efficiently to the berth.



RTA Mining Lease boundary
Township
Drainage
Road/track
Weipa Port Limits

South of Embley Project

Fig. 2-9: Port, Spoil Ground and Mooring Locations

N

0 5 10 15km

Datum/Projection: GDA94/MGA Zone 54 Date: 01/04/2011

RioTintoAlcan

The estimated shipping frequencies at each production level are summarised below:

- 15Mdptpa – up to 215 ships/annum (4–5 ships/week)
- 30Mdptpa – up to 430 ships/annum (8–9 ships/week)
- 50Mdptpa – up to 700 ships/annum (14 ships/week).

The operation of the proposed port would require the services of three tugs at maximum production. When not in use, it is proposed to berth these tugs in unprotected moorings alongside the approach jetty or, if weather conditions require, at protected moorings alongside the existing Lorim Point east wharf. Modification to the existing east wharf at Lorim Point would be required with the installation of berthing frames and walkways on the landward side of the east wharf.

Once loaded, bulk carriers travelling to Gladstone would continue sailing the existing route through the Gulf of Carpentaria, the Torres Strait shipping route, and transit the inner route of the Great Barrier Reef under pilotage.

RTA operates the existing Lorim Point ship-loader at the Port of Weipa and has implemented the MarineSafe system developed by Rio Tinto Marine. This system implements the requirements of the Australian Maritime Safety Authority (AMSA), ISO14001 and other relevant international statutory authorities, relevant class rules, regulations and ship management contracts. The proposed port would operate under this system.

Further details regarding shipping are presented in **Section 14.4**.

2.7 Associated Infrastructure

This section describes infrastructure that would be constructed as part of the Project to support the mining, processing and shipping activities.

2.7.1 Workforce and Accommodation

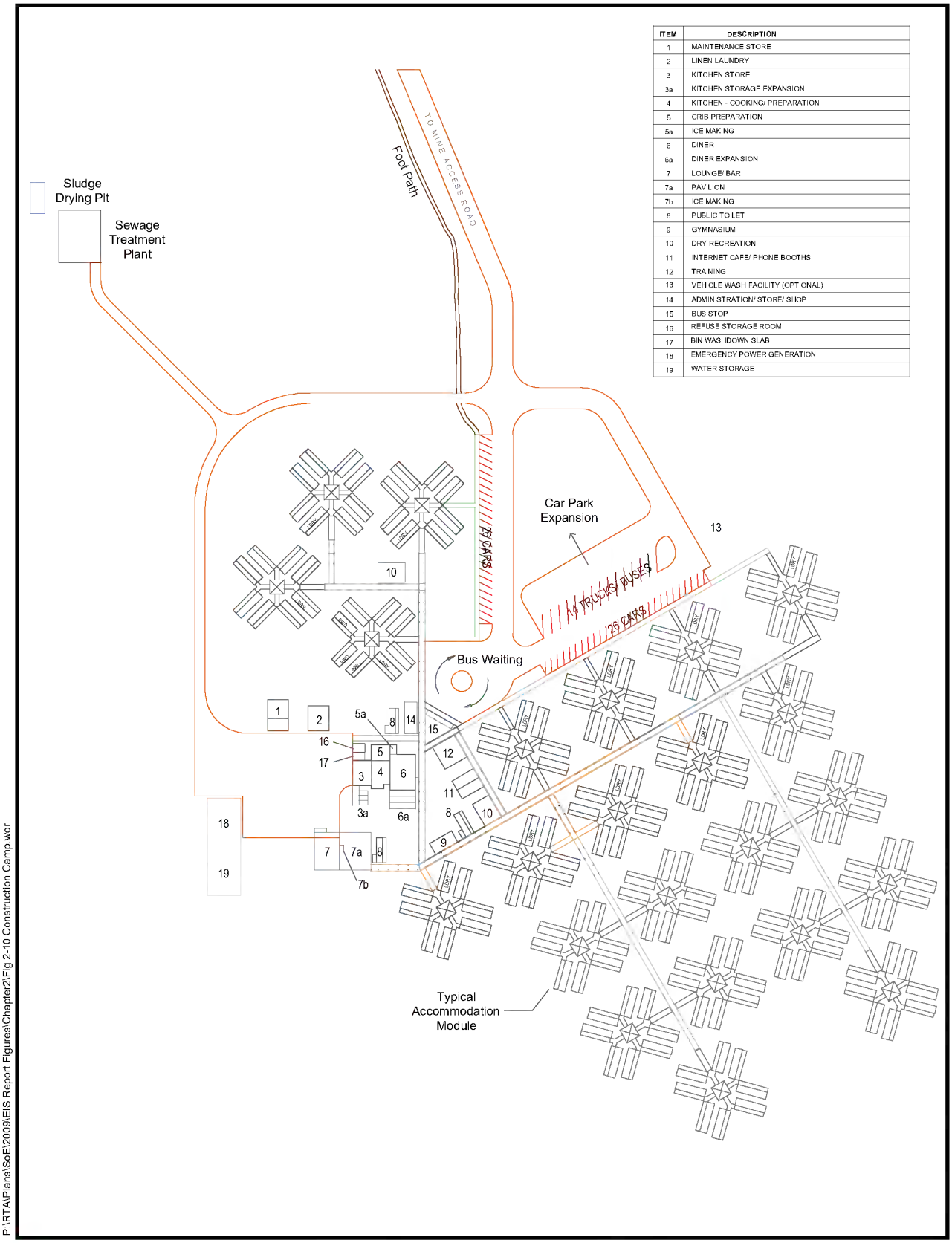
The construction phase would take three years and workforce numbers would vary over that period, peaking at about 630 and averaging approximately 307 full-time equivalents over three years. There may be opportunities to shorten the construction phase, possibly by up to 12 months depending on availability of certain contractors, equipment and labour. Should this occur, the average and peak construction workforce would rise in approximate inverse proportion to the reduction in the length of the construction phase.

The Project construction workforce would be a "single status" workforce. When not on roster, the construction workers would return to their point of hire. The large majority of these would be from the east coast of Australia and they would fly-in and fly-out of Weipa airport and be transported back and forth to the construction site by RTA in buses. Local hire construction workers would return to their existing residences in Weipa, Napranum, Aurukun or Mapoon when off roster. No changes to the Weipa airport infrastructure would be required, although additional commercial flights would be required during the construction period.

A temporary construction camp would be established 2km north-east of the Boyd infrastructure area, away from any noise and dust arising from construction works. The camp design would enable expansion up to 630 beds for the peak construction workforce. The camp would consist of:

- sleeping quarters;
- canteen, kitchen and crib preparation;
- mess hall, recreational areas and sporting facilities;
- training room;
- ablution facilities; and
- laundry.

The camp layout is shown in **Figure 2-10**.



ITEM	DESCRIPTION
1	MAINTENANCE STORE
2	LINEN LAUNDRY
3	KITCHEN STORE
3a	KITCHEN STORAGE EXPANSION
4	KITCHEN - COOKING/ PREPARATION
5	CRIB PREPARATION
5a	ICE MAKING
6	DINER
6a	DINER EXPANSION
7	LOUNGE/ BAR
7a	PAVILION
7b	ICE MAKING
8	PUBLIC TOILET
9	GYMNASIUM
10	DRY RECREATION
11	INTERNET CAFE/ PHONE BOOTHS
12	TRAINING
13	VEHICLE WASH FACILITY (OPTIONAL)
14	ADMINISTRATION/ STORE/ SHOP
15	BUS STOP
16	REFUSE STORAGE ROOM
17	BIN WASHDOWN SLAB
18	EMERGENCY POWER GENERATION
19	WATER STORAGE

P:\RTA\Plans\SoE\2009\EIS Report Figures\Chapter2\Fig 2-10 Construction Camp.wor

Rio Tinto Alcan

South of Embley Project

Fig. 2-10: Construction Camp Layout

N

0 100m

Datum/Projection: GDA94/MGA Zone 54

Date: 15/07/2010

There would be a licensed wet mess at the temporary camp near Boyd Bay for the responsible service of alcohol to camp occupants only. The consumption of alcohol would be well regulated and confined to the wet mess and immediate delineated area (refer **Section 16.3.8** for further information). The following additional alcohol controls would apply:

- secure storage;
- limits on daily consumption;
- restricted hours of operation/availability;
- close supervision of premises;
- RTA's standard drug and alcohol testing protocols, including random testing as a part of the Fitness for Work program;
- alcohol from the wet mess or elsewhere would not be permitted to be taken into the rest of the camp by occupants or visitors; and
- management approval would be required to drink alcohol outside the wet mess area.

The camp has been designed to meet the relevant requirements of the Building Act 1975 (Qld) and Building Fire and Safety Regulation 2008 (Qld). The camp does not require local government planning approval. Where necessary, control programs for vermin and mosquitoes would be undertaken on a regular basis by a licensed Pest Control Technician. Camp wastes would be disposed of in the existing Evans Landing landfill at Weipa.

During construction there would be an emergency services facility located at the Boyd infrastructure area staffed by qualified personnel. A site emergency response plan would be prepared which would document the methods and procedures to accommodate visiting police and emergency services to deal with any major incident (refer **Section 19.3** for further information). Safety management standards and procedures are discussed in detail in **Section 18**.

The on-site construction camp would be removed at the completion of construction.

The existing Evans Landing camp, which has been previously used for construction projects north of the Embley River, would also be utilised as required. A mobile construction camp may be used during construction of the Mine Access Road and an accommodation barge may be used during dredging for the Port. These camps would be utilised for a limited number of people over a shorter timeframe.

The SoE operational workforce would be based in Weipa. Details of operational workforce numbers at RTA's existing operations (including ML7024 and ML7031) and the estimated SoE operational workforce are shown in **Table 2-3.** While SoE and Andoom/Ely are both in production, the SoE employee component is estimated to be 500. The predicted generation of direct and indirect employment in the local economy is detailed in **Section 17.4.3**.

Table 2-3 Operations Workforce

Production Scenario	Average Operations Workforce		
	Employee	Contractor	Total
2006 – East Weipa, Andoom and Ely	777	107	884
2007 – East Weipa, Andoom and Ely	825	345	1170
2008 – East Weipa, Andoom and Ely	912	245	1157
2009 – East Weipa, Andoom and Ely	826	85	911
15Mdptpa – South of Embley, Andoom and Ely	800	200	1000
30Mdptpa – South of Embley	760	190	950
50Mdptpa – South of Embley	1020	255	1275

The effects of the Project on the size of the local population and demand for accommodation are discussed in **Section 16.2.1** and **Section 6.3.11** respectively.

The occupational groupings of the SoE workforce would be unchanged from the current workforce and would include engineers and other professionals, technicians, tradespeople, plant operators and semi-skilled and unskilled labour. RTA would continue to work with the local community to invest in employment and training to create a locally-based labour pool with the appropriate skill sets and knowledge to meet the particular employment needs of the Project. Information on employment opportunities, recruitment and training programs, including those conducive to the recruitment and retention of local Aboriginal employees, is included in **Section 16.3.4**.

In 2008, Rio Tinto Alcan, together with numerous other partners, signed the Regional Partnership Heads of Agreement (RPA). The RPA was a statement of intent by the parties to work together to improve opportunities for employment and training of Indigenous people in the Western Cape region. The Agreement established a job placement target of 50 additional local Indigenous people into mainstream jobs within the Western Cape region each year for five years (refer **Section 17.4.7**). RTA would identify and pursue Indigenous employment opportunities related to the Project in the following areas:

- youth development, education, vocational programs and bursaries;
- pre-work development, including school-to-work pathways and work readiness programs;
- local Aboriginal Traineeship and apprenticeship programs;
- leadership development; and
- employment opportunities with RTA contractors and other local businesses.

2.7.2 Transport

Prior to construction of the barge and ferry terminals, construction workers would travel by road to the SoE site via the PDR, Aurukun Road, Beagle Camp Access Road and Pera Head Access Road. Once the ferry terminals and new Mine Access Road have been constructed, they would be transported from the Hornibrook Terminal by ferry to the Hey River Terminal and then by bus to the construction camp at the beginning and end of each roster. Access to the barge, ferry and Mine Access Road would be subject to authorisation by RTA.

The maximum vehicle trip ends (vte) anticipated during the construction phase is 20 per day for the link between Weipa and site via the PDR and Aurukun Road. A full description of transportation requirements, infrastructure and potential impacts is provided in **Section 14**. The proposed transport infrastructure is shown in **Figure 1-3**.

During operations, the workforce would be housed in the existing Weipa community and commute to SoE on a daily basis via ferry and the Mine Access Road. The ferry would be sized according to the number of people on each shift and would be sufficiently seaworthy to sail in all but severe weather events. Ferries would operate as needed, however 3–4 ferry crossings per day is estimated for 15Mdptpa, increasing to 4–6 crossings per day at 50Mdptpa. The ferry crossing would take approximately 12 minutes each way.

Roads

RTA proposes to upgrade the intersections from the Humbug barge terminal and the Hornibrook ferry terminal with the PDR to improve traffic flow and safety. No other changes affecting State or local Government controlled roads are required to support the Project.

A new 38km "on-lease" Mine Access Road from the Hey River Terminal to the Boyd infrastructure area is proposed. It would have a sealed pavement with a design speed of 110km/hr. The number of vehicle movements along the Mine Access Road would be very low, with most employees and contractors travelling to and from the mine on buses. Signs would be posted to raise awareness of possible fauna movement across the Mine Access Road.

The road alignment and creek crossings are designed to provide all weather access up to a 1 in 10-year storm event. A section of the access road near the Boyd infrastructure area would be

widened to meet the Royal Flying Doctor Service standards to provide for emergency aircraft evacuation of sick or injured people.

A typical cross section of the Mine Access Road is shown in **Figure 2-11.** The maximum clearing width is 45m to account for the following in both directions:

- 1.5m shoulder;
- 3.5m traffic lane; and
- up to 17m for table drains and also setback area to provide roadside visibility.

The Mine Access Road alignment follows elevated portions of the landscape wherever possible to enable all weather access; however, box culvert causeways would be required at certain watercourses. The road would transverse nine separate watercourse crossing points and require up to eight adjacent box culverts (3.6m wide x 1.8m high) at each crossing.

When the Norman Creek infrastructure area is developed, a 24km spur road would be constructed from the main Mine Access Road. Four box culvert causeways would be required along the Norman Creek access road.

The locations of the proposed culvert causeways are shown on the vegetation maps presented in **Section 7** (refer **Figure 7-4a and Figure 7-4d**). Smaller culverts would also be used as necessary in lower parts of the landscape similar to those used in conventional roads of similar design standard. Sediment controls are described in **Section 3.6.2**.

Borrow pits would be utilised where necessary to provide material for the construction of the roads.

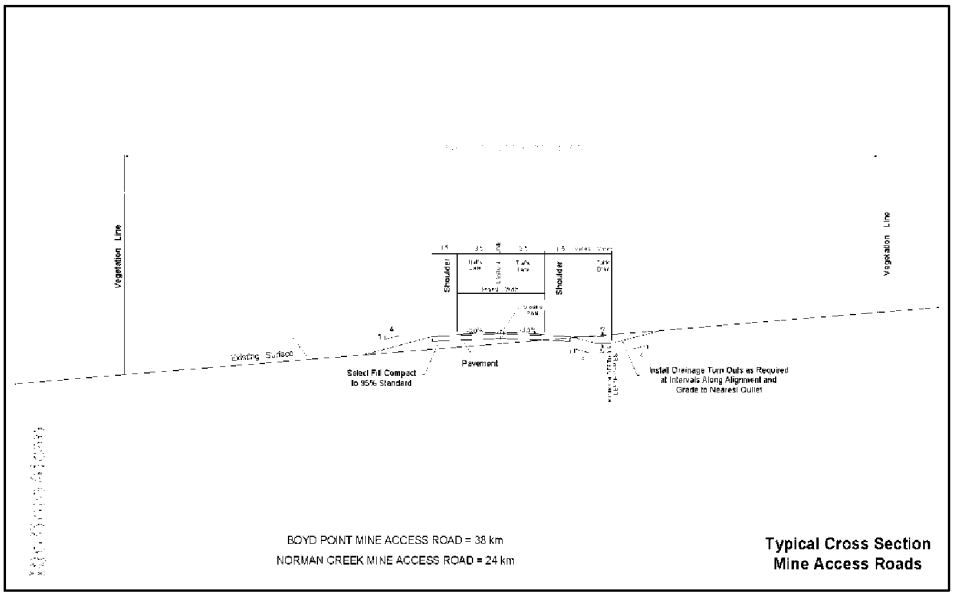


Figure 2-11 Mine Access Road Cross Section

Watercourse crossings may also be required for certain internal mine haul roads that link mining blocks to the beneficiation plants. Haul road alignments would be planned during the mine construction phase and are subject to change to meet mine development requirements. It is anticipated that haul roads would be approximately 45m wide. Watercourse crossings would use similar culvert designs to the Mine Access Roads.

Barge and Ferry Terminals

Plant, equipment and materials coming in by barge from Cairns would be offloaded at Humbug Wharf. The Humbug barge terminal would be located adjacent to Humbug Wharf to enable the efficient transfer of equipment and material bound for SoE without the need to use public roads. The proposed Humbug Terminal is shown in **Figure 2-3.**

The Hornibrook ferry terminal would be constructed at Hornibrook Point, south-east of the Lorim Point Ship Loading Wharf (refer **Figure 2-4**). The Hey River barge/ferry terminal would be located on the southern bank of the Hey River on ML6024. It would operate as a joint RORO barge and ferry terminal (refer **Figure 2-5**).

The RORO barge when loaded would have a displacement of approximately 300 tonnes and a draft of 1.6m. The ferry would have a displacement of less than 30 tonnes and a draft of 1.1m. The vessel movements and amount of materials moved through the terminals during construction and operations is detailed in **Section 14.4**.

2.7.3 Water Supply and Management

The Project's principal water requirements are for process water, haul road watering, vehicle wash-down, dust suppression and potable supplies. The Project's principal sources of supply are local surface waters (water storage dam and direct pumping from stream), deep artesian groundwater and recycled water from the tailings storage facilities. The overall water balance for the Project is summarised in **Table 2-4.**

Table 2-4 Average Annual Water Balance

Production Rate	Average Annual Demand (GL)	Average Annual Supply (GL)					
		Recycle from tailings	Artesian	Dam C	Slots*	River	Total Supply
15Mdptpa	16.4	4.7	3.1 (5.2 peak)	7.8 (Stage 1)	0.8	0	16.4
30Mdptpa	33.0	9.4	6.0 (10.6 peak)	13.8 (Stage 2)	1.6	2.2	33.1
50Mdptpa	63.7	22.1	11.9 (15 peak)	25.4 (Stage 2)	1.6	2.5	63.5

* Trenches dug adjacent to tailings storage facilities to recover water

Typically, water would be drawn in order of preference from tailings recycle, recovery slots, surface water dam (Dam C), and artesian bores. Some supplementary surface water would be drawn directly from the Ward River to minimise the risk of inadequate supply from Dam C. The artesian demand would therefore fluctuate depending on whether there is above or below average rainfall runoff into the dam. RTA has an existing artesian water licence for 9GL per annum which allows abstraction from bores located on ML7024. RTA proposes to apply to increase the artesian allocation to 12GL on a five-year moving average with a maximum of 15GL in any one year to cover peak artesian demand (refer **Section 5.4.3**).

A reverse osmosis potable water treatment plant would be used to treat raw water to a standard that meets the *Australian Drinking Water Guidelines* (NHMRC 2004). Approximately 200kL/day of potable water would be treated during the construction phase to service the construction camp and the plant construction sites. At the commencement of operations, potable water use would decline by about 90%. Potable water use would then increase pro-rata with future production increases. Treated water would be stored in two 160kL ground level storage tanks.

The water supply infrastructure for the Project would not be connected to the water supply infrastructure for the existing Weipa operations. However, water may be trucked or barged from Weipa operations in the early stages of construction if required, prior to water infrastructure for the Project being commissioned.

Dam C would be a conventional earth-fill dam constructed on a tributary of Norman Creek and would have a catchment area of 77.3km^2. The dam spillway would be designed to pass the peak flow from a 1:2,000 Annual Recurrence Interval (ARI) flood event. The spillway would also be designed to facilitate fish passage during flow events (refer **Section 8.16.2**). The cross-section of Dam C is shown in **Figure 5-10**.

To supplement the Dam C supply at production rates between 30Mdptpa and 50Mdptpa, some water would be pumped directly from the lower reaches of the Ward River. The proposed pump station layout is shown schematically in **Figure 5-19** and **Figure 5-20**. Further information on the water storage dam and the Ward River pump station is provided in **Section 5.2.3**.

Schematic diagrams of the proposed water management systems for the Boyd infrastructure area and Norman Creek infrastructure area are shown in **Figure 5-8** and **Figure 5-9** respectively. Sediment ponds are sized to capture runoff equivalent to a 1 in 10-year 24-hour event.

Stormwater runoff generated within mine areas would mostly be captured within the internally draining mine pits. The post-mining landscape effectively provides internally draining sumps that contain stormwater runoff which then infiltrates through the pit floor and walls. In the event that the post-mining topography is not an internally draining pit, stormwater runoff would be directed via a sediment pond. Sediment traps would also be included as part of the drainage designs at points where haul roads cross watercourses.

No watercourses would be diverted as part of the Project.

2.7.4 Sewage

During the initial construction phase, prior to a sewage treatment plant (STP) being commissioned, the construction areas would be serviced by portable ablution facilities. Sewage would be stored in holding tanks and regularly trucked by a licensed regulated waste transporter back to Weipa for treatment in an existing licensed STP. This method would also be utilised if temporary mobile construction camps were used for the Mine Access Road or an accommodation barge used during dredging of the Port.

The construction camp and Boyd infrastructure area would be serviced by separate package STP's. The effluent would be treated to Class A standard and would be recycled for use in dust suppression, process water, landscape watering or other appropriate uses on-site that are suitable for the quality of water.

An additional package STP would be installed in the Norman Creek infrastructure area when it is developed.

The construction camp STP would be designed to a capacity of 630 people, while the Boyd and Norman Creek STPs would be designed to a capacity of 150 people. Based on the predicted average workforce, the total treated effluent volume during construction and at various production rates would be:

- 90kL/day during construction;
- 8kL/day at 15Mdptpa;
- 15kL/day at 30Mdptpa; and
- 20kL/day at 50Mdptpa.

Further details about sewage treatment are presented in **Section 13.3.7**.

2.7.5 Power Generation and Supply

Electricity for the Project would be generated by a diesel-fuelled power station located at the Boyd infrastructure area. The power station would be expanded in stages using multiple generating units in the range of 1.4 to 6MW capacity to meet the following demands:

- 15.4MW at 15Mdptpa;
- 29MW at 30Mdptpa; and

- 54MW at 50Mdptpa.

Transmission lines would be installed as required to reticulate power to artesian bores, dam and river water supply pumps and the Norman Creek infrastructure area. Power transmission lines would comprise a single circuit with three active conductors and an overhead earth elevated on 20m poles, similar to conventional transmission lines used throughout Queensland. The power station would not be connected to the existing Weipa electricity grid north of the Embley River.

To minimise energy consumption to the extent practicable, the following actions would be undertaken for the Project:

- diesel and electrical efficiency considerations would be included in assessments of new fixed equipment, such as using high efficiency motors;
- equipment not in use would be switched-off where practical – e.g. conveyors, lighting, air conditioning;
- transmission line voltages would be selected to minimise electrical losses;
- a process to monitor use, efficiency, emissions and regularly review new opportunities to reduce emissions and use energy efficiently would be established;
- RTA would participate in the Australian Government's Energy Efficiency Opportunities program which is designed to encourage large energy-using businesses to improve their energy efficiency;
- equipment would be regularly maintained to retain high levels of diesel efficiency; and
- employee training on greenhouse gas awareness and energy efficiency would be implemented.

2.7.6 Mine Infrastructure Areas

The Boyd and Norman Creek mine infrastructure areas are shown on **Figure 2-7** and **Figure 2-8** respectively and comprise the following facilities:

- heavy equipment workshop and service bay;
- fixed plant workshop;
- warehouse;
- diesel and oil storage;
- light vehicle and heavy vehicle wash-down areas;
- tyre store and change bay;
- offices and crib room; and
- emergency service centre.

Two 250kL diesel storage tanks are proposed, providing a minimum of three days supply at a production rate of 15Mdptpa. As production increases, additional tank storage would be added to maintain the minimum three-day storage capacity. Hydrocarbons would be stored in accordance with Australian Standard *AS1940 The Storage and Handling of Flammable and Combustible Liquids*. Fuel would be trucked in via the Mine Access Road from existing storage facilities in Weipa. The storage of fuel and other dangerous goods is described in **Section 19.1**.

The Boyd and Norman Creek mine infrastructure areas would be linked by a 15km infrastructure corridor approximately 64m wide. The corridor would contain an overland conveyor, access road, transmission line and water supply pipeline. The corridor would traverse four watercourses (tributaries of Norman Creek), each requiring up to six adjacent box culverts (3.6m wide x 2.1m high). A second 16km long, 50m wide corridor would link the Norman Creek infrastructure area with the Ward River pumping station and provide space for an access road, transmission line and water supply pipeline.

2.7.7 Telecommunications

New telecommunications facilities would be developed for the Project and would be operated autonomously from the existing Weipa telecommunication system. The technology adopted would depend upon that which is most feasible and technically appropriate at the time of implementation. Facilities are likely to include a mobile phone tower and underground land lines connecting infrastructure areas.

2.8 Decommissioning and Rehabilitation

2.8.1 Decommissioning

On the completion of mining, buildings, structures and other infrastructure would be treated as follows:

- The barge/ferry terminals, port, water storage dams and certain roads may have some ongoing beneficial use. Subject to agreement with relevant regulators and Traditional Owners, some of these facilities may be left in place. Otherwise, RTA shall remove these facilities.
- Buildings, plant, equipment, tanks, conveyors, pipelines and transmission lines would be removed and the surface rehabilitated. Concrete pads would be broken up, buried, and then the area rehabilitated.

2.8.2 Mine Rehabilitation

Rehabilitation would be undertaken progressively during the life of the mine. RTA's objective for the rehabilitation of areas disturbed by SoE Project mining activities is to establish a self-sustaining vegetation community using appropriate local native tree, shrub and grass species. Under the WCCCA, and at the request of the relevant WCCCC sub-committee, RTA may establish post-mining land use options other than those required by regulation, subject to obtaining all necessary government approvals (refer **Section 3.10.1**). While it is not currently envisaged that land uses other than native vegetation be established, RTA would consult with Traditional Owners about rehabilitation objectives and rehabilitated land completion criteria and objectives. The overall objective would be to return the land to a post-mining land use that would be stable, self-sustaining, and requires minimal maintenance, and protects downstream water quality.

Rehabilitation success criteria suitable for the Project area would be developed and these would form criteria against which rehabilitation performance could be measured.

The approach to rehabilitation has been based on the *Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland* (DME 1995a) and is described in more detail in **Section 3.10**.

Soil Management

The dominant soil type of the Project area is Red Kandosol, which is weathered and low in nutrients, and supports vegetation adapted to such conditions. The majority of seed readily able to germinate is present in the upper 5cm of soil.

Approximately 60cm of soil would be stripped and then placed directly back on previously mined areas or stockpiled for future use in rehabilitation once a suitable area becomes available. If soil is stockpiled, it would be managed so as to maintain optimum growth media properties by maximising the stockpile surface area and minimising compaction. Stockpiled soil would be typically used within one year to maximise the benefits of the natural seed bank and conserve symbiotic micro-organisms.

The rehabilitation strategy and topsoil management are described further in **Section 3.10.**3 and **Section 3.10.4** respectively.

Revegetation

Revegetation is likely to include ripping the mine floor and compacted areas, respreading of freshly stripped topsoil or stockpiled topsoil, soil surface scarifying prior to seeding, seeding and fertilising. Pit floor ripping and pre-seeding scarification assist in providing suitable growing media properties which optimise plant growth (e.g. porosity and water holding capacity). Revegetation techniques are described further in **Section 3.10.5.**

At current RTA operations north of the Embley River, direct seeding has been found to be the best method for establishing desired plant species. Seeding would occur in November and December of each year to help ensure the soil moisture and follow-up rainfall is favourable to seedling establishment.

Native species seed mixes would be tailored to the anticipated post-mining conditions of the area to be rehabilitated. Free draining areas would be seeded with a range of tree, shrub and groundcover species from *Eucalyptus* and *Corymbia* dominated woodlands. In areas that are likely to be less free draining and seasonally inundated, species from *Melaleuca* and *Lophostemon* dominated vegetation communities would be used.

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Environmental Impact Statement

for South of Embley Project

Section 3
Land

3 LAND

3.1 Land Use

3.1.1 Existing Land Use

Current land uses within and adjacent to the Project area are shown on **Figure 3-1**. Lands within the Project area are not used for agriculture and are relatively undisturbed by development. There are no rural properties within the Project area. The nearest residential areas and rural properties to the Project area are shown on **Figure 3-1** and described in **Section 12.3**. Tracks to various parts of the Project area are used by recreational vehicle users, Traditional Owners and for access for exploration. Exploration activities, including drilling and associated road development, have taken place throughout the Project area; on-going activities such as drilling, ore sampling, creation of associated road access and other exploration activities are continuing. Some cattle grazing took place within the Project area in the early to mid 1900s but has been discontinued (refer **Section 11.2.2**). Some limited logging and sawmilling activity also took place during this period and has been discontinued (Venn 2004).

The use of the Project area by Traditional Owners and management of access to the Project area by Traditional Owners are discussed in **Section 16.3.2**. Areas of cultural and recreational importance to Traditional Owners include Hey Point, Boyd Bay, Pera Head, Norman Creek, Amban (False Pera Head), Waterfall (near Ina Creek) and Six Ti-Tree. Use of the Project area and surrounds by tourists and the general public is also discussed in **Section 16.3.2**.

While overall there has been very little direct disturbance and the terrestrial environment is generally in good condition, some areas have been affected by camping and rubbish dumping, and some areas have been significantly affected by the frequent fires and damage from feral pigs. The effect of the current fire regime on the *Eucalyptus tetrodonta* ecosystem has been the development of a homogeneous vegetation structure that varies little throughout the Project area.

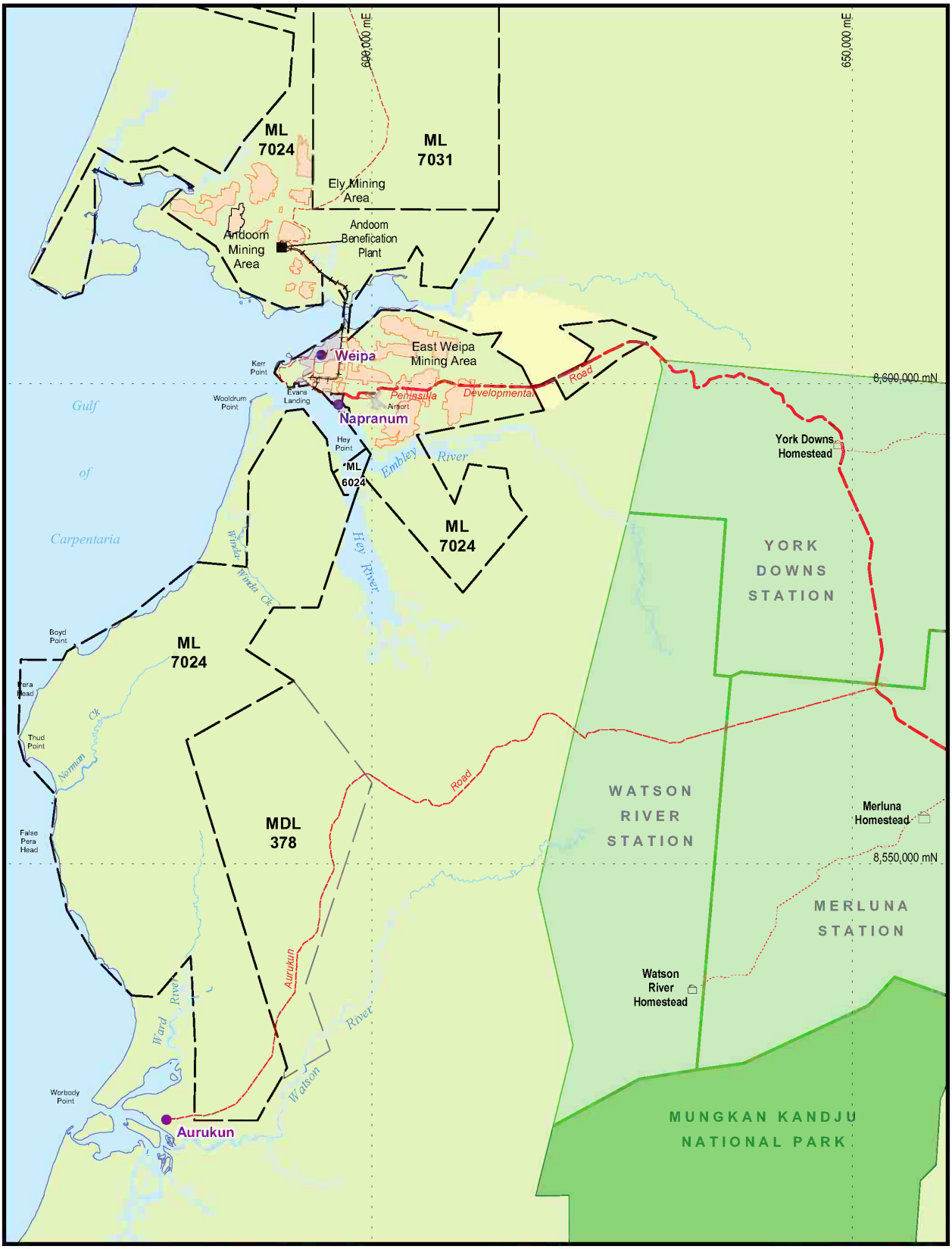
The proposed port site, Hey River barge/ferry terminal site and Hornibrook ferry terminal site have no existing infrastructure and no specific existing land use. The proposed Humbug barge terminal site is adjacent to the Humbug Wharf and to cattle yards. The existing wharf is used by incoming barges carrying general cargo and fuel for Weipa and RTA's existing operations. There are infrequent live cattle exports from this wharf.

The current land tenure of the Project area and adjacent areas are discussed in **Section 2.2** and shown on **Figure 2-1**.

3.1.2 Impact on Existing Land Use

There are no rural properties within the Project area and therefore no properties would be directly affected by the Project. There has been no cattle grazing in the SoE area for many years and there would be no direct impact on agricultural land uses or management practices of surrounding land. Further information on primary industries is presented in **Section 16.2.8**. The Humbug barge terminal would be designed to minimise interference with the adjacent live cattle export facility. Access is typically required to Humbug Wharf once or twice each year over a 3–4 day period. Direct impacts by the proposed Project on live cattle exports are anticipated to be minimal as long as appropriate forward planning is undertaken.

When evaluating the impact of the Project on current and potential future land uses of surrounding land, the local and regional planning provisions are relevant to consider. ML7024 lies within the Cook Shire Local Government Area, ML6024 lies within the Napranum Shire, and land adjacent to the Project area is within the Napranum and Aurukun Shires (refer to **Figure 2-1**). The Cook Shire has a Planning Scheme where all land to which the scheme applies is placed within a zone. The Cook Shire Planning Scheme does not apply to ML7024. The Napranum Aboriginal Shire and Aurukun Shire do not have a Planning Scheme. There are no regional plans that cover the Cook, Aurukun or Napranum shires. Therefore there are no local or regional planning provisions that apply to the Project area or surrounds.



P:\RTA\Plans\SoE\EIS Report Figures\Chapter3\Fig 3-1 Current Land Use.wor

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South of Embley Project

Fig. 3-1: Current Land Use

Construction and operation of the Project would affect the ability of Traditional Owners and the general public to access certain parts of the Project area from time to time for cultural reasons, fishing, hunting and recreational purposes. The prime restriction on access relates to the need to separate the public from active mining and development areas to maintain safety. RTA would continue to manage access for Traditional Owners to specific areas, including the three outstations in the Project area at Amban (False Pera Head), Waterfall (near Ina Creek) and Six Ti-Tree (just south of Waterfall). Amban, Waterfall and Six Ti-Tree are generally utilised in the dry season for varying periods. Access would be managed in accordance with RTA's obligations outlined within the Western Cape Communities Co-existence Agreement (WCCCA). This would be monitored on a regular basis in line with the mine plan, safety requirements during construction and operational phases and the needs of Traditional Owners of the Project area. RTA would work collaboratively with Traditional Owners and the relevant WCCCA sub-committee to develop a land access strategy aimed at causing as little disturbance as possible to Traditional Owner access. The strategy would aim to provide access for Traditional Owners both during active and non-active mining periods for areas including Hey Point, Boyd Bay, Pera Head, Amban / Norman Creek and Waterfall / Six Ti-Tree / Ina Creek.

To mitigate the impacts of the Project on recreational use of the Project area, RTA would work with Traditional Owners and other relevant stakeholders to develop an effective permit system to protect significant cultural heritage sites and environmental values and allow controlled access for recreational purposes. The administration of such a system by Traditional Owners would be subject to discussions between Traditional Owners, RTA and other stakeholders. Existing uses of the Project area and surrounds, potential impacts on those uses and proposed mitigation strategies are discussed in detail in **Section 16.3.2**.

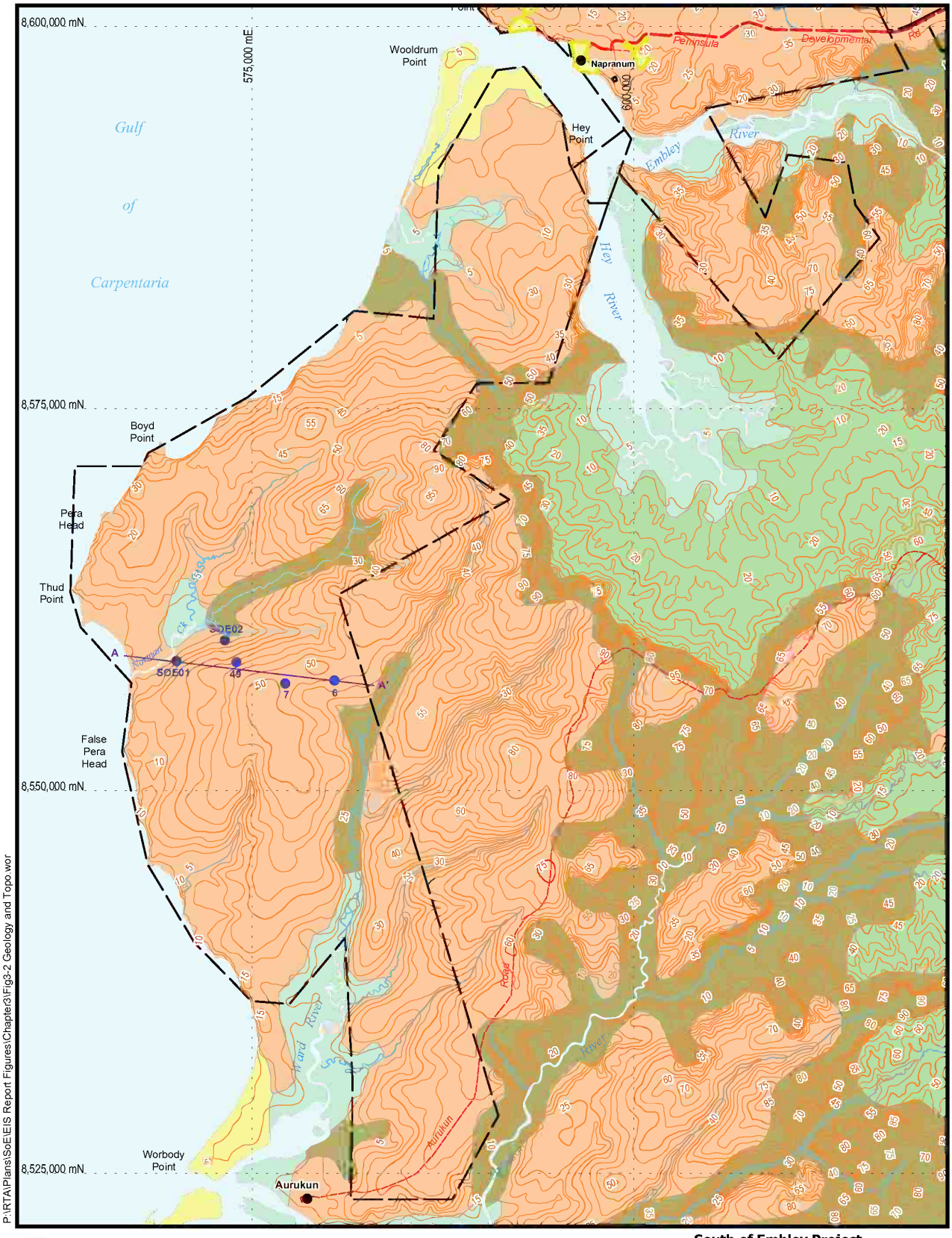
Stakeholder groups consider that improved access to the Project area, via the proposed Mine Access Road and barge/ferry terminals, may increase some recreational activities that are considered to have negative impacts on the Project area and adjacent coastal and beach areas. Potential impacts of the Project on these recreational uses of the Project area and adjacent beach and coastal areas, and proposed mitigation strategies, are discussed in **Section 16.3.1**.

RTA is committed to continuing support for the development of Indigenous businesses in the Western Cape, particularly as it relates to the Project. RTA supports the establishment of a timber harvest operation south of the Embley River that would harvest timber on areas of the mining lease proposed to be mined, or cleared for development of Project infrastructure, in a manner that does not impede development work. This may include joint venture arrangements that support the further creation of employment, training and business development opportunities for local Indigenous people, and in particular, for the Traditional Owners whose land is being proposed for development. Potential impacts on business development and mitigation strategies are discussed in further detail in **Section 16.3.7**.

3.2 Geology

The Project area is located in the Carpentaria Basin, which consists of marine and fluvial sediments. The geology units of the Project are shown in **Figure 3-2** and **Figure 3-3**. The geology of the Project area is represented by the following geological units which are listed in descending stratigraphic order:

- Coastal dunes
- Estuarine and delta deposits
- Ferruginous duricrust, including bauxite (the Aurukun Surface which is derived from laterised Bulimba Formation). This formation is part of the Wyaaba beds
- Bulimba Formation
- Rolling Downs Group
- Gilbert River Formation
- Garraway Beds
- Permian Basement Rock.



P:\RTA\Plans\SoE\EIS Report Figures\Chapter3\Fig3-2 Geology and Topo.wor

RTA Mining Lease boundary
Township
Road/track
5m topographic contour
Geological Cross Section
Bore hole

Coastal Dunes
Estuarine and delta deposits
Ferruginous duricrust
Bulimba Formation
Rolling Downs Group

Geology: Geoscience Australia 1:1mil (2008)

South of Embley Project

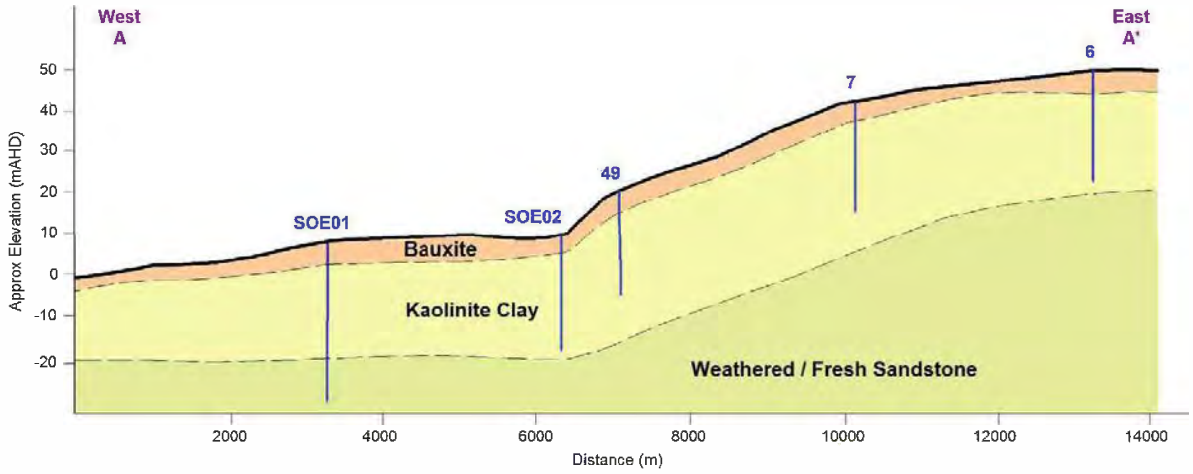
Fig. 3-2
Geology and Topography

N

5 0 5km

Datum/Projection: GDA94/MGA Zone 54 Date: 01/04/2011

Figure 3-3 Geological Cross Section from East to West (Project Area)



The dominant geological unit of the Project area is the Ferruginous Duricrust, which is derived from heavily laterised sandstones of the Bulimba Formation. Ferruginous Duricrust is essentially the same as the Andoom land system as defined by Godwin (1985) and Gunness *et al.* (1987). The Bulimba Formation underlies the Ferruginous Duricrust. Between the bauxite and sandstone there is a transitional zone consisting of kaolinite clay, unlike the sharp ironstone-bauxite contact as in the East Weipa and Andoom mines. The depth of mining in the Project area would be determined by the grade of ore. The stratigraphy of the surface layers in the Project area is shown in **Figure 3-4**.

The Bulimba Formation is associated with channels cut into the underlying Rolling Downs Group and outcrops along drainage lines within the Project area. The Rolling Downs Group sediments have been exposed where the overlying Bulimba Formation has been eroded. Estuarine and delta deposits consisting of mainly silts and clays are associated with alluvial deposits along rivers. Coastal dunes are associated with coastal areas and consist of coquina, calcarenite and shelly quartzose sand.

Drilling and resource evaluation work has been undertaken in the Project area since the 1970s. In the 1970s much of the Project area was drilled at a spacing of 800m x 400m. In 2005 two of the Project area ore bodies, the Boyd Bay and Norman Creek ore bodies, were drilled on a 800m x 1200m grid to gain more bauxite quality information. Over 2006 and 2007 the Boyd Bay and Norman Creek ore bodies were drilled at a spacing of 400m x 200m to gain additional information for mine planning purposes. Further in-fill drilling was under taken in 2008 and 2009 at spacings of 200m x 100m and 100m x 100m.

The areas proposed to be mined in years 1–13 and in years 14–40 are shown in **Figure 3-5** along with other mineralised areas within the Project area. As of 31 December 2010, a total of 1,602 million tonnes of bauxite reserves with a 53% grade have been reported within RTA's Weipa mining leases, with a considerable proportion of the reserve within the SoE portion of ML7024. Ore reserves are reported in accordance with the *Australasian Code for Reporting of Exploration Results, Mineral Resources and Ore Reserves* (known as the JORC Code) as required by the Australian Securities Exchange (ASX). The bauxite overlies kaolinite but exploitation of the kaolinite is not economically viable. Bauxite mining would not prevent any future exploitation of kaolinite should it ever become viable.

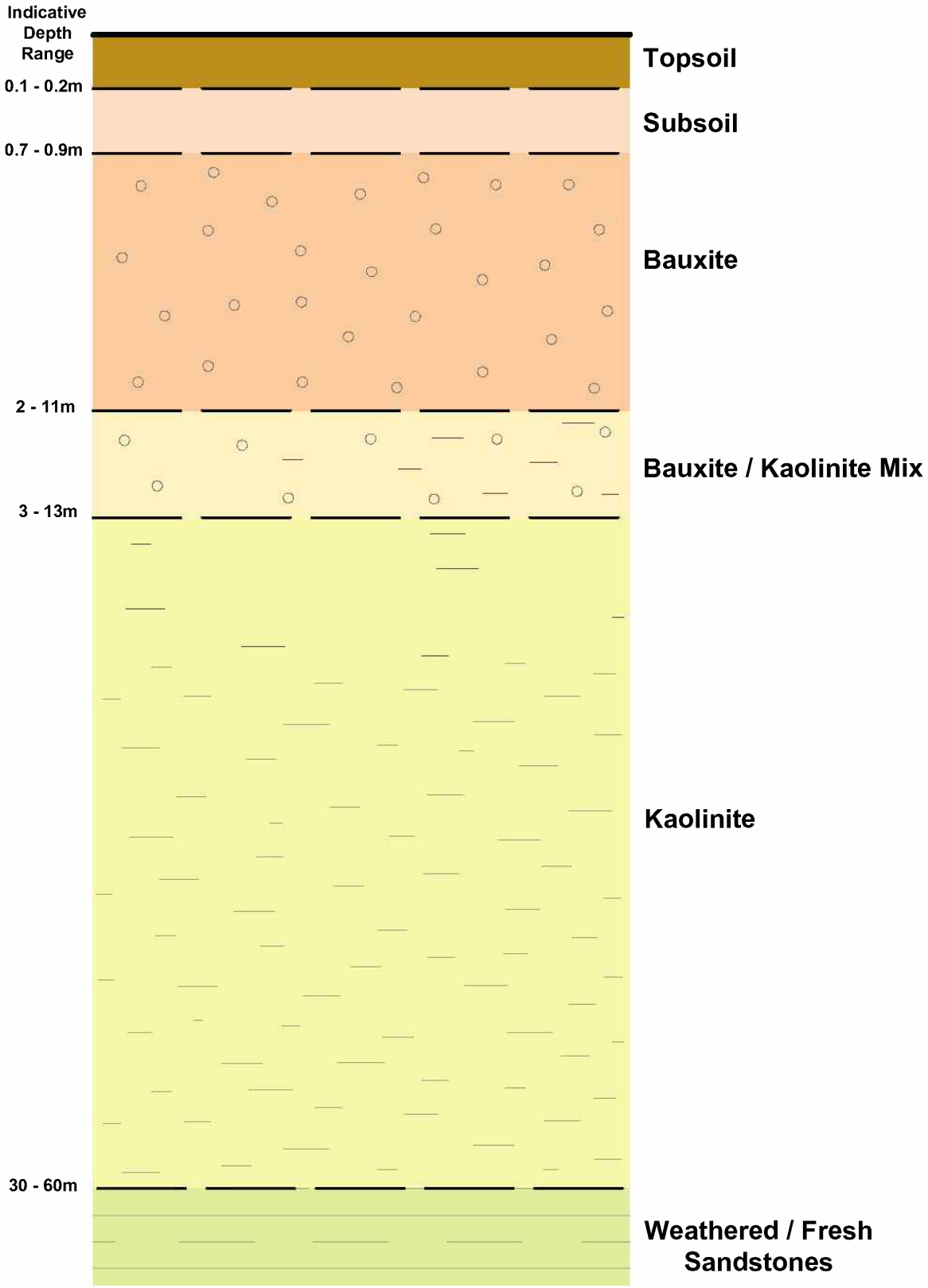
The infrastructure associated with mining has been located as far as practicable so as not to sterilise bauxite reserves. The Boyd tailings storage facility and parts of the Norman Creek tailings storage facility are located on bauxite reserves. The economic bauxite reserves would be mined from each relevant area before tailings are deposited so as not to sterilise economic reserves (refer **Sections 2.2** and **2.5.2**).

The selected mining schedule and method, as well as the beneficiation method, have been designed to best utilise bauxite reserves and minimise resource wastage. The mining method is described in **Section 2.4.3** and the beneficiation method is described in **Section 2.5**.

Bauxite ore and tailings are geochemically benign. The geochemistry of ore and tailings and potential for land and water contamination are discussed in detail **Section 13.3.4**. The use of oversize material for road construction or other productive uses is described in **Section 13.3.5.**

3.3 Topography

The location of the Project in a regional context is shown on **Figure 1-1**, and the topography within the Project area is shown on **Figure 3-2**. The topography within the Project area comprises a gently undulating bauxite plateau landform cut by a network of rivers and smaller creeks. Landfall is from the east to the west toward the Gulf of Carpentaria. There are bauxite cliffs along the coastline, particularly between Boyd Point and Thud Point. The highest elevations (95m AHD) within the Project area are along the eastern boundary. A number of semi-perennial watercourses plus numerous smaller ephemeral creeks traverse the Project area and flow in a westerly direction eventually discharging into the Gulf of Carpentaria. Bauxite is not usually found in the main drainage lines. There are large estuaries associated with the Hey,



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South of Embley Project

Fig. 3-4: Stratigraphy

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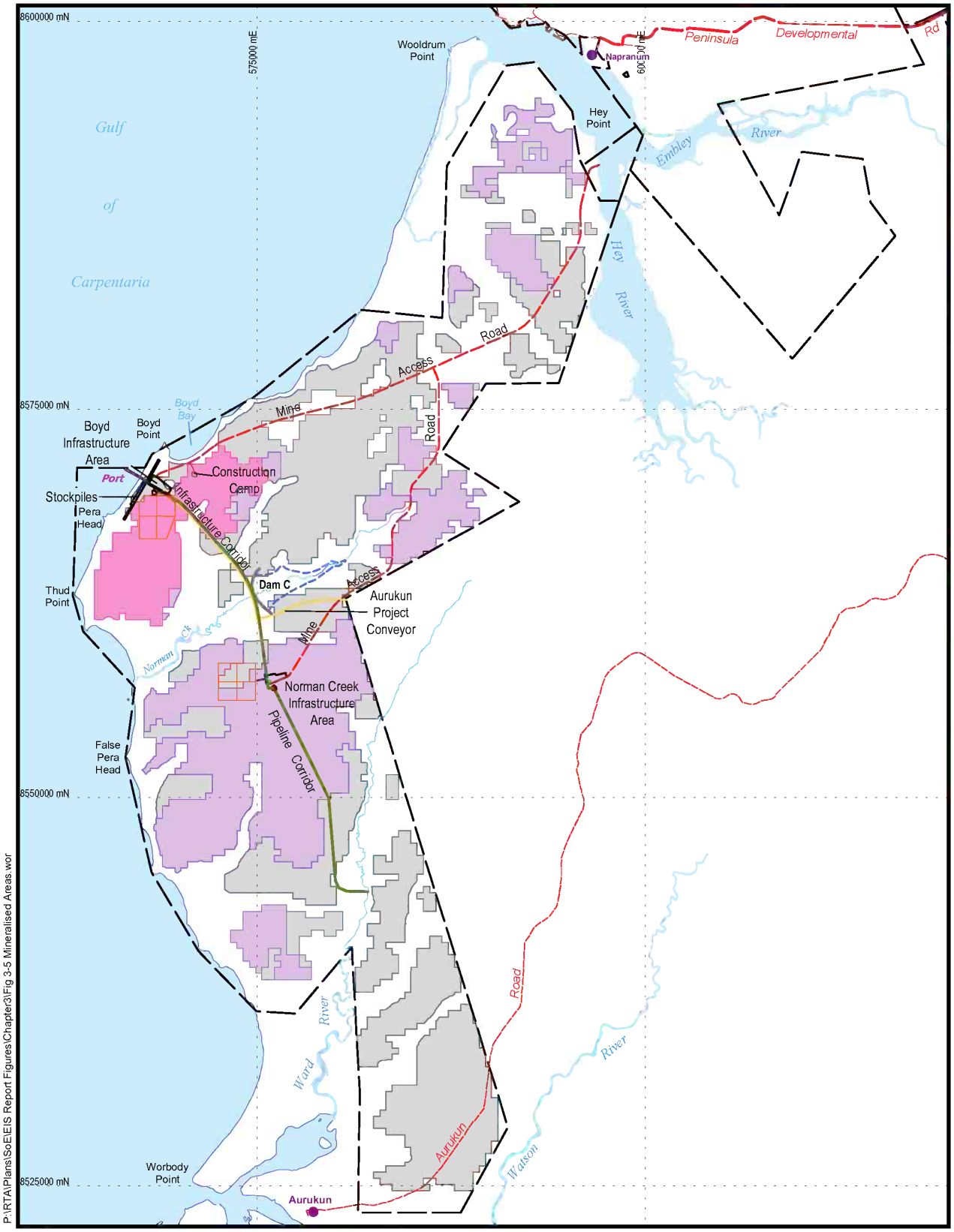
Date: 15/07/2010



P:\RTA\Plans\SoE\EIS Report Figures\Chapter3\Fig 3-5 Mineralised Areas.wor

RTA Mining Lease boundary
Township
Road/track
Freshwater dam
Tailings storage facility

Mining Years 1 -13
Mining Years 14 - 40
Other Mineralised Areas

South of Embley Project

Fig. 3-5: Mineralised Areas

N

5 0 5km

Datum/Projection: GDA94/MGA Zone 54 Date: 01/04/2011

Embley and Ward Rivers.

The landscape character and broad-scale topography and vegetation character of the Project area is discussed in **Section 12.2**.

The Indigenous and non-Indigenous cultural heritage values of the Project area are described in **Section 11.1** and **Section 11.2** respectively. Archaeological, anthropological and historic places are discussed, along with landscape features and aspects of the natural environment that have cultural significance.

3.4 Soils

3.4.1 Previous Studies

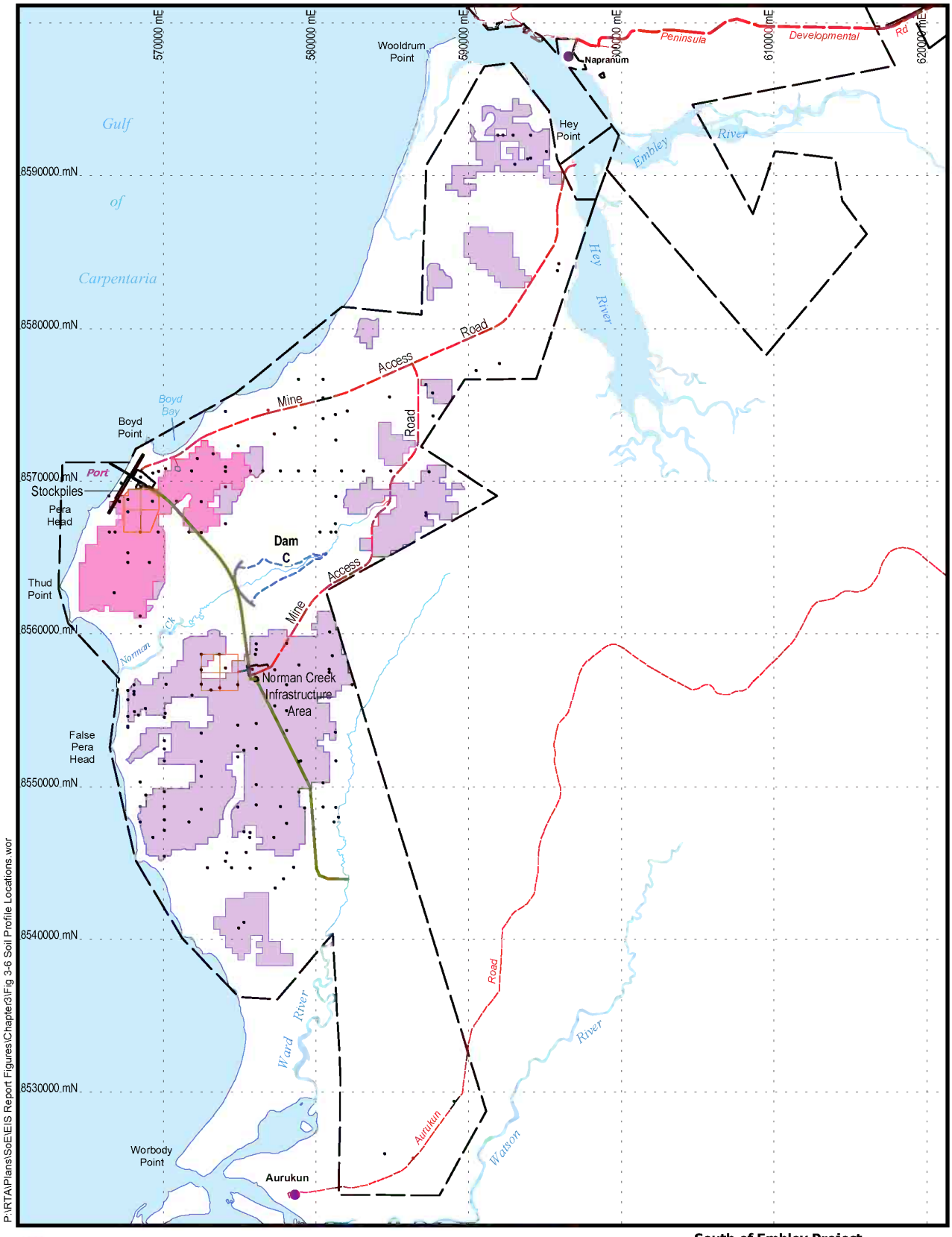
Broad scale soil mapping on Cape York Peninsula was first undertaken as a part of the compilation of the *Atlas of Australian Soils* (Isbell *et al.* 1968). The Queensland and Commonwealth Governments established the Cape York Peninsula Land Use Strategy (CYPLUS) in 1992 to assist government make sustainable land use and planning decisions regarding Cape York Peninsula. CYPLUS included a Natural Resource Analysis Program, which included a soil survey and agricultural land suitability assessment (Biggs and Philip 1995). This assessment used site and chemical analysis data from previous soil surveys as well as profile descriptions and chemical analyses from a new field survey to produce detailed soil descriptions and a soil map at a scale of 1:500,000.

Biggs and Philip (1995) also identified and described seven soil landscapes on the Cape York Peninsula based on distinctions in physiography and geology as well as elements of vegetation and current land use. These soil landscapes are useful for providing an overview of the soils and explaining their position in the landscape. The landscape for the Project area is located entirely within the Batavia Landscape.

3.4.2 Survey Methodology

A soil survey of the Project area was undertaken for the EIS by Landline Consulting for RTA in December 2007. The objective of the survey was to describe and map soil types, map current land use suitability and quantify topsoil volumes. A free survey method was adopted as described by Reid (1988). 174 soil profiles were described to a depth of 1.2m. The soil profile locations are shown on **Figure 3-6**. Soil profiles were augered by hand to a depth of 1.2m or until resistance was reached. Additional descriptions were made of relatively intact soil profiles exposed in track cuttings and road-side borrow pits. The survey was constrained to a degree by wet season conditions which restricted access to some areas, particularly the drainage lines. Profile descriptions were consistent with the *Australian Soil and Land Survey Field Handbook* (McDonald *et al.* 1990). The previous soils mapping undertaken at 1:500,000 scale indicated major uniformity across the Project area and relatively distinct drainage areas (Biggs and Philip 1995). The number of soil profiles described and the scale of soil mapping for this study is appropriate considering the uniformity of soil types.

Ten soil types were identified on the Project area. The characteristics of the soils, particularly in relation to landscape position, are discussed in **Section 3.4.3**. Locations of the soil types in the Project area are discussed in **Section 3.4.4**, and the soil types are described in **Section 3.4.5**. A profile and detailed description for each of the ten soils is presented in **Appendix 3A.** Australian Soil Classification nomenclature has been adopted; however, the soil nomenclature of Biggs and Philip (1995) is also provided. Soil types that were consistent with those of Biggs and Philip (1995) have been noted as having "affinities with" these soil types, but the descriptions reflect the 2007 survey. Certain soil units that were generally outside the footprint of disturbance were not described during the survey. In these cases, soil descriptions from Biggs and Philip (1995) were used.



P:\RTA\Plans\SoE\EIS Report Figures\Chapter3\Fig 3-6 Soil Profile Locations.wor

RTA Mining Lease boundary
Township
Road/track
Freshwater dam
Tailings storage facility
Infrastructure corridor
Soil profile locations

Mining Years 1 -13
Mining Years 14 - 40

South of Embley Project

Fig. 3-6: Soil Profile Locations

N

5 0 5km

Datum/Projection: GDA94/MGA Zone 54 Date: 01/04/2011

Profiles at 14 representative sites were sampled and analysed for pH, electrical conductivity (EC), nitrate, chloride, extractable-phosphorus, extractable sulphate sulphur, organic carbon, total nitrogen, cation exchange capacity, exchangeable cations (calcium, magnesium, potassium and sodium) and total copper, zinc, iron and manganese, as well as particle size distribution. Analyses were undertaken at a NATA registered laboratory. Chemical and particle size analyses are presented in **Appendix 3B** and discussed in **Section 3.4.6**.

3.4.3 Soil Types

Biggs and Philip (1995) described seven soil landscapes on the Cape York Peninsula, which are based on distinctions in physiography and geology as well as elements of vegetation and current land use. These soil landscapes are useful for providing an overview of the soils and explaining their position in the landscape.

The landscape for the Project area (the Weipa plateau) is located entirely within the Batavia Landscape and is associated with the lateritised Bulimba Formation and Rolling Downs Group (siltstone, labile glauconitic sandstone, and mudstone). The soils are largely related to the overlying Aurukun Surface, which is derived from lateritised sandstones of the Bulimba Formation. Some soil elements of the Heathlands Landscape located north of Weipa are also represented within the Project area. The Heathlands Landscape consists principally of soils derived from sandstone that are vegetated with heaths and *Eucalyptus tetrodonta* woodlands.

On the Weipa plateau the lateritic horizons are aluminous (bauxitic) in nature. These soils are infertile, with their moisture holding capacity restricted by their lighter texture and the presence of bauxite or ironstone segregations within the profile.

Red Kandosols occur in upper to mid landscape positions with smaller areas of Yellow Kandosols occasionally found in lower slope positions. Red Kandosols have affinities with the Weipa soil type, and Yellow Kandosols have affinities with the Andoom soil type of Biggs and Philip (1995).

Weakly ferruginised Yellow Kandosol acid soils are associated with the footslopes of the lateritic remnants. They are derived from recent exposures of the underlying sediments of the Rolling Downs Group and are more acidic.

Redoxic Hydrosols (the Mapoon soil type of Biggs and Philip (1995)) occur in swamps common to the lower parts of this landscape. These soils have a clay subsoil texture in the swampy areas, but commonly have less developed gradational texture profiles (kandosolic) in the more common minor drainage lines. Redoxic Hydrosols are restricted to the Aurukun Surface. Biggs and Philip (1995) noted that the formation of these swamps is considered by some authors as a laterite-karst feature. Flooding and poor drainage are the over-riding restrictions on the use of these soils for agriculture.

Orthic Tenosols, Supratidal Hydrosols and Aquic or Grey Vertosols (the Caravan, Marina, George and Somerset soil types of Biggs and Philip (1995)) are associated with the Heathlands Landscape. Areas of beach ridge material and sand dunes (Orthic Tenosols) occur on the western coastal margin. In some areas, older beach ridge deposits may have a red colour which is a result of influence by the adjacent and underlying lateritic surface (Somerset soils). Minor occurrences of marine clays (Supratidal Hydrosols and Aquic or Grey Vertosols) occur on the coastal alluvial areas often associated with estuarine deposits (Intertidal Hydrosols) and mangroves.

A summary of the soil types identified within the Project area and their topographic position is provided in **Table 3-1**.

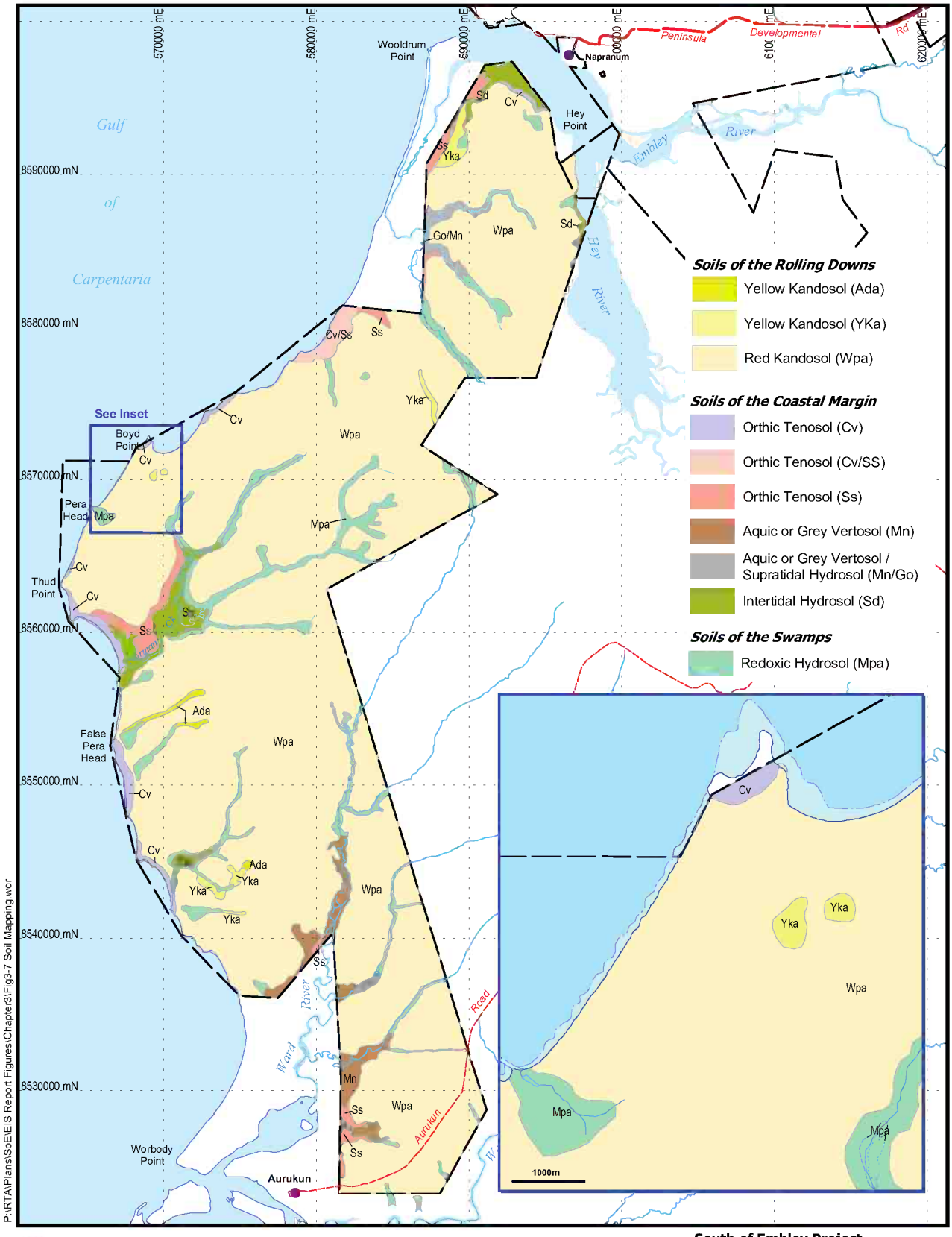
Table 3-1 Soil Types Identified in the Project Area

Australian Soil Classification [1]	Great Soil Group [2]	Biggs and Philip (1995) Name	Occurrence	Comment
Soils of the Rolling Downs Group and Lateritised Bulimba Formation				
Red Kandosol	Red earth	Affinities with Weipa (Wpa)	This is the most common soil on crests and slopes of gently undulating slightly elevated plains.	Surface and subsoil colour variations were recognised during the survey but were unable to be mapped at the scale of this survey.
Red Kandosol	Red earth	Affinities with Weipa – Deep red phase (WpDr)	Usually occurs on upper level crests and well drained areas.	The more significant variation of Wpa. This soil was described during this survey but is unable to be mapped at the scale of this survey.
Red Kandosol	Red earth	Affinities with Weipa – Ferric phase (WpFp)	Usually occurs in lower landscape positions and on change of slope.	This soil was described during this survey (as part of the Wpa soil type) but is unable to be mapped at the scale of this survey.
Yellow Kandosol	Yellow earth	Affinities with Andoom (Ada)	This soil or its equivalent occurs in association with Weipa soil type on the less well drained areas – lower slopes, and along drainage lines.	These soils are not extensive and only some minor occurrences could be mapped separately.
Yellow Kandosol	Yellow earth	Yellow Kandosol acid soil (YKa)	These deep, often acid soils occur on lower slopes and along drainage lines.	Commonly with many Fe/Mn nodules. Most occurrences of this soil are unable to be mapped at scale of this survey.
Soils of the Drainage lines and Swamps				
Redoxic Hydrosol	Humic gley	Affinities with Mapoon (Mpa)	A soil of low lying drainage depressions and lines on gently undulating plains and swamps.	Has affinities with Mapoon, but often lighter textured subsoil. Limited sampling during the survey.
Soils on the Coastal Margin – Beach ridge and dune deposits				
Orthic Tenosol	Siliceous sands	Caravan (Cv) [3]	A soil of the narrow coastal margin associated with younger sand dune deposits and beach ridges. Very minor distribution.	Not described during this survey.
Orthic Tenosol	Earthy sand/ Siliceous sands	Somerset (Ss) [3]	A soil of the coastal margin associated with beach ridges.	Not described during this survey.
Soils on the Coastal Margin – Estuarine and near coastal plains				
Supratidal Hydrosol	Solonchak	George (Go) [3]	A soil of minor distribution on estuarine deposits, usually as bare areas along tidal flats and estuaries. Associated with saltpans.	Not described during this survey.
Aquic or Grey Vertosol	Grey clay	Marina (Mn) [3]	A soil of the coastal margin which occurs along flooded plains and tidal flats. Minor distribution on coastal drainage areas.	Not described during this survey.
Intertidal Hydrosol	No suitable group	Skardon (Sd) [3]	A soil of minor distribution on estuarine deposits under mangroves along tidal flats and estuaries.	Not described during this survey.

1. Australian Soil Classification (Isbell 2002).
2. Great Soil Group (Stace *et al.* 1968).
3. Soils not described during survey, therefore soil type descriptions are directly from Biggs and Philip (1995).

3.4.4 Soil Mapping

The locations of soil types within the Project area are shown in **Figure 3-7**. Previous studies (refer **Section 3.4.1**) were used to assist in mapping.



P:\RTA\Plans\SoE\EIS Report Figures\Chapter3\Fig3-7 Soil Mapping.wor

RTA Mining Lease boundary

Township

Road/track

South of Embley Project

Fig. 3-7: Soil Mapping Units

N

5 0 5km

Datum/Projection: GDA94/MGA Zone 54 Date: 01/04/2011

Most of the area to be disturbed contains Red Kandosol (Affinities with Weipa) soil type on slightly elevated plains with a level to gently undulating surface. For this soil type there is noticeable variation in soil surface colour from dark red to yellow-brown or grey. A deep red phase of the Red Kandosol was described and is the more significant variation, and a ferric phase of the Red Kandosol was also described. No significant morphological or chemical differences could be shown to be associated with these colour variations, and they are still consistent with the description for Red Kandosol. Although variations related to surface and subsoil colour were recognized within this soil type, these could not be mapped at the scale of this survey.

There are smaller areas of (Yellow Kandosols) (Affinities with Andoom) and Yellow Kandosol acid soils in areas of lesser drainage and on lower slopes fringing drainage lines. These soil types could not be mapped consistently but some areas have been tentatively mapped where they could be expected to occur. Areas of these soils are expected to also occur in association with Redoxic Hydrosols (Affinities with Mapoon), particularly in the narrow drainage lines and along their margins.

Orthic Tenosols (Caravan and Somerset soils) have been mapped on the very coastal margin. The distinction between Caravan and Somerset soil types was not always possible so in some areas they have been mapped as one unit.

There is a mixture of soil types associated with alluvial areas on estuarine and marine sediments. These are mapped as predominantly Aquic or Grey Vertosols (Marina), Supratidal Hydrosols (George) and Intertidal Hydrosols (Skardon) but most units include bare areas associated with areas of low groundcover and mangroves.

3.4.5 Soil Descriptions

Soils of the Rolling Downs Group and Lateritised Bulimba Formation

Red Kandosol (Affinities with Weipa (Wpa))

Red Kandosol is the most widespread soil type in the Project area and is the dominant bauxitic soil of the Aurukun surface, generally occurring on plains (**Plate 3-1**). The Red Kandosol contains aluminous concretions throughout the profile, but most commonly concentrated in a band below depths of 55 to 75cm. It may also contain some ferruginous concretions. Its surface colour is red-brown or red, but varies reflecting differing profile or landscape drainage conditions and the influence of differing levels of organic matter. Surface soils tend to be paler in lower sloping positions in the landscape due to restricted drainage. Soil colour grades to red or red brown, and occasionally yellowish-brown or brown, with depth. These variations in colour could not be mapped and they do not suggest major differences in physical or chemical soil features. There is little variation in profile texture, commonly grading from loamy surfaces (20 to 30cm) to clay loam subsoils. Uniform texture profiles may occur.

Mine infrastructure, mining areas and the Mine Access Road would be generally located on the higher elevations in the landscape, which are dominated by Red Kandosol soils. Cut and fill earthworks would be undertaken to level ground surfaces for facilities, and to construct a water storage dam, tailings storage facilities, a truck dump station and access roads. The suitability of excavated soil for construction is discussed in **Section 2.3**.

Red Kandosol (Affinities with Weipa – Deep red phase (WpDr))

A very deep phase of the Red Kandosol soil occurs on some upper slope and flat crest areas. These are commonly very red soil profiles to depth with the band of bauxitic concretions not encountered before 120 to 150cm. This soil variant is often more acidic than the Red Kandosol soil, however it is difficult to map consistently and has been mapped within the Red Kandosol soil unit. It is a fairly consistent observation that aluminous concretions do not occur in these acid to occasionally-strongly-acid profiles, but deeper drilling is required to confirm this relationship.

Plate 3-1 Red Kandosol soil

Red Kandosol (Affinities with Weipa – Ferric phase (WpFp))

A ferric phase of the Red Kandosol was identified on lower elevations or where there is a significant change of slope. This soil is characterised by iron–cemented bands or ferricrete layers within the bauxite layer, but was mainly detected by exposures or in areas of soil disturbance. Its extent was not able to be mapped. This soil phase is described as part of Red Kandosol with which it is otherwise consistent.

The Red Kandosols are consistently vegetated with Darwin Stringybark (*Eucalyptus tetrodonta)* and Grey Bloodwood (*Corymbia clarksoniana*) tall woodland, frequently with Cocky Apple (*Planchonia careya*) and Cooktown Ironwood (*Erythrophleum chlorostachys*) (**Plate 3-2**). Species less frequently associated include *Alphitonia excelsa* and minor patches of palms. *Acacia* spp., *Hakea* spp., Milky Pine (*Alstonia spp.*), Sandpaper Fig (*Ficus opposita*), *Brachychiton* spp. and *Grevillea glauca* may also occur with varying frequency.

Plate 3-2 Tall Darwin stringybark and bloodwood woodland on the Kandosol soils

Yellow Kandosol (Affinities with Andoom (Ada))

The Yellow Kandosol is a deep Bauxitic Yellow Kandosol occurring on the Weipa Plateau. It occurs in conjunction with Red Kandosols and Redoxic Hydrosols, and is sub-dominant to Red Kandosol. This soil type occurs in less well-drained areas – for example, the lower sloping positions and margins of drainage lines. The concentration of aluminous concretions is variable and lower in the surface than the yellow subsoil. These soils are not extensive and only some minor occurrences could be mapped separately.

Vegetation is similar to that for Red Kandosols, *Eucalyptus tetrodonta* and *Corymbia clarksoniana* tall woodland with a greater presence of the Bloodwood. *Planchonia careya* and *Erythrophleum chlorostachys* are frequently associated with *Alphitonia excelsa* and *Grevillea glauca* less commonly associated. *Eucalyptus leptophleba* was also recorded.

Yellow Kandosol (Yellow Kandosol acid soil (YKa))

The Yellow Kandosol acid soil is a deep yellow, often acidic soil occurring predominantly along low lying drainage lines and in areas with restricted drainage which temporarily pond shallow water. In lower slope positions it appears to be formed on less weathered underlying sediments with a paler A2 horizon and mottling in the yellow to yellow-brown B horizons. Ferruginous concretions often occur in the deeper B horizons. It occurs in conjunction with Red Kandosols and Yellow Kandosols.

Vegetation on Yellow Kandosol acid soils consists of *Eucalyptus tetrodonta* and *Corymbia clarksoniana* medium to tall woodland. In wetter areas this woodland is more open with *Corymbia clarksoniana* often more prominent than *Eucalyptus tetrodonta.* These areas are also associated with *Acacia* spp. and occasionally *Erythrophleum chlorostachys* and *Banksia* species.

Soils of the Drainage Lines and Swamps

Redoxic Hydrosol (Affinities with Mapoon (Mpa))

The Redoxic Hydrosols have been mapped to include the small swamps and defined drainage lines of the alluvial country associated with the Rolling Downs landscape. Clay soils of the Redoxic Hydrosol type soil predominantly occur in seasonal swamp areas with the more gradational profiles with clay loam subsoils predominant in the drainage lines. The morphology of Redoxic Hydrosols varies a great deal and it typically consists of an organic-influenced, medium-textured surface overlying an occasionally bleached, grey medium-textured horizon. Below this are mottled grey or pale clay B horizons that are usually structured. Redoxic Hydrosols shows evidence of organic matter accumulation and may be classified as a Humose Orthic Redoxic Hydrosol. The gradational lighter-textured profiles tend to be Humose or Dystrophic Kandosolic Redoxic Hydrosols. Field pH of the profile ranges from very strongly acid to slightly acid.

Melaleuca species dominate in the swamp areas with *Melaleuca leucadendron* dominant along watercourses. In the drainage lines open woodlands are more common on the margins with *Banksia* species and *Melaleuca viridiflora* commonly associated. Insectivorous plants are commonly present in the ground layer in more open areas.

Soils of the Coastal Margin

The descriptions of soils of the coastal margin are based on the descriptions of Biggs and Philip (1995) as they were not described as part of the 2007 survey.

The soils of the coastal areas are divided into two categories that are principally related to texture and mode of formation.

(a) Beach ridge and dune deposits

Soils within this category are all dominated by the sand fraction and have been deposited by wind and/or wave action. Windblown dune deposits are a minor feature of the site and are a small feature of the coastal margin in this area. The beach ridges have been reworked by coastal movement and only narrow strips remain.

Orthic Tenosol (Caravan (Cv))

Orthic Tenosols (Caravan soil type) occur in the narrow coastal strip. Colour within the profile varies considerably, with yellow-brown or grey common. It consists of an A1 horizon showing some evidence of organic matter accumulation, over a paler A2 horizon. Below the A2 are B2 horizons displaying distinct to prominent mottling. Following the B2, two scenarios are possible. Some of the remnant deposits of Orthic Tenosols lie directly on marine clays, and this is evident as a D horizon. It is likely that the B2 and 2B2 horizons reflect wet season and dry season water table fluctuations. Vegetation on Orthic Tenosols varies from open woodlands to heath or herblands.

Orthic Tenosol (Somerset (Ss))

A second type of Orthic Tenosol was identified by Biggs and Philip (1995) and they named this soil type Somerset. It is found in areas of sand that have been deposited on, or influenced by, another surface (usually lateritic in nature in this area). The profile consists of multiple A2, B1 and B2 horizons below a dark A1. Textures range from sand to loamy fine sand throughout. The profile is red or red-brown throughout except for the A1 and A21 horizons. Vegetation is often *Eucalyptus tetrodonta* woodlands, but in exposed areas it may be heath.

(b) Estuarine and near coastal plains

Extensive estuarine and near coastal plains are found in the Project area. These plains typically consist of large areas of Vertosols and saltpans. The plains are often incised by rivers and variable amounts of localised alluvial influence exist. The mapped units often comprise mixes of these soil types.

Supratidal Hydrosol (George (Go))

Supratidal Hydrosols are associated with saltpans. The observations of Biggs and Philip (1995) were limited but they noted that the soil varied according to degree of tidal influence. It was also found in some non-tidal areas where it appears to be more consolidated. The only site described was in a bare saltpan with mangroves found on the margins. The surface of the soil consisted of a very thin yellow-brown alkaline light clay below which occurred a grey light medium clay. The profile trends moderately acid in the brown heavier textured B2 horizons and then mottled yellow in the B3. Presence of a saline water table prevented extensive description of the neutral grey C horizon.

Aquic or Grey Vertosol (Marina (Mn))

Aquic or Grey Vertosols are an extensive soil type on the coastal plain on the Weipa peninsula. Close to the coast, or in low lying areas, Aquic Vertosol are usually found, but further inland the older deposits are generally Grey Vertosols. The plains are typically flat but in some areas may be gently undulating. Gilgai are commonly (but not always) found. The soil surface is a mottled dark or grey light clay to light medium clay that is usually pedal, but on occasion massive. It is followed by a B1 horizon with a similar range of characteristics. The extensive B2 horizons are mottled grey medium clay to heavy clay although texture may change to light clay below 1m, in which case it is usually interpreted as a B3 horizon. Field pH is variable but is typically extremely acid to moderately acid in the surface, remaining either very strongly acid to moderately acid throughout, or trending alkaline with depth. Tussock grasslands with occasional halophytes are the dominant vegetation on Marina.

Intertidal Hydrosol (Skardon (Sd))

Intertidal Hydrosols are found where mangroves occur along the estuarine coastline. The only site recorded by Biggs and Philip (1995) was difficult to excavate and describe due to a watertable just below the surface. The soil was described as arenaceous (sandy) in nature but it is likely that it varies considerably. Intertidal Hydrosols, and the associated mangroves, are often found in narrow strips intermittently along the coast.

3.4.6 Soil Chemical and Physical Properties

Laboratory analysis of soil chemical and physical parameters was undertaken on samples from 14 soil profile sites. The profiles were sampled at standard depths of 0–10cm, 20–30cm, 50–60cm, 80–90cm and 110–120cm below surface. The top of the bauxite layer was sampled where required. Thirteen sites representing Red Kandosols (including one site representing Red Kandosol – Deep red phase), and one site representing Yellow Kandosol acid soil were sampled. These soil types were selected for sampling and laboratory analysis because they are the dominant soil types in the area to be disturbed. The results of the laboratory chemical and physical analyses are presented in **Appendix 3B**. Field pH analyses were undertaken on all soil profiles and field pH data are presented with soil profile descriptions in **Appendix 3A**.

Results of laboratory analyses indicate Red Kandosols are slightly to moderately acid with a pH range generally of 5.7 to 6.5. Field pH assessments of Red Kandosol soil profiles ranged from slightly acidic in the A horizon (pH 6.0 to 7.0) becoming more neutral at depth (pH 6.5 to 7.0). Laboratory analysis of one sample representing Red Kandosol – Deep red phase was strongly acidic (pH 4.9 to 5.4). However, field pH assessments of soil profiles representing Red Kandosol – Deep red phase were less acidic and within expected ranges (pH 6.0 to 7.0). Yellow Kandosol acid soils and Redoxic Hydrosols are more acidic with pH range ranges of generally 5.0 to 6.5 and 4.5 to 6.5 respectively. Laboratory Electrical Conductivity (EC) analysis on Red Kandosols – Deep red phase and Yellow Kandosol acid soil types indicate these soil types have low salinity (EC < 0.5 deciSiemens (dS/m). Low chloride levels throughout the soil profiles for these soil types indicate good drainage.

All soil profiles sampled and analysed were non-sodic (exchangeable sodium percentage (ESP<6), with only two profiles becoming slightly sodic (ESP 6) below 50cm. However, both exchangeable sodium and cation exchange capacity (CEC) concentrations are very low, making ESP results less meaningful in these soils.

Observations and results for this study are consistent with those of Biggs and Philip (1995). Red Kandosols generally have low levels of calcium, magnesium and potassium, which limit their suitability for a range of crops and improved pasture plants. The low CECs are associated with low clay contents (<35%) and the predominance of kaolin (which has a low CEC), common in lateritic landscapes. There is a consistent trend of higher CEC values in the surface than in the rest of the profile, which is linked to higher organic carbon in the surface. Levels of all cations are higher in the surface and decline consistently with depth. Biggs and Philip (1995) found the CEC of Hydrosols increased with depth, reflecting increasing clay contents.

The Kandosol soils are extremely infertile with low levels of Colwell extractable phosphorus (<1mg/kg) and very low exchangeable potassium (<0.35mg/kg). The average calcium/ magnesium (Ca/Mg) ratio in the top 30cm is 1.6, and at 50-60cm depth the average Ca/Mg ratio is 0.95. These ratios are within the range considered desirable for good plant growth. At depths below 70cm the Ca/Mg ratio is on average 0.8, indicating an imbalance that could result in calcium deficiency and poor root growth if that layer was exposed at the surface during rehabilitation. Nutrients such as nitrogen, calcium and potassium are concentrated in the surface 10cm of soil, due to nutrient recycling in the litter layer. This layer represents the main nutrient storage capacity for tropical soils, and therefore would need to be preserved to facilitate rehabilitation following mining.

3.4.7 Particle Size Distribution

The Red Kandosols consistently have higher coarse and fine sand contents than clay reflecting the sandstone parent material. Red Kandosols with high fine sand contents appear to hardset when leaf litter is removed and the soil surface is exposed; however, these appear to be uncommon. The Yellow Kandosol acid soils have significantly higher clay content, reflecting the lower landscape position. They also have higher silt content in the surface, which is consistent with their hardsetting nature.

3.5 Salinity hazard

A report on land degradation in the Cape York Peninsula was prepared under the CYPLUS Land Use Program (AGSO *et al.* 1995). The report outlines a number of characteristics of saline soils in the region and stated that the Rolling Downs Landscapes has a localised salinity hazard. However, the 2007 survey revealed very low soil EC levels throughout the well-drained soil profiles, relatively low levels of sodium, and no evidence of a salinity hazard. Although the Weipa plateau is well vegetated, the high rainfall for the area and well drained nature of the bauxitic soil profiles suggest that any lower landscape salinity problems would already be evident. The low soil salinity indicates that the risks of salinity developing, associated with clearing and development for mining, would be low in the survey area.

The salinity rating for each soil type identified within the Project area is presented with the soil profile descriptions in **Appendix 3A.**

3.6 Erosion Potential and Control

3.6.1 Erosion Potential

The Kandosol soil types encountered in the survey area in mid to upper landscape positions have low potential to develop accelerated erosion when cleared of vegetation for mining or infrastructure development. The predominantly sandy surface soils together with the low slopes on the bauxite plateau facilitate infiltration and reduce the rate of runoff. Rainfall runoff modelling indicates surface runoff from rainfall is a very low proportion (about 1%) of total incident rainfall due to the very high infiltration rates of the bauxite plateau and the flat topography (refer **Section 5.1.1**). The results of erosion monitoring of rehabilitated mined areas at the existing Weipa operations indicate that once soil profiles have settled (usually five years after topsoil has been respread) little active erosion is observed.

The Hydrosol and Tenosol soil types in the drainage lines and coastal margins have a higher erosion potential. Any of these areas to be disturbed by the Project have a risk of erosion during the wet season.

The erodibility rating for each soil type identified within the Project area is included in the land use limitations in **Appendix 3A.**

3.6.2 Erosion and Sediment Control

The erosion potential and proposed erosion and sediment control measures to be employed for each area throughout the life of the Project are summarised in **Table 3-2**.

Table 3-2 Erosion Potential and Erosion and Sedimentation Control

Area	Erosion Potential	Control Measures
Land cleared of vegetation for mining	Bauxite does not occur in swamps and drainage lines where soils with higher erosion potential occur. Most of the area to be disturbed for mining is on Red Kandosol soil, which has low erosion potential.	- Clearing would be restricted to areas essential for mining to minimise length of time soil is exposed to wind and rain. - Vegetation clearing would occur following the wet season, to reduce risk of water erosion and downstream sedimentation. - Vegetation buffers would be established to provide "setback" distances of mining areas from riparian, wetland and estuarine vegetation to minimise sediment transport into streams and to protect sensitive vegetation types (refer **Section 7.9.2**).
Active mining pits and backfilled pits awaiting rehabilitation	Bauxite does not occur in swamps and drainage lines where soils with higher erosion potential occur. Most of the area to be disturbed for mining is on Red Kandosol soil which has low erosion potential.	- Active mining pits and backfilled pits awaiting rehabilitation would be lower than surrounding landform, which effectively provides internally draining sumps that contain stormwater runoff. Contained stormwater runoff then infiltrates through the pit floor and walls. - Backfilled pits would be revegetated as soon as is practicable to reduce the risk of wind and water erosion. - In the event that active or backfilled pits are not fully internally draining, stormwater runoff would be directed via a sediment pond. - Vegetation buffers would be established to provide "setback" distances of mining areas from riparian, wetland and estuarine vegetation to minimise sediment transport into streams and to protect sensitive vegetation types (refer **Section 7.9.2**). - Where mining leaves batters on the edges of the pit, these would be recontoured to a maximum slope of 20% (1 in 5 or 11 degrees).
Boyd and Norman Creek infrastructure areas (including proposed port infrastructure)	Infrastructure construction would involve ground levelling, which would typically not require more than 0.5m excavation but may reach 2m. Boyd and Norman Creek infrastructure areas and the proposed port infrastructure are located on Red Kandosol soils, which have low erosion potential. Infrastructure related ground levelling has low potential to cause erosion.	- Construction work would be completed during the dry season where possible to reduce the risk of water erosion. - Disturbed areas around construction sites would be rehabilitated promptly to reduce the risk of wind and water erosion.
Haul road crossings of drainage lines	The Hydrosol soil types in the drainage lines have a higher erosion potential. These areas where vegetation is removed have a risk of erosion during the wet season.	- Sediment traps would be included as part of the drainage designs at points where haul roads cross watercourses. - Construction of the haul roads, including construction of sediment traps, would be completed during the dry season where possible to reduce the risk of water erosion and downstream sedimentation.
Mine Access Road	The access roads to both the Boyd and Norman Creek infrastructure areas would be constructed using cut and fill techniques. There is potential for runoff from the road surface to cause erosion of cleared areas adjacent to the road. To enable all weather access, the road alignment follows elevated portions of the landscape. Elevated portions of the landscape are dominated by Red Kandosols, which have low erosion potential.	- Roads would generally be constructed on Red Kandosols, which have low water erosion potential. - The Mine Access Road would be sealed, which would reduce the risk of wind and water erosion. - Road construction work would be completed during the dry season where possible to reduce the risk of water erosion and downstream sedimentation. - Table drains and culverts would be installed along Mine Access Roads to reduce the risk of water erosion and

Area	Erosion Potential	Control Measures
		downstream sedimentation. Drainage turnouts would be installed as required at intervals along the alignment and would be graded to the nearest outlet (refer **Figure 2-11**).
Water storage and tailings storage facilities	The water storage dam would be constructed on a watercourse using conventional earth-fill construction techniques. Areas adjacent to the watercourse are Red Kandosol soils, which have low erosion potential; however, soils in areas along the water course are Hydrosols, which have a higher erosion potential. There is some potential for erosion of construction areas along the watercourse during dam construction. Impacts related to sediment runoff during dam construction are discussed in **Section 5.1.3.** The tailings storage facilities would each have four cells, which are constructed over several years. The tailings storage facilities are located on Red Kandosols, which have a low erosion potential. The downstream face of water storage and tailings storage facilities have the potential to erode.	- Dam construction work would be completed prior to the wet season where possible, to reduce the risk of water erosion and downstream sedimentation. - Impacts and mitigation of impacts related to sediment runoff during dam construction are discussed in **Section 5.1.3**. - Prior construction of each cell, the economic bauxite reserves from within each cell would be mined. The tailings storage facilities cells would be internally draining and contain stormwater runoff, to reduce the risk of water erosion and downstream sedimentation. - Grasses would be established on the downstream face of water storage and tailings storage facilities, to reduce the risk of water erosion and downstream sedimentation.
Stockpiles of topsoil and excavated waste	Approximately 60cm of soil is stripped and then placed directly back on previously-mined areas or stockpiled for future use in rehabilitation once a suitable area becomes available. Topsoil stockpiles have the potential to erode.	- Generally, soil and overburden would be placed directly back on previously mined areas wherever possible, rather than being placed in stockpiles which are at risk of water and wind erosion. - If soil is stockpiled it would be typically used within one year. - Topsoil stockpiles would be sown with a native local seed mix to control weeds and erosion. - The final landform would not have any out-of-pit dumps of excavated wastes or soil (refer **Section 3.10.2**).

3.6.3 Erosion Monitoring and Maintenance

An erosion monitoring procedure would be developed and implemented for the Project. Prior to, and after, the end of the wet season each year, mined areas and other potential erosion sites would be visually monitored to identify active erosion rills and gullies. Areas where erosion has been remediated previously would also be monitored. Active erosion would be stabilised by grassing and/or constructing engineered structures.

There are no State soil conservation plans over the Project area.

3.7 Land Use Suitability

3.7.1 Pre-mine Land Use Suitability

Biggs and Philip (1995) assessed the suitability of the soils of Cape York Peninsula for a number of land uses using the methods described by DPI (1990). Interpreting land suitability using these methods is a requirement in the *Planning Guidelines: The Identification of Good Quality Agricultural Land* (DPI & DHLGP 1993). The following five land uses were directly assessed by Biggs and Philip (1995):

- peanut cropping;
- sorghum and maize cropping;
- high input pastures;
- medium input pastures; and
- low input pastures.

These land uses were chosen because they are currently practiced at certain locations on Cape York Peninsula.

The suitability of each of the soil types present on the Peninsula was assessed for each of the above land uses. The land suitability assessment for the selected agricultural uses was based on an evaluation of 12 land use limitations.

The nomenclature used for each limitation by Biggs and Philip (1995) is shown in brackets:

- Climate (C)
- Moisture supply (M)
- Fertility (N)
- Wetness (W)
- Flooding (F)
- Rockiness (R)
- Topography (T)
- Physical condition (P)
- Vegetation (V)
- Water Erosion (E)
- Landscape complexity (X)
- Salinity (S).

The final suitability classes for a particular land use are defined as follows:

- Class 1 – Suitable land with negligible limitations
- Class 2 – Suitable land with minor limitations
- Class 3 – Suitable land with moderate limitations
- Class 4 – Marginal land which is presently considered unsuitable due to severe limitations
- Class 5 – Unsuitable land with extreme limitations.

Land allocated a final suitability class of 4 or 5 for a particular land use was assessed as unsuitable for any of the five selected land uses. Class 5 land includes mangroves and is designated as "land not suitable for the nominated uses". Class 4 land is land with a very low fertility status. Land assessed as Class 4 for low input pastures is designated as "land suitable for low intensity grazing of native pastures".

The land suitability assessment for this EIS was undertaken using similar methodology to Biggs and Philip (1995). However, the suitability assessment by Biggs and Philip (1995) for cropping uses assumes there are no infrastructural restrictions in relation to product handling and marketing. That assumption was not considered appropriate for the land suitability assessment of the Project area, therefore cropping land uses were not considered.

The suitability of each soil type within the Project area for the non-cropping land uses (low and medium input pasture and high input pasture) was assessed based on the land use limitations (refer **Table 3-3**). The full land use limitations of each soil type are presented with the profile descriptions in **Appendix 3A** and a summary of land use limitations for each soil type is presented in **Table 3-3**. Biggs and Philip (1995) provide an explanation of each limitation used in their study, how each limitation was assessed and the relationship between limitation level and limitation class. The nomenclature, codes and relationship between limitation and limitation class developed by Biggs and Philip (1995) have been adopted for this land suitability assessment.

Each soil type was given an Agricultural Land Classification based on the agricultural land class definitions in the guidelines for the identification of good quality agricultural land (DPI / DHLGP 1993), and these are also presented in **Table 3-3**. According to these definitions, crop land (Class A), marginal crop land (Class B) and land suitable for improved pastures (Class C1) are good-quality agricultural land (GQAL). Pasture land not suitable for improved pastures (Class C2) and land not suitable for agricultural uses (Class D) are not GQAL. The soils suitable for low intensity grazing were assessed as Class C2 and soils not suitable for pasture or grazing were assessed as Class D.

Table 3-3 Land Suitability Classes

Soil Type	Low-medium input pasture	High input pasture	Suitability for low intensity grazing of native pastures	Land use Limitations[1]	Agricultural Land Classification
Red Kandosol	Class 4	Class 5	Suitable	C2, M4, N8, W2m, F0, Rf4, T0, P1, Vc2e2, E2s, X0, Si1	C2
Red Kandosol - Deep Red phase	Class 4	Class 5	Suitable	C2, M4, N8, W2m, F0, Rf4, T0, P1, Vc2e2, E2s, X0, Si1	C2
Yellow Kandosol	Class 4	Class 5	Suitable	C2, M4, N8, W4m, F0, Rf4, T0, P1, Vc2e2, E2s, X0, St2	C2
Yellow Kandosol acid	Class 4	Class 5	Suitable	C2, M4, N8, W4s, F0, R0, T0, P1, Vc2e2, E2s, Xi, So2	C2
Redoxic Hydrosol	Class 4	Class 5	Suitable	C2, M4, N8, W5s, F3, R0, T0, P0, Vc2e2, E1s, X1, X0, Sn	C2
Orthic Tenosol (Caravan)	Class 4	Class 5	Suitable	C1, M6, N8, W4h, F0, Ro, T0, Po, Vc2e2, E2u, Xi, Sn	C2
Orthic Tenosol (Somerset)	Class 4	Class 5	Suitable	C2, M6, N8, W1h, F0, R0, T0, Po, Vc1e2, E2u, Xi, Sn	C2
Supratidal Hydrosol	Class 5	Class 5	Not suitable	C1, M6, N8, W6v, F3, R0, T0, P7, Vc1e1, E1v, Xi, Ss	D
Aquic or Grey Vertosol	Class 5	Class 5	Not suitable	C1, M5, N7, W6v, F3, R0, T2, P8, Vc1e1, E2u, X0, Ss	D
Intertidal Hydrosol	Class 5	Class 5	Not suitable	C1, M6, N8, W6m, F3, R0, T0, Po, Vc1e1, E1u, Xi, Ss	D

1 – Land use limitation codes are from Biggs and Philip (1995)

The outcome of the land suitability assessment shows that none of the soil types within the Project area are suitable for improved pasture land uses. Most of the soils are suitable for low intensity grazing of native pastures. Land suitable for low intensity grazing of native pastures represents native pasture grazing land with a very low fertility status. However, it is often associated with areas suitable for pastoral development and is a useful component of the total grazing system. Soils associated with estuarine areas and near coastal plains within the Project area are not suitable for any improved pasture or native pasture grazing land uses. There is no GQAL within the Project area.

The areas of each land suitability class within the Project area are presented in **Table 3-4**. A map of pre-mine suitability for low intensity grazing is shown in **Figure 3-8**. The land suitability areas shown in **Figure 3-8** are based on the distribution of soil types (refer to **Figure 3-7**) and the suitability of each soil type for low intensity grazing, as presented in **Table 3-3**.

Biggs and Philip (1995) mapped land suitability of the Cape York Peninsula at a scale of 1:700,000. The land suitability mapping was based on the suitability of the dominant soil type of each map unit, and the dominant soil types were based on soil survey data from air photo interpretation and ground observations. Biggs and Philip (1995) mapped most of the Cape York Peninsula north of Aurukun as "land suitable for low intensity grazing of native pastures".

Table 3-4 Land Suitability of the Project Area

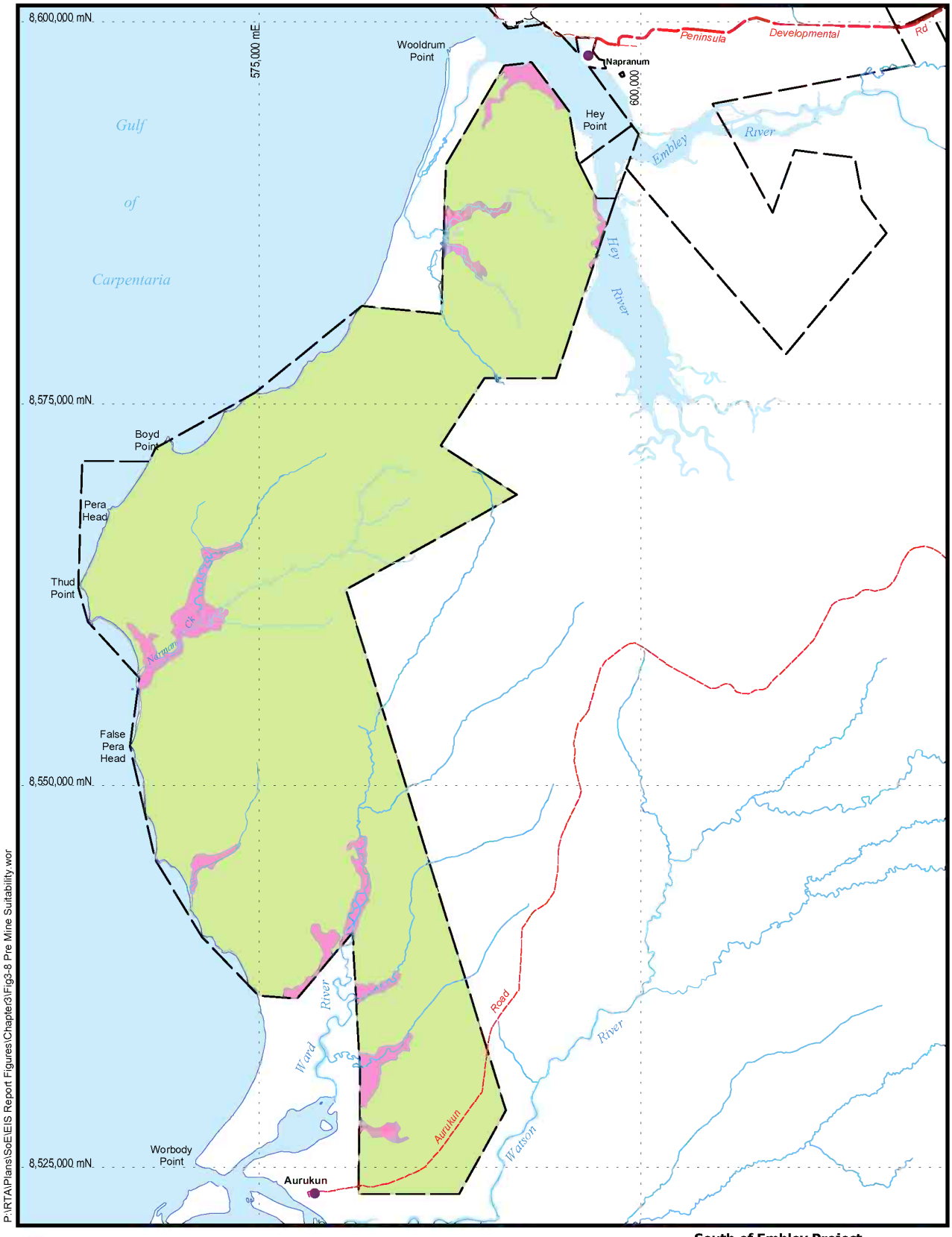
Land suitability – Pre mine	Area within Project Area (ha)	Area within Project Area (%)
Low intensity grazing of native pastures	95,500	95
Not suitable for nominated land uses	4,750	5
Medium and low input improved pastures	0	0
High, medium and low input pastures	0	0
Total	100,250	100

3.7.2 Post-mine Land Use Suitability

Mining involves removing around 1m of soil and overburden above the bauxite and then excavating the bauxite (which has an average thickness of approximately 3.4m). The overburden would be returned to mined-out pits and then soil would be respread during rehabilitation. The final landform would be at a lower elevation than the original landform due to the removal of the bauxite, but the overall slope of the landform would be similar. Where mining leaves batters on the edges of the pit, these would be recontoured to a maximum slope of 20% (1 in 5, or 11 degrees). The rehabilitated mined landform would be predominantly internally draining. During the wet season there are likely to be some areas at the lowest topographical locations of previously mined areas that would receive increased inundation and have elevated soil moisture. Rehabilitated infrastructure areas would not exhibit this changed drainage effect. During the dry season there is unlikely to be any change in the capacity of native grasses to exploit soil moisture. Overall, the post-mining land suitability for low intensity grazing is likely to be the same as the pre-mining suitability. The rehabilitated tailings storage facilities would be an exception due to slopes, and would not be suitable for low intensity grazing.

RTA's objective for the rehabilitation of areas disturbed by SoE Project mining activities is to establish a self-sustaining vegetation community using appropriate local native tree, shrub and grass species (refer **Section 3.10.1**). In the past in its operations north of the Embley River, RTA has, with the encouragement and support of Queensland Government agencies, experimented with the establishment of improved pasture, forest plantation species and horticulture on mined land. Based on this experience, it has been concluded that post-mining land is most suited to the establishment of native vegetation communities.

Under the WCCCA and at the request of the Western Cape Communities Coordinating Committee (WCCCC), RTA may establish post-mining land use options other than those required by regulation subject to obtaining all necessary government approvals (refer to **Section 3.10.1**). While it is not currently envisaged that land uses other than native vegetation be established, RTA would consult with Traditional Owners about rehabilitation objectives and rehabilitated land completion criteria and objectives.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575,000 mE.
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Wooldrum Point
Napranum
Peninsula
Developmental
Rd
Hey Point
Gulf
of
Carpentaria
Embley
River
Hey
River
8,575,000 mN.
Boyd Point
Pera Head
Thud Point
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Norman
False Pera Head
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Ward
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Road
River
Ward
Aurukun
Watson
Worbody Point
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P:\RTA\Plans\SoE\EIS Report Figures\Chapter3\Fig3-8 Pre Mine Suitability.wor
RTA Mining Lease boundary
Township
Road/track
Suitable for low intensity grazing
Unsuitable for agriculture or grazing
South of Embley Project
Fig. 3-8:
Pre Mine Land Suitability
N
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5km
Datum/Projection: GDA94/MGA Zone 54
Date: 01/04/2011

3.8 Contaminated Land

3.8.1 Potential for Contamination from Existing and Past Uses

Contaminated land refers to land contaminated by hazardous substances that may pose a risk to human health and/or the environment. Lands south of the Embley River are relatively undisturbed by development. Some cattle grazing took place within the Project area in the early to mid 1900s. Exploration activities have taken place throughout the Project area. While there has been domestic rubbish dumping at some camping locations, there is no known historic land contamination south of the Embley River.

Activities identified as being likely to cause land contamination are listed as Notifiable Activities in Schedule 3 of the *Environmental Protection Act 1994* (Qld). Landowners and local government must inform the Department of Environment and Resource Management (DERM) that land has been or is being used for a Notifiable Activity. Land that has been or is being used for a Notifiable Activity, and about which DERM is notified, is recorded on the Environmental Management Register (EMR). Sites recorded on the EMR pose a low risk to human health and the environment under the current land use. Entry on the EMR does not mean the land must be remediated or that the current land use must stop. The Contaminated Land Register (CLR) is a register of known contaminated land that is causing, or may cause, serious environmental harm. Land is recorded on the CLR when scientific investigation shows it is contaminated and action needs to be taken to remediate or manage the land.

The land parcels and tenure within the Project area are summarised in **Table 2-1** and shown in **Figure 2-1**. Not all land parcels within the Project area would be disturbed by Project activities. Searches of the EMR and CLR were undertaken to identify land that may be contaminated from past and current Notifiable Activities and/or land that is known to be contaminated, only for land parcels that would be disturbed by the Project.

Land to be disturbed by the Project that is on the EMR or CLR is detailed in **Table 3-5**. Most of the Project area is covered by Lot 7024 MP41159, which also covers existing RTA mining operations north of the Embley River. Where the EMR and CLR search identified Notifiable Activities that were known to occur within existing RTA mining operations north of the Embley River, and not within the Project area, those activities were excluded from the results presented in **Table 3-5**.

Table 3-5 Environmental Management Register and Contaminated Land Register Status

Aspect	Mining Tenement	Land Parcel	Environmental Management Register	Contaminated Land Register
Mine, port, infrastructure	ML7024 (RTA)	Lot 7024 MP41159 Note: This land parcel covers the area of existing RTA mining operations north of the Embley River as well as the Project area.	No notifiable activities occur within the Project area portion of this land parcel	No
Hey River barge/ferry terminal	ML6024 (RTA)	Lot 121 SP 135863	No	No
Humbug barge terminal	Not applicable. Located within Strategic Port Land	Lot 29 SP116854	No	No
		Lot 14 SP120446	Yes – used for petroleum product storage A site within this land parcel has been subject to a hazardous contaminant. Possible contamination with heavy metals due to accidental burning of batteries. The barge terminal is not at the location of the above sites.	No
Hornibrook Ferry Terminal	Not applicable. Located within Strategic Port Land	Lot17 SP116853	No	No
		Lot 14 SP120446	Yes – used for petroleum product storage A site within this land parcel has been subject to a hazardous contaminant. Possible contamination with heavy metals due to accidental burning of batteries. The ferry terminal is not at the location of the above sites.	No

3.8.2 Contamination Prevention and Control

A number of Notifiable Activities are proposed to be undertaken within the Project area (refer **Table 3-6**). These activities have the potential to cause land contamination through spills, leaks or uncontrolled runoff from contaminated areas.

Table 3-6 Project Notifiable Activities

Notifiable Activity	Description	Location
14	Engine reconditioning works	Boyd and Norman Creek infrastructure areas
25	Mineral processing	Beneficiation plants
29	Petroleum product or oil storage: b)(iii) petroleum products that are combustible liquids in class C1 or C2 in AS1940 – more than 25,000L capacity	Boyd and Norman Creek infrastructure areas
37	Waste storage, treatment or disposal	Temporary storage of regulated waste in mining infrastructure areas (e.g. batteries, tyres and waste oil)

Potentially contaminated runoff from the heavy equipment workshops and service bays, fixed plant workshops, and light vehicle and heavy vehicle wash-down areas would be directed to the mine industrial area drainage slot from where it would be recycled to the Process Water Pond for reuse (refer **Figure 5-8** and **Figure 5-9**). Runoff from infrastructure areas is unlikely to cause land contamination.

Water for dust suppression and bauxite washing would be drawn from tailings recycle and recovery slots (via the Process Water Pond), water supply dam (Dam C), surface water stream (Ward River) and artesian bores. Water from the heavy and light vehicle wash bays would be treated in oil water separators and drain to the Mine Industrial Area Drainage Slot prior to being pumped to the tailings storage facility. The Process Water Pond would not contain contaminants in concentrations that are hazardous. The water used for bauxite washing and dust suppression is not considered a potential source of land contamination. The site water management system is discussed further in **Section 5.2.2,** and tailings characteristics are discussed in **Section 13.3.4**.

Fuel storage areas have the potential to cause land contamination through leaks, spills and rupture of tanks. Contamination would be prevented by bunding fuel storage areas. Hydrocarbons would be stored in accordance with Australian Standard *AS1940 The Storage and Handling of Flammable and Combustible Liquids.*

Hydrocarbons would be handled in the heavy equipment workshop and service bays, fixed plant workshops, and diesel and oil storage areas within the Boyd and Norman Creek infrastructure areas. There is the potential for land contamination to arise from hydrocarbons spills in these areas during operations. This potential would be minimised through the development and implementation of standard operating procedures for transport, handling and storage of hydrocarbons. Employees would be trained in hydrocarbon handling and emergency spill response. Prevention and management of spills is discussed in **Section 19.1** and **Section 19.3.1.**

Management of regulated wastes (including temporary storage of regulated wastes in mining and infrastructure areas) to minimise risk of land contamination is discussed in **Section 13.3.6** and **Section 13.3.7**. Regulated wastes include batteries, heavy vehicle tyres, waste grease and oil, waste oil filters and oily rags, clinical waste and small amounts of waste chemicals. Standard procedures for the storage, handling, disposal and spill response for potentially hazardous waste materials would be adopted to minimise potential for generation of contaminated soil. These procedures are described in **Section 19.** Procedures for remediating soil that does become contaminated are discussed **in Section 13.3.3**.

Bauxite ore and tailings are benign. The chemical characteristics of bauxite and tailings are discussed in **Section 13.3.4.**

The disturbance of Acid Sulphate Soils (ASS) and placement of ASS sediments on land has the potential to cause contamination. The potential impacts and management of onshore ASS are discussed in **Section 3.9** and the acid sulphate soil potential of sediments excavated by dredging activities is discussed in **Section 6.5.**

3.9 Acid Sulphate Soils

Potential Acid Sulphate Soils (PASS) are soils that contain iron sulphides, commonly in the form of pyrite. When these soils are disturbed and exposed to air, they may oxidise to produce sulphuric acid, which may be released to waters. The release of acid reduces the pH and has the potential to mobilise toxic concentrations of iron, aluminium and heavy metals.

Dredging of sediments is required at the proposed port site between Pera Head and Boyd Point, and at the barge/ferry terminals at Hornibrook Point, Humbug Point and Hey River. Dredged sediments are proposed to be barged to spoil grounds at sea. However, in the event that dredged sediments are required to be placed on land they have potential to generate acid and cause land contamination through oxidation of sulphidic material in the sediments. The acid

sulphate soil potential of sediments from dredging activities was assessed and is discussed in **Section 6.5.** The acid sulphate soil potential of soils is discussed in this section.

Acid sulphate soil mapping in Queensland is undertaken by the DERM. No mapping is currently available for the Project area. In the absence of mapping, elevation is used as an indicator for mapping the distribution of PASS, as they are typically encountered at elevations below 5m AHD. Mangroves, salt marshes, floodplains, swamps, wetlands and estuaries are typical environments conducive to PASS formation.

Three locations within the footprint of disturbance have been identified as potentially containing PASS, based on elevation and soil type: the Humbug barge terminal, the Hornibrook ferry terminal and the Hey River barge/ferry terminal.

3.9.1 Humbug Barge Terminal

Construction activities at the Humbug barge terminal would include reclaiming a small area (about 400m^2) behind a sheet pile wall and constructing a road and parking area. The road and parking area construction would involve cut and fill to allow creation of a road base and possibly installation of shallow buried services. These proposed activities trigger the criterion listed in Section 2.3 of *State Planning Policy 2/02: Planning and Managing Development involving Acid Sulfate Soils*. To meet the requirements of this policy, ASS investigations were undertaken of soil at the proposed Humbug barge terminal.

The north bank of the Embley River at Humbug Wharf is known to have been reshaped and levelled. A superficial cover of fill was expected and the fill was known to potentially be derived from dredged alluvium as well as locally derived Ironstone and Weipa Bauxite. Soil sampling at the Humbug barge terminal was undertaken by Coffey Geotechnics on 12 May 2009. Six test pits were constructed using a backhoe and were located within the alignment of the proposed access road and parking area (refer **Figure 3-9**). The test pits were constructed to depths where they became unstable due to rapid water inflow (2.3 to 3.5m). Each test pit recorded a similar soil profile. A cover of fill was recorded at each point, ranging in thickness from 0.5m to in excess of the full depth of excavation of 3.5m closest to the riverbank. The fill was described as sandy (fine grained) rounded gravel of bauxite locally intermixed with subangular cobbles of low strength ironstone and moderately strongly cemented (medium strength) bauxite. In five of the six test pits (TP511 to TP515) the fill overlay possibly undisturbed medium to coarse grained loose sand with many shell fragments, identified as Marine (Estuarine) Alluvium. Firm sandy clay was identified at depth in test pits TP512 and TP511. Instability due to groundwater inflows prevented excavation progressing to the intended full depth of these test pits. The soil types at each depth are summarised in **Table 3-7**.

Soil samples were collected at 25cm depth intervals through the soil profile from three of the test pits. All soil samples collected underwent field ASS analysis (pH_F and pH_{FOX}). One sample from each of two pits and two samples from one pit were selected for laboratory ASS analysis. Reference was made to the *Guidelines for Sampling and Analysis of Lowland Acid Sulfate Soils (ASS) in Queensland 1998* (Ahern *et al.* 1998) for the specification of sampling and subsequent testing. Action criteria in the guidelines were used to interpret the results. The results of the field and laboratory ASS analyses are presented in **Table 3-7**, and a summary of the results is presented below.

The field pH (pH_F) of the soils tested ranged from 6.0 to 8.3, indicating the sulphide oxidation has probably not occurred in the past and that there are no actual ASS soils present. The field pH after oxidation with peroxide (pH_{FOX}) ranged from 5.7 to 8.9. All samples had a high pH_{FOX} (greater than 5) and there was little or no drop in pH between pH_F and pH_{FOX} (pH change less than 1 pH unit). This indicates the samples had little or no net acidifying ability.

The Titratable Actual Acidity (TAA), which measures the soil's actual acidity prior to any oxidation taking place, was low or below the detection level for all samples. This indicates no acid generation has yet taken place in the soil.

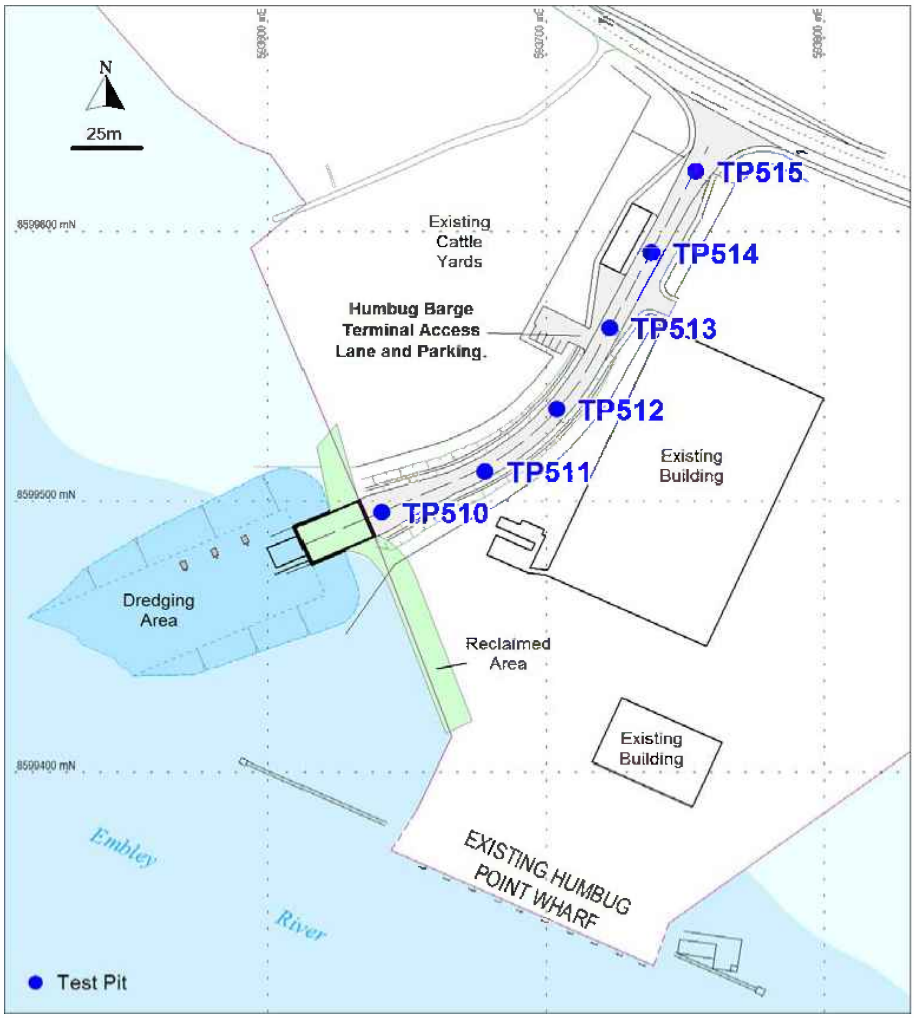


Figure 3-9 Acid Sulphate Soil Test Pit Sites at Humbug Barge Terminal

Table 3-7 Results of Acid Sulphate Soils Tests – Humbug Barge Terminal

Sample ID	Depth	Soil Texture	Action Criteria		pH_F	pH_{FOX}	pH_{KCl}	TAA	S_{KCl}	S_{Cr}	S_{NAS}	S_{EQ}	Ca_{KCl}	Mg_{KCl}	$S_{ANC_BT/FF}$	Ca_{NAS}	a-Net Acidity
			Sulphur Trail	Acid Trail													
Units			%S	Moles H+/t	pH units	pH units		mol/t	%	%	%	%	mg/kg	mg/kg	%	mg/kg	moles H+/t
TP 510	0.25 – 0.5	Fill – Sandy Gravel			6.9	6.7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TP 510	0.5 – 0.75	Fill – Clayey Gravel			7.2	6.8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TP 510	0.75 – 1.0	Fill – Clayey Gravel			6.8	6.7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TP 510	1.0 – 1.25	Fill – Clayey Gravel	0.03	18	6.4	5.7	6.22	1	0.02	<0.01	<0.01	0.003	106	44	ND	31	ND
TP 510	1.25 – 1.5	Fill – Clayey Gravel			6.3	6.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TP 510	1.5 – 1.75	Fill – Clayey Gravel			7.0	7.2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TP 510	1.75 – 2.0	Fill – Clayey Gravel			6.8	7.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TP 510	2.0 – 2.25	Fill – Clayey Gravel			7.2	7.6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TP 510	2.25 – 2.5	Fill – Clayey Gravel			7.3	7.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TP 510	2.5 – 2.75	Fill – Clayey Gravel			7.0	7.4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TP 511	0.25 – 0.5	Fill – Sandy Gravel			7.8	8.4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TP 511	0.5 – 0.75	Sand			7.8	8.7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TP 511	0.75 – 1.0	Sand			7.8	8.7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TP 511	1.0 – 1.25	Sandy Clay			8.0	8.9	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TP 511	1.25 – 1.5	Sandy Clay			8.3	8.7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TP 511	1.5 – 1.75	Sandy Clay			7.8	8.8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TP 511	1.75 – 2.0	Sandy Clay	0.03	18	7.9	8.1	8.49	0	0.03	**0.21**	0.04	0.096	3541	123	0.15	34581	**37.0**
TP 511	2.0 – 2.25	Sandy Clay			7.9	6.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TP 511	2.25 – 2.5	Sandy Clay			7.8	7.3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TP 515	0.25 – 0.5	Fill – Sandy Gravel	0.03	18	6.1	5.7	6.60	0	<0.01	<0.01	<0.01	-0.007	463	51	0.01	144	-6.2
TP 515	0.5 – 0.75	Fill – Sandy Gravel			6.0	6.2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TP 515	0.75 – 1.0	Clayey Sand			6.3	6.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TP 515	1.0 – 1.25	Clayey Sand	0.03	18	6.5	6.6	6.59	0	<0.01	<0.01	<0.01	0.001	634	39	<0.01	216	0

Sample ID	Depth	Soil Texture	Action Criteria		pH_F	pH_{FOX}	pH_{KCl}	TAA	S_{KCl}	S_{Cr}	S_{NAS}	S_{EQ}	Ca_{KCl}	Mg_{KCl}	$S_{ANC_BT/FF}$	Ca_{NAS}	a-Net Acidity
			Sulphur Trail	Acid Trail													
Units			%S	Moles H+/t	pH units	pH units		mol/t	%	%	%	%	mg/kg	mg/kg	%	mg/kg	moles H+/t
TP 515	1.25 – 1.5	Clayey Sand			6.5	6.4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TP 515	1.5 – 1.75	Sand			6.6	6.6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TP 515	1.75 – 2.0	Sand			7.4	7.7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TP 515	2.0 – 2.25	Sand			7.7	8.3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TP 515	2.25 – 2.5	Sand			8.1	8.6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Note: Bold values indicate exceedence of action criteria.

ND: No Data

The chromium reducible sulphur (S_{CR}) is a measure of potential sulphidic acidity. The S_{CR} results for three of the four samples that underwent laboratory analysis were below detection indicating they had no potential to generate sulphidic acidity.

One sample (TP 511 depth 2.0m) had a S_{CR} concentration of 0.21%, which is higher than the corresponding action criteria. The sample included a significant content of shells and the laboratory analyses indicated a high calcium and also magnesium content that is associated with shells. The shell content contributed to the relatively high acid neutralising capacity (ANC) of sample. The ANC was 0.15% S, indicating there was sufficient ANC in the sample to neutralise most of the potential sulphidic acidity. However, the net acidity of the sample was 37 moles H+/tonne, which was higher than the corresponding action criteria, indicating the material represented by this sample has the potential to generate sulphidic acidity.

Overall, given the depth of fill, the underlying marine alluvium is unlikely to be disturbed by land-based development for access roads and car parking. Where development creates disturbance to soils limited to superficial sand or gravelly sand/sandy gravel (fill) the potential to disturb soils susceptible to sulphide acidification is assessed to be low. In such a case no "acid sulphate soil management plan" would be needed. Where deeper excavation is proposed, whereby cohesive marine alluvium soil is to be exposed to air, there is a potential acidification hazard. The hazard would be (at least) partly ameliorated by the shell content enabling calcium and magnesium buffering.

Material represented by samples from sites TP510 and TP515 would require no management if placed on land. However, material represented by sample TP511 depth 2.0m would require the addition of lime to manage acid generation if the material was to be placed on land.

3.9.2 Hornibrook Ferry Terminal

Construction at the Hornibrook ferry terminal would involve an area of about 1,900m^2 being reclaimed and supported by rock revetment and/or sheet piles and the construction of road pavement. Any earthworks would be shallow cut and fill only, to allow creation of a road base and possibly installation of shallow buried services.

In October 2008 four test pits were excavated by Coffey Geotechnics using an excavator. Each pit progressed through fill extending to between 2.6m and in excess of the total depth of excavation of 3.3m.

Profile descriptions were completed on all four test pits. Hornibrook Point is known to be a reclaimed peninsula into the Embley River that was built up using locally-derived fill. The observations of the test pits confirm the peninsula comprises reclaimed (filled) ground. In each pit the initial cover of fill comprised kaolinite clay with some gravel of ironstone (ferricrete) and in some places pisoliths of bauxite, all derived from the laterite profile that prevails across the Weipa area. In one test pit fill below 1.1m was described as reworked alluvium (sand with some gravel and shells). A layer of alluvium-derived fill was also identified in another test pit below 1.4m depth, and a darker-coloured alluvial clay below 1.7m depth in a third test pit. Undisturbed alluvium might be present at about 2.6 to 2.9m depth in two of the test pits.

The superficial fill is not alluvial in provenance and would not be acid sulphate susceptible. There is the potential for alluvial-derived fill recorded at depth to be acid sulphate soil. However, the proposed construction works at the Hornibrook ferry terminal would be shallow cut and fill only and these potentially acid sulphate soils would not be disturbed.

Since there is no proposed disturbance of potential ASS or actual ASS at Hornibrook ferry terminal, ASS sampling and analysis were not undertaken at this site.

3.9.3 Hey River Barge/Ferry Terminal

Construction at the Hey River barge/ferry terminal would involve an area of about 4,400m^2 being reclaimed and supported by rock revetment and/or sheet piles. This activity triggers the criterion listed in Section 2.3 of *State Planning Policy 2/02: Planning and Managing Development involving Acid Sulfate Soils*. To meet the requirements of this policy, ASS investigations were undertaken of soil at the Hey River barge/ferry terminal.

An onshore drilling investigation was undertaken between 21 and 28 July 2008. Five drill holes (DH511to DH515) were bored using a track-mounted Hydrapower Scout rig equipped for continuous flight auger and wash boring techniques. A test pit (TP220) was excavated by backhoe on 9 July 2008.

The onshore boreholes (DH511 to DH515) typically encountered red soil topsoil, 0.2 to 0.4m thick, overlying Ironstone, 1.1 to 2.0m thick, overlying kaolinite rich clay, extending for the remaining depth of investigation (maximum 10m depth).

Samples from three of the drill holes and one test pit were collected by Coffey Geotechnics for laboratory analysis. Samples were collected at 0.5m depth intervals to a depth of 3m from the drill holes, and one sample was collected at a depth of 0.5m from the test pit. Locations of the drill holes and test pit are shown in **Figure 3-10**. PASS were tested using the Suspension Peroxide Oxidation Combined Acidity and Sulphate (SPOCAS) suite of analyses. Action criteria in the *Guidelines for Sampling and Analysis of Lowland Acid Sulfate Soils (ASS) in Queensland, 1998* (Ahern *et al.* 1998) were used to interpret the results. The results of the laboratory ASS analyses are presented in **Table 3-8**, and a summary of the results is presented below.

- The pH (pH_{KCl}) of the soils tested ranged from 5.0 to 8.9, indicating the sulphide oxidation has probably not occurred in the past and that there are no actual ASS soils present.
- The pH after oxidation with peroxide (pH_{OX}) ranges from 4.6 to 9.2. The pH_{OX} of all but three samples was greater than 5, indicating most samples had little net acidifying ability.
- Only three samples (DH513 0–0.5m, DH514 0–0.5m and DH514 2.5–3.0m) had a pH_{OX} between 4 and 5, indicating sulphides may be present either in small quantities and be poorly reactive or the sample may contain shell/carbonate, which neutralises some or all acid produced by oxidation. Equally, the pH_{OX} value may be due to the production of organic acids and there may be no sulphides. The potential sulphidic acidity (S_{POS}) for these three samples indicated the oxidisable sulphur content was lower than the corresponding action criteria. This indicates the material at these sites has little potential to generate sulphidic acidity.
- The Titratable Peroxide Acidity (TPA), which measures the soil's potential acidity, marginally exceeded the action criteria in only two samples (DH512 0.5–1.0m and DH514 2.5–3.0m). However, the potential sulphidic acidity (S_{POS}) for these samples was below detection. This indicates the material at these sites has no potential to generate sulphidic acidity.
- The potential sulphidic acidity (S_{POS}) results indicated the oxidisable sulphur content was below detection in most samples and was lower than the corresponding action criteria in all samples, except sample DH515 0–0.5m. This indicates the material at all sites, except DH515, has little or no potential to generate sulphidic acidity.
- The sample from site DH515 had a high S_{POS} result, however this sample has a significant neutralising capacity (ANCE 5.3%$CaCO_3$). The net acidity of this sample, which is used to predict the acid risk of a soil, was lower than the detection limit.
- If material represented by the samples tested was to be placed on land, the addition of lime to manage acid generation would not be required.

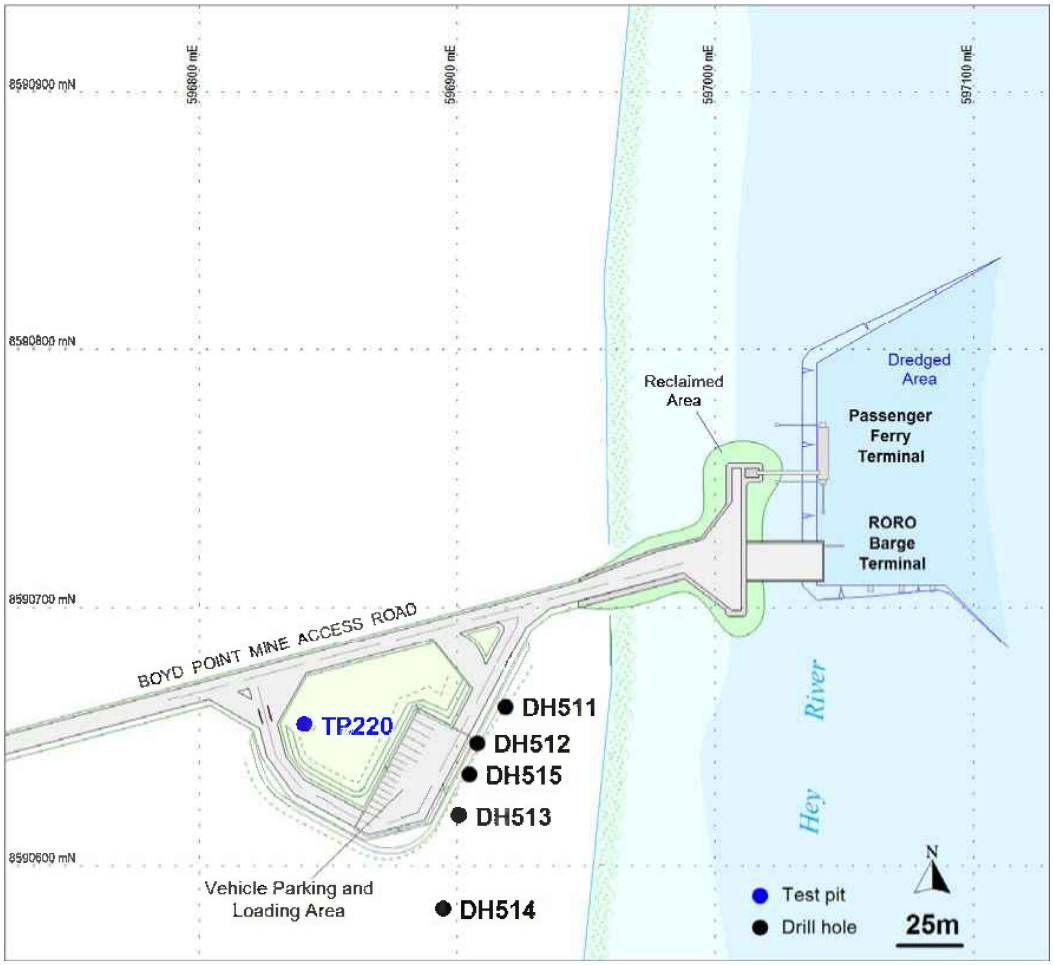


Figure 3-10 Acid Sulphate Soil Drill Hole and Test Pit Location at Hey River Barge/ferry Terminal

Table 3-8 Results of Acid Sulphate Soils Tests – Hey River Barge/ferry Terminal

Sample ID	Units	PQL	DH 512	DH 512	DH 512	DH 512	DH 512	DH 512	DH 513	DH 513	DH 513	DH 513
Depth	m		0 – 0.5	0.5 – 1.0	1.0 – 1.5	1.5 – 2.0	2.0 – 2.5	2.5 – 3.0	0 – 0.5	0.5 – 1.0	1.0 – 1.5	1.5 – 2.0
Soil Texture			Gravelly Sandy/ Silty Clay	Gravelly/ Sandy Clay	Sandy Clay	Sandy Clay	Sandy Clay	Gravelly Sandy Clay	Gravelly Sandy/ Silty Clay	Gravelly/ Sandy Clay	Sandy Clay	Sandy Clay
Action Criteria												
Sulphur Trail	% S		0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Acid Trail	moles H+/t		18	18	18	18	18	18	18	18	18	18
pH Measurements												
pH KCl	pH units		5.4	5.6	5.5	5.4	5.2	5.2	5.5	5.7	5.7	5.4
pH Ox	pH units		5.2	5.8	5.6	5.5	5.5	5.9	4.6	5.5	5.7	5.7
Titratable Acidity												
TAA pH 6.5	moles H+/t	<5	<5	7	6	6	6	7	9	<5	<5	6
TPA pH 6.5	moles H+/t	<5	9	6	**19**	7	10	7	<5	<5	9	11
Percentage Sulphur												
SKCl	%w/w S	<0.005	<0.005	<0.005	0.006	0.005	0.006	0.007	<0.005	<0.005	<0.005	0.006
SP	%w/w	<0.005	0.011	<0.005	0.008	0.008	0.008	0.009	0.007	<0.005	<0.005	0.008
Percentage Calcium												
CaKCl	%w/w	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.079	0.012	<0.005	<0.005
CaP	%w/w	<0.005	0.015	<0.005	<0.005	<0.005	<0.005	<0.005	0.087	0.014	<0.005	<0.005
Percentage Magnesium												
MgKCl	%w/w	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.008	<0.005	<0.005	<0.005
MgP	%w/w	<0.005	0.006	<0.005	<0.005	<0.005	<0.005	<0.005	0.009	<0.005	<0.005	<0.005
Titratable Sulphidic Acidity												
s-TAA pH 6.5	%w/w S	<0.01	<0.01	0.01	0.01	0.01	0.01	0.01	0.01	<0.01	<0.01	0.01
s-TPA pH 6.5	%w/w S	<0.01	0.01	0.01	0.03	0.01	0.02	0.01	<0.01	<0.01	<0.01	0.02

Sample ID	Units	PQL	DH 512	DH 512	DH 512	DH 512	DH 512	DH 512	DH 513	DH 513	DH 513	DH 513
TSA pH 6.5	moles H+/t	<5	9	<5	12	<5	<5	<5	<5	<5	<5	<5
s-TSA pH 6.5	%w/w S	<0.01	0.01	<0.01	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Acid Neutralising Capacity												
ANCE	% CaCO3	<0.05	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
a-ANCE	moles H+/t	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
s-ANCE	%w/w S	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Peroxide Oxidisable Sulphur												
SPOS	%w/w	<0.005	0.011	<0.005	<0.005	<0.005	<0.005	<0.005	0.007	<0.005	<0.005	<0.005
a-SPOS	moles H+/t	<5	7	<5	<5	<5	<5	<5	<5	<5	<5	<5
Percentage Reacted Calcium												
CaA	%w/w	<0.005	0.015	<0.005	<0.005	<0.005	<0.005	<0.005	0.008	<0.005	<0.005	<0.005
Percent Reacted Magnesium												
MgA	%w/w	<0.005	0.006	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Net Acidity												
a-Net Acidity	moles H+/t	<10	7.0	7.5	7.5	7.7	7.7	8.7	13	<5	5.2	7.2

Note: Bold values indicate exceedence of action criteria.

Table 3.8 (continued) Results of SPOCAS Acid Sulphate Soils Tests – Hey River Barge/ferry Terminal

Sample ID	Units	PQL	DH 513	DH 513	DH 514	DH 514	DH 514	DH 514	DH 514	DH 514	DH 515
Depth	m		2.0 – 2.5	2.5 – 3.0	0 – 0.5	0.5 – 1.0	1.0 – 1.5	1.5 – 2.0	2.0 – 2.5	2.5 – 3.0	0 – 0.5
Soil Texture			Sandy Clay	Gravelly Sand	Gravelly Silt	Gravelly Silt	Gravelly Silt	Gravelly Silt	Gravelly Silt	Gravelly clayey Silt	Unknown
Action Criteria											
Sulphur Trail	% S		0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Acid Trail	moles H+/t		18	18	18	18	18	18	18	18	18
pH Measurements											
pH KCl	pH units		5.4	5.3	5.4	5.6	6.0	5.4	5.2	5.0	8.9
pH Ox	pH units		5.4	5.7	4.7	5.0	6.0	5.6	5.3	4.8	9.2
Titratable Acidity											
TAA pH 6.5	moles H+/t	<5	6	7	11	9	<5	7	9	11	<5
TPA pH 6.5	moles H+/t	<5	<5	<5	<5	<5	<5	12	17	**19**	<5
Percentage Sulphur											
SKCl	%w/w S	<0.005	0.007	0.008	<0.005	<0.005	<0.005	0.011	0.014	0.021	0.046
SP	%w/w	<0.005	0.007	0.010	0.006	0.005	<0.005	0.014	0.015	0.025	0.16
Percentage Calcium											
CaKCl	%w/w	<0.005	<0.005	<0.005	0.041	0.036	<0.005	<0.005	<0.005	<0.005	0.16
CaP	%w/w	<0.005	<0.005	<0.005	0.044	0.040	0.006	<0.005	<0.005	<0.005	1.6
Percentage Magnesium											
MgKCl	%w/w	<0.005	0.007	<0.005	<0.005	<0.005	<0.005	<0.005	0.005	<0.005	0.034
MgP	%w/w	<0.005	0.008	<0.005	<0.005	<0.005	<0.005	<0.005	0.006	<0.005	0.034
Titratable Sulphidic Acidity											
s-TAA pH 6.5	%w/w S	<0.01	0.01	0.01	0.02	0.01	<0.01	0.01	0.01	0.02	<0.01
s-TPA pH 6.5	%w/w S	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	0.03	0.03	<0.01
TSA pH 6.5	moles H+/t	<5	<5	<5	<5	<5	<5	<5	9	7	<5
s-TSA pH 6.5	%w/w S	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	0.01	<0.01
Acid Neutralising Capacity											

Sample ID	Units	PQL	DH 513	DH 513	DH 514	DH 514	DH 514	DH 514	DH 514	DH 514	DH 515
ANCE	% CaCO3	<0.05	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	5.3
a-ANCE	moles H+/t	<5	<5	<5	<5	<5	<5	<5	<5	<5	1000
s-ANCE	%w/w S	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	1.7
Peroxide Oxidisable Sulphur											
SPOS	%w/w	<0.005	<0.005	<0.005	0.006	<0.005	<0.005	<0.005	<0.005	<0.005	**0.12**
a-SPOS	moles H+/t	<5	<5	<5	<5	<5	<5	<5	<5	<5	72
Percentage Reacted Calcium											
CaA	%w/w	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	1.5
Percent Reacted Magnesium											
MgA	%w/w	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Net Acidity											
a-Net Acidity	moles H+/t	<10	6.2	8.5	15	11	<5	9.0	9.5	14	<5

Note: Bold values indicate exceedence of action criteria.

3.10 Rehabilitation

3.10.1 Post-Mining Land Use

The overall objective of the rehabilitation program would be to return the land to a post-mining land use that will be stable, self-sustaining, requires minimal maintenance, and protects downstream water quality. Specifically, the objectives for the rehabilitation of areas disturbed by mining activities would be:

- to establish a self-sustaining vegetation community using appropriate local native tree, shrub and grass species; and
- to ensure land is made stable – in both geotechnical and erosion terms – to ensure post-mine land use is not compromised by site instability.

Under the WCCCA, RTA has commitments to consult Traditional Owner groups about rehabilitated land completion criteria. RTA would jointly develop a rehabilitation process with the Traditional Owners and relevant WCCCC sub-committee prior to the commencement of mining. RTA would also consult with the Traditional Owners and WCCCC sub-committee regarding timelines for development of rehabilitated land completion criteria, aiming to have these developed within three years of commencement of mining. RTA would continue to report annually to the relevant WCCCC sub-committee on rehabilitation programs, including an inventory of areas disturbed by mining, timeframes for rehabilitation, and supporting reports pertaining to the monitoring of rehabilitated areas. Ongoing community consultation during the EIS process is described in **Section 15.4** and ongoing community engagement thereafter, including engagement with Traditional Owners, is discussed in **Section 16.3.3**.

At the request of the WCCCC, RTA may establish post-mining land use options other than those required by regulation, subject to obtaining all necessary government approvals. RTA also has commitments under the WCCCA to surrender parts of the mining lease after their rehabilitation. Such surrendering of parts of the mining lease would be undertaken where it is practical to do so, and would be subject to government approvals.

Traditional Owners have indicated during consultation that seed collection and rehabilitation are two potential business opportunities arising from the Project. RTA would continue to involve Traditional Owners in rehabilitation programs where practicable. The steps RTA would take to support the development of Indigenous businesses in the Western Cape region are detailed in **Section 16.3.7**.

3.10.2 Post-Mining Landform

Areas disturbed by mining activities and infrastructure would be rehabilitated to a stable landform with a self-sustaining vegetation cover. After overburden and soil are returned to mined-out pits, the final rehabilitated landform would be at a lower elevation than the original landform due to the removal of the bauxite, but the overall slope of the landform would be similar. Where mining leaves batters on the edges of the pit, these would be recontoured to a maximum slope of 20% (1 in 5, or 11 degrees). The final landform would not have any out-of-pit dumps of excavated overburden or soil.

Given the changes to topography due to mining and infrastructure at a local scale would be minor, and there would be no final out-of-pit dumps of overburden, there would be no significant changes to the broad scale topography of the Project area. Mining would involve clearing vegetation (refer **Section 7.9**); however, vegetation would be retained within environmental buffers along the coastline and beside waterways, with mining excluded within buffer areas (refer **Section 7.9.2**). Through the retention of vegetation buffers and proposed progressive rehabilitation with native species, no significant changes to broad scale vegetation character of the Project area at the landscape scale are expected.

The tailings storage facility embankments and surface would be revegetated after decommissioning and minor earthworks undertaken to install suitable water management features.

Topographical information is currently being prepared which would assist with preparation of a conceptual mine closure landform model for the mined areas.

3.10.3 Rehabilitation Strategy

The rehabilitation strategy for the Project has been based on the Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland – Determination of Post-Mine Land Use (DME/DEH 1995). The strategy consists of the following integrated measures:

- implementation of practical landform designs, to prevent erosion and establish final landform stability;
- revegetation trials, for selection of appropriate revegetation species and methodologies;
- progressive rehabilitation of disturbed areas, using rehabilitation procedures appropriate to the type of disturbance;
- appropriate management of the final bauxite processing waste, including construction of an earth cover; and
- implementation of erosion control measures, consistent with the practices described in the *Technical Guidelines for Environmental Management for Exploration and Mining in Queensland – Erosion Control* (DME/DEH 1995).

Rehabilitation would commence progressively as areas become available and in accordance with the Plan of Operations. The Plan of Operations would be provided to the relevant WCCCC sub-committee in accordance with the requirements of the WCCCA.

A detailed operational rehabilitation procedure, including a quality assurance process, would be developed and implemented.

3.10.4 Topsoil Management

The dominant soil type of the Project area is Red Kandosol, which has a topsoil depth of 10 to 20cm. These soils are weathered and low in nutrients, and support vegetation adapted to such conditions. The majority of seed readily able to germinate is present in the upper 5cm of soil.

Prior to mining, all topsoil, subsoil and waste bauxite overlying the surface of the bauxite is stripped. Soil moisture levels would be assessed before soil stripping commences to ensure the soil is not so wet it would lose its structure when handled. Approximately 60cm of soil would be stripped and directly placed on mined-out areas in readiness for revegetation. This technique would help minimise the area of mined land exposed at any one time. If direct placement is not possible, soil would be stockpiled. If soil is stockpiled, it would be managed so as to maintain optimum growth media properties by maximising the stockpile surface area and minimising compaction. Stockpiled soil would be typically used within one year to maximise the benefits of the natural seed bank and conserve symbiotic micro-organisms. Any soil stockpiled for more than one year would be sown with a native local seed mix to control weeds and erosion. Areas receiving stockpiled material are sown with a special seed mix containing additional species to the standard seed mix, including seed of species that usually "volunteer" from natural seed store in freshly returned topsoil, such as grasses and Acacias.

Procedures for topsoil stripping, stockpiling and placement activities, including a quality assurance process, would be developed, implemented and included in the site rehabilitation procedure.

3.10.5 Revegetation

Revegetation is the component of the rehabilitation process that involves rebuilding the soil of disturbed land, seeding and/or planting plants. At RTA's current operations north of the Embley River the following approach is taken to revegetation:

- respreading freshly stripped topsoil or stockpiled topsoil;
- ripping the mine floor to 50cm at 3.4m centres to break up the compacted floor and increase water infiltration (note, sometimes the mine floor is ripped before topsoil is

replaced). Other compacted surfaces to be rehabilitated (such as haul roads) are repeatedly cross-ripped to ensure water infiltration and root penetration is achieved;

- scarifying along the contour prior to seeding;
- seeding with a seed mix of locally occurring native species at a density and richness to facilitate a self-sustaining local native ecosystem; and
- applying fertiliser at an appropriate rate, if required.

A similar revegetation methodology would be adopted and refined for the Project area.

The soil surface would be scarified prior to seeding, except where the topsoil has been ripped immediately prior to seeding and the soil surface forms an appropriate seedbed. Pre-seeding scarification assists in providing suitable growing media properties to optimise plant growth (e.g. porosity and water holding capacity). Scarifying also breaks up soil surface crusting and produces a soft soil bed for seeds, which maximises the chances of the seeded species germinating and establishing by increasing soil–seed surface contact. Scarification may be carried out using various means, such as a tractor-towed disc plough, a tractor-towed multi-tyne scarifier, a grader with a scarifier or a grader with a ripper beam attachment.

At current RTA operations north of the Embley River, direct seeding has been found to be the best method for establishing desired plant species. Direct seeding is generally undertaken using a belt spreader towed behind a tractor. The relatively small volumes of seed are bulked with a medium such as sand or sawdust to ensure a steady and adjustable delivery rate. Aerial seeding techniques are also currently being trialled. Seed is applied as close as practicable to the onset of the tropical monsoon rains (approximately December each year) to ensure the soil moisture and follow-up rainfall are favourable to seedling establishment.

Native species seed mixes would be tailored to the anticipated post-mining conditions of the area to be rehabilitated. The proximity of the post-mined landscape to the wet season water table is the key factor determining which native plant community is most appropriate for the post-mining landscape.

Free-draining areas are most suited to "Tall Darwin Stringybark woodland on lateritic red earths" and "Tall Darwin Stringybark woodland on yellow earths". Free-draining post-mining landscapes would be seeded with a range of tree, shrub and groundcover species from these communities. Suitable tree species are likely to include *Eucalyptus tetrodonta*, *Corymbia nesophila*, *Erythrophleum chlorostachys*, *Corymbia stockerii* and *Eucalyptus polycarpa*. Suitable mid-storey species may include *Acacia rothii*, *Alphitonia obtusifolia*, *Antidesma ghaesembilla*, *Breynia cernua*, *Exocarpus latifolius*, *Grevillea glauca*, *Grevillea parellala*, *Livistona muellerii*, *Parinari nonda*, *Petalostigma pubsecens*, *Planchonia careya* and *Xylomelum scottianum*. Suitable groundcover species may include *Heteropogon triticeus*, *Sorghum plumosum*, *Heteropogon contortus*, *Aristida macrantha*, *Eriachne triseta*, *Eriachne pallescens* and *Ectrosia leporina*.

Post-mining landscapes likely to be less free draining and seasonally inundated are most suited to Melaleuca swamp and Melaleuca/Swamp mahogany vegetation communities. Suitable species are likely to include *Lophostemon suaveolens, Melaleuca stenostachya, Melaleuca viridiflora, Melaleuca leucadendra, Banksia dentata, Asteryomyrtus symphyocarpa, Calycopeplus casuarinoides, Corymbia polycarpa, Eucalyptus brassiana, Syzygium suborbiculare, Livistona meulleri* and *Pandanus spiralis.*

At current RTA operations north of the Embley River, fertiliser is applied at the time of seeding, with an aim to provide the best possible nutrition to maximise initial establishment and plant growth during the first wet season. The type and rate of fertiliser application is determined by the nature of the rehabilitated soils and plant species being re-established. Generally, superphosphate is applied at a rate of 200kg/ha using a tractor-towed belt spreader.

3.10.6 Success Criteria

Preliminary rehabilitation success criteria for the Project area would be developed within three years of commencement of bauxite mining. On-site revegetation trials would be undertaken to test selected species, seeding rates and establishment methodologies. Success criteria would be

based on the outcomes of the rehabilitation trials and on-going monitoring. Rehabilitation performance would be measured against the adopted criteria. Different success criteria may be developed for different developmental stages of each relevant vegetation community. The criteria may change over time as more rehabilitation knowledge relevant to the Project area is gained.

Soil indicators such as bulk density, surface cover and soil invertebrates are potentially suitable for the Project area. Appropriate indicators of ecological function may include framework species presence, species richness and density, structural composition, native species recruitment, presence of weed species and fauna.

3.10.7 Maintenance

Rehabilitated areas would be regularly monitored to identify any areas in need of maintenance at an early stage. Rehabilitation maintenance activities are likely to include:

- re-seeding of areas that have not reached a sufficient growth density of vegetation or have not achieved the desired species diversity;
- a fire management program aimed at excluding wildfires from rehabilitated land through construction and maintenance of fire access tracks and a prescribed burning program. The burning program would include areas adjacent to new rehabilitation. Prescribed burning is conducted early in the burning season, when fuel flammability is sufficient to carry a fire but low enough to maintain a relatively cool, low intensity burn (refer **Section 7.10.2**);
- weed monitoring and management; and
- erosion monitoring and control.

The early establishment monitoring of rehabilitation areas would be undertaken annually around August and September to provide an indication of the success of earthworks and seeding undertaken in the previous year. Re-seeding in the first or second year following establishment offers the most effective rehabilitation remedial response if remediation is required.

Where supported by knowledge of rehabilitation ecology and fire impacts, controlled burning of rehabilitation may be conducted to influence rehabilitation vegetation composition, structure and function. Controlled introduction of fire to developing sites can ensure fire-sensitive species do not dominate, and that desirable fire-resilient species and characteristics are encouraged.

Any controlled burning of rehabilitation would be accompanied by a monitoring program including a pre- and post-burn vegetation survey, fuel load estimations and fire intensity calculations, and spatial data of burnt areas and degree of vegetation removal, including canopy scorch.

3.10.8 Monitoring

A monitoring program would be developed to regularly assess the success of rehabilitation against preliminary success criteria.

The monitoring would focus on a range of indicators that reflect vegetation composition and structure and may include species richness and density, structural composition, native species recruitment and presence of weed species. The monitoring methodology would be likely to be similar to that currently used for operations north of the Embley River and include:

- monitoring in the first year after establishment at a scale of one 500m^2 transect plot per 10ha of rehabilitation; and
- follow-up monitoring 4, 8 and 12 years after establishment.

Soil indicators such as bulk density, surface cover and soil invertebrates may be useful indicators in some situations and may also be monitored. Fauna indicators such as representative species of soil mites, ants, birds, mammals and reptiles may be useful indicators in some situations and may also be monitored.

The outcomes of the monitoring program would be used to refine rehabilitation success criteria, identify areas that may need remedial measures, plan progressive certification of the acceptability of rehabilitation areas and, in the longer term, relinquishment.

The impacts of both controlled burning and wildfire on rehabilitation areas would also be monitored.

Erosion monitoring and maintenance of rehabilitation areas is discussed in **Section 3.6.3**.

3.10.9 Decommissioning and Closure

The decommissioning and final rehabilitation of the Project would occur on a staged basis over several years. A Final Rehabilitation Report, which includes a contaminated site assessment, would be prepared prior to surrender of the mining lease. A contaminated site register would be maintained for the operation. Areas of soil contamination would be investigated prior to rehabilitation. Contaminated sites would be managed using methods developed on a case-by-case basis in accordance with DERM guidelines.

RTA would jointly develop an initial mine closure plan with the Traditional Owners and relevant WCCCC sub-committee prior to the commencement of mining and update this plan every five years.

On the completion of mining, buildings, structures and other infrastructure would be treated as follows:

- The barge/ferry terminals, port, water storage dam and certain roads may have some ongoing beneficial use. Subject to agreement with relevant regulators and Traditional Owners, some of these facilities may be left in place. Otherwise, RTA would remove these facilities.
- Buildings, plant, equipment, tanks, conveyors, pipelines and transmission lines would be removed and the surface rehabilitated. Concrete pads would be broken up, buried, and then the area rehabilitated.
- RTA would provide Traditional Owners with the opportunity to purchase decommissioned construction camp accommodation on fair, agreed commercial terms, once the construction phase is complete.

Environmental Impact Statement

for South of Embley Project

Section 4
Climate

4 CLIMATE

4.1 Meteorology

The Project area lies within the Australian Monsoon Zone which has a tropical climate with distinctive wet and dry seasons. The area typically experiences warm summers with high maximum temperatures and warm winters.

The summer wet season is relatively short, lasting from approximately December to March, and occurs with the change in the prevailing south-east trades to the north-west monsoons. Approximately 95% of the region's rainfall occurs between November and April.

A significant influence on the year-to-year weather variability is exerted by the El Niño Southern Oscillation (ENSO) phenomenon, an eastern Pacific system of atmospheric and oceanic interactions which affects the weather worldwide and can result in large variations in the timing and amount of wet season rainfall on Cape York.

The closest weather stations to the Project area are maintained by the Bureau of Meteorology (BoM). The stations are:

- Weipa Aerodrome (Station No. 027045) – records from 1972 to present;
- Eastern Avenue, Weipa (Station No. 027042) – rainfall records from 1914 to present and temperature, evaporation and wind records from 1959 to 1994; and
- Aurukun (Station No. 27000) – rainfall records only from 1914 to present.

The Weipa Aerodrome station is 7km south of the Eastern Avenue station, and presents similar average climatic data, with the exception of higher rainfall averages (1,967mm vs 1,769mm). A summary of records from the Eastern Avenue station is presented in **Table 4-1**. Daily rainfall is also recorded at Aurukun station, which has a mean annual rainfall of 1,647mm (refer summary in **Table 4-2**).

Table 4-1 Climate Averages – Eastern Avenue Station, Weipa

Month	Temperature (°C)		Relative Humidity (%)		Evaporation (mm)	Wind Speed (km/h)		Rainfall (mm)		
	Mean max	Mean min	9am	3pm	Mean Daily	9am	3pm	Mean Monthly	Highest Daily	Highest Monthly
Jan	31.9	24.0	85	75	4.3	4.4	8.4	448.8	279.2	1112.0
Feb	31.4	24.0	87	78	4.0	3.9	8.6	444.9	226.1	919.0
Mar	31.7	23.6	84	73	4.5	5.2	7.9	247.4	217.9	1063.0
Apr	32.0	22.5	80	62	4.8	7.6	8.7	108.1	152.4	396.3
May	31.6	21.3	78	57	4.4	8.6	10.1	16.8	45.0	133.4
June	30.6	19.5	77	53	4.2	8.3	10.1	4.3	54.9	60.0
July	30.4	18.9	76	51	4.4	8.1	11.0	1.7	13.5	13.5
Aug	31.6	18.8	73	46	5.2	8.4	11.3	2.8	26.4	45.4
Sept	33.3	20.0	68	44	6.0	9.8	11.8	5.6	58.7	63.2
Oct	34.8	21.4	66	46	6.6	9.1	11.1	25.2	118.9	208.1
Nov	34.7	23.2	70	53	6.4	6.4	10.0	103.8	168.8	450.6
Dec	33.3	23.9	78	65	5.4	4.5	8.3	261.1	191.6	859.6
Annual Average	**32.3**	**21.8**	**77**	**59**	**1,825.0**	**7.0**	**9.8**	**1,769.3**	—	—

Source: BoM (2009a)

Table 4-2 Rainfall Averages – Aurukun Station

Month	Rainfall (mm)		
	Mean Monthly	Highest Daily	Highest Monthly
Jan	454.7	232.4	991.9
Feb	466.5	346.2	863.7
Mar	325.1	167.0	743.5
Apr	91.2	255.8	484.0
May	12.3	68.0	123.1
June	3.0	100.8	108.9
July	1.0	11.9	15.4
Aug	1.1	28.2	28.2
Sept	1.9	21.6	32.5
Oct	14.9	80.0	153.4
Nov	73.4	94.5	342.4
Dec	225.3	154.2	632.6
Annual Average	**1646.7**	—	—

Source: BoM (2009b)

4.1.1 Temperature

Average daily maximum temperatures range from 30.4°C in July to 34.8°C in October, before the commencement of the wet season (BoM 2009a). Average minimum temperatures range from 18.8°C in August to 24.0°C in January and February. A highest temperature of 39.1°C was recorded in October 1980. A lowest temperature of 9.6°C was recorded in August 1990.

4.1.2 Humidity

Relative humidity is fairly consistent throughout the year with highest averages recorded in the morning (9am) ranging from an average of 66% in October to an average of 87% in February. Afternoon averages (3pm) are more variable between the dry and wet seasons, with an average of 44% in September and 78% in February.

4.1.3 Rainfall

The mean annual rainfall at Weipa is 1,769mm, falling on an average of 109 days per year, with the majority of rainfall occurring from December through to March. The mean monthly rainfall varies from 1.7mm in July to 448.8mm in January. January has also recorded the highest number of rain days with an average of 21.9 days.

The variability index of mean annual rainfall is classified by the BoM as low to moderate. Surface water storage is required to provide sufficient water for operations for the extent of the dry season. Water supply is discussed further in **Section 5.2.1** and water storage is discussed in **Section 5.2.3**. The high rainfall experienced in the wet season can restrict vehicle movements and is likely to curtail some construction activities in wetter months.

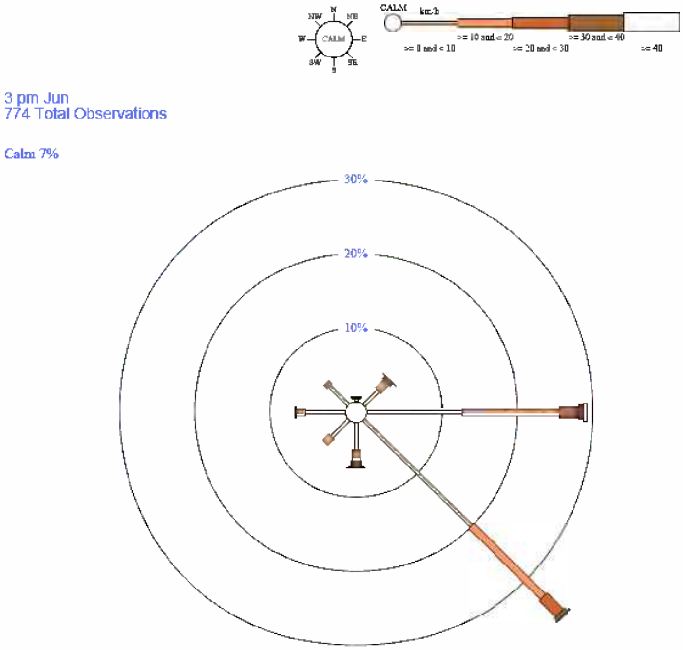
The mean annual evaporation rate is 1,825mm. Mean daily evaporation ranges from 4.0mm/day in February to 6.6mm/day in October.

The highest daily rainfall was 279.2mm, recorded on 31 January 1982. The mean number of days of rain over 25mm is at its highest in summer with 5.8 days recorded in the months of January and February.

4.1.4 Wind

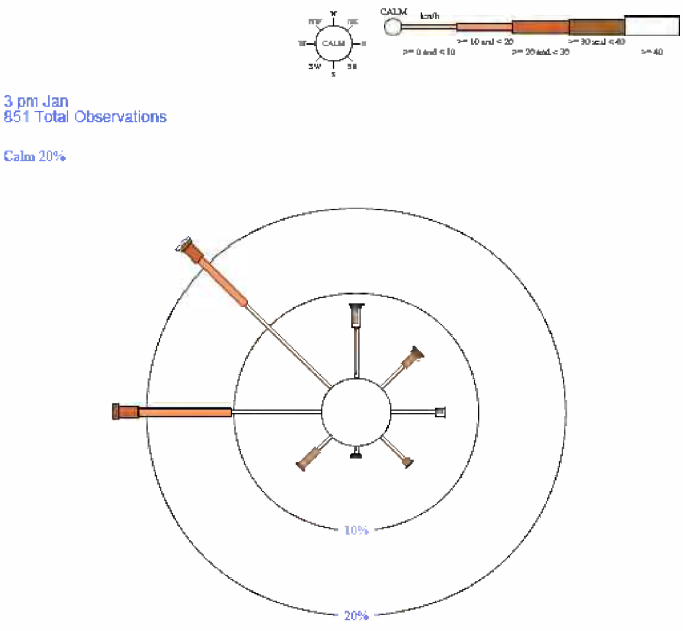
The region tends to have light to moderate south-east to easterly winds during the dry season (refer **Figure 4-1**). Over the wet season, winds are mostly light tending moderate westerly to north-westerly when the monsoon trough dips south of the area (refer **Figure 4-2**). Fresh winds (30–39km/h) occur occasionally but strong or gale force winds normally only occur with a tropical cyclone.

Figure 4-1 Wind Rose for Typical Dry Season (June), Weipa



(BOM 2009a)

Figure 4-2 Wind Rose for Typical Wet Season (January), Weipa



(BOM 2009a)

4.2 Extreme Events

4.2.1 Cyclones

Cyclones regularly affect the Project area between December and April and have a strong relationship with the ENSO phenomenon, with almost twice as many impacts during La Niña than during El Niño (BoM 2009c).

The severity of a tropical cyclone is described in terms of categories ranging from one (1) to five (5) related to the zone of maximum winds. The categories are described in **Table 4-3**, along with the typical impacts of each category.

Table 4-3 Tropical Cyclone Category Descriptions

Category	Strongest gust (km/h)	Typical impacts
1 Tropical Cyclone	Less than 125km/h Gales	Minimal house damage. Damage to some crops, trees and caravans. Boats may drag moorings.
2 Tropical Cyclone	125–164km/hr Destructive winds	Minor house damage. Significant damage to some crops. Risk of power failure. Small boats may break moorings.
3 Severe Tropical Cyclone	165–224km/hr Very destructive winds	Some roof and structural damage. Some caravans destroyed. Power failure likely.
4 Severe Tropical Cyclone	225–279km/hr Very destructive winds	Significant roof and structural damage. Many caravans destroyed and blown away. Dangerous airborne debris. Widespread power failures.
5 Severe Tropical Cyclone	More than 280km/hr Extremely destructive winds	Extremely dangerous with widespread destruction.

Source: BoM (no date)

From the available records, there are 1 to 1.5 tropical cyclones in the Gulf of Carpentaria per year on average; however the numbers range from 0 to 5 in any one year. There has been a total of 24 Category 3 and above tropical cyclones in the recorded history of the Gulf region, an average of one severe coastal crossing every six years. Only three of these cyclones have reached Category 4.

The landlocked nature of the Gulf means that, when a tropical cyclone develops, it is very likely to strike the coast and is also likely to do so within only a day or two of the commencement of its development, unless it has originated outside the Gulf. This very short life cycle means a relatively small proportion of the total number of tropical cyclones attain severe Category 3 status or higher. Many of the longer-lived and more intense tropical cyclones that have impacted the Gulf are cyclones that originally developed over the Coral Sea and crossed over Cape York Peninsula, weakening rapidly as they strike the Great Dividing Range then redeveloping again very rapidly once back over the waters of the Gulf.

Table 4-4 provides information on the impact of cyclones in the Weipa area.

Cyclones present a number of risks to the Project including:

- health and safety of employees and the community from storm surge, flooding and wind-blown debris;
- damage to port, ferry and barge infrastructure from storm surge and waves, and damage to other infrastructure from wind and flooding; and
- damage to revegetation from wind and heavy rain.

Table 4-4 Tropical Cyclones on the Eastern Coast of the Gulf of Carpentaria

Cyclone	Origin	Impact
Dawn 11 Feb 1970	South-west of the Gulf of Carpentaria	*Dawn* crossed the coast near Weipa as a Category 1 cyclone. Thursday Island reported a gust of 52 knots (96km/hr). There was minor vegetation damage and telephone lines were down. Weipa recorded 443mm of rain over six days.
Faith 13 Apr 1972	North of the Gulf of Carpentaria	*Faith* crossed the coast just south of Weipa as a Category 1 cyclone. Wind gusts up to 84km/hr were reported at Aurukun and these caused some tree damage. Aurukun registered 256mm of rain in 24hrs.
Otto 7 Mar 1977	Gulf of Carpentaria	*Otto* crossed the coast between Aurukun and Weipa as a Category 2 cyclone. Wind gusts to 94km/h were reported at Weipa, with rough seas, however no storm surge was reported. Tree damage was reported at Weipa.
Greta 10 Jan 1979	Gulf of Carpentaria	*Greta* crossed the coast 20km south of Weipa as a Category 2 cyclone. Weipa recorded a maximum wind gust of 42 knots (78km/hr). Little damage was experienced.
Stan 14 Apr 1979	Originally developed in the Coral Sea moving north to the Arafura sea then changed direction to track east across the Gulf of Carpentaria	*Stan* crossed the coast 40km north of Weipa as a Category 1 cyclone causing no damage. A 0.5m storm surge was reported at Weipa. The 24hr rainfall total was 84mm at Weipa.
Dominic 7 Apr 1982	North Gulf of Carpentaria	*Dominic* crossed the coast near Cape Keerweer, approximately 100km south of the Project area, strengthening to a Category 4. Storm damage occurred at Aurukun. A storm surge of 1m was recorded at Weipa.
Rebecca 22 Feb 1985	North of the Northern Territory coast in the Arafura Sea	*Rebecca* crossed the coast just to the north of Weipa as a Category 1 cyclone. Tree damage at Weipa.
Mark 10 Jan 1992	West Arafura Sea	*Mark* travelled east across the Gulf of Carpentaria and crossed the coast near Weipa as a Category 2 cyclone. Weipa suffered widespread minor damage with falling trees largely responsible for house and power line damage. Weipa recorded 167mm rainfall in 24hrs and a 1.2m storm surge.
Ethel 9 Mar 1996	Gulf of Carpentaria	*Ethel* made landfall 33km west northwest of Weipa as a Category 2 cyclone. Trees up to 1m in diameter were uprooted. Strips of up to 2km wide were completely defoliated. The beach area about the point of landfall was affected by large waves and storm surge. Wind gusts of up to 100km/hr and a 72hr rainfall of 320mm were recorded at Weipa. A peak storm surge of 1.18m was recorded at Weipa.
Bernie Jan 2002	North-west Gulf of Carpentaria	*Bernie* intensified to a Category 2 cyclone as it tracked southward through the Gulf of Carpentaria and crossed the coast near the Northern Territory border. A maximum storm surge height of 0.4m was recorded at Weipa.
Craig 7-12 Mar 2003	North Gulf of Carpentaria	*Craig* was a tropical cyclone that tracked east along the north coast of the Northern Territory until it moved south across the Gulf of Carpentaria, intensifying to Category 2 level. Weipa recorded a storm surge of 1.1m, significant wave heights of 3m, and peak wave heights of 5m.
Ingrid Mar 2005	North Gulf of Carpentaria	*Ingrid* originally developed north of the Gulf of Carpentaria in March 2005 and tracked east to the Coral Sea where it intensified into a Category 5 cyclone as it moved west towards the east coast of Queensland. Ingrid had weakened to a Category 1 cyclone as it tracked directly over the Project area before intensifying again to a Category 5 cyclone near the northeast corner of the Northern Territory.
Monica Apr 2006	Coral Sea	*Monica* tracked west across Cape York, weakening from a Category 3 to a Category 1 cyclone as it crossed the coast south of the Project area. It intensified again to a Category 5 cyclone as it moved west across the Gulf of Carpentaria. During the week of 23 April 2006, the Project area received between 200mm and 300mm of rain.
Nelson Feb 2007	Originally developed south Gulf of Carpentaria and tracked east to Queensland where it intensified into a Category 2 cyclone	*Nelson*, a Category 2 cyclone, caused storm surge up to 1.1m in height at Weipa.

Source: BoM (2009c)

The risk to the health and safety of employees and the community from potential cyclone impact is managed by a detailed Disaster Management and Recovery Plan and specific Cyclone Emergency Procedures. These are described further in **Section 19.3.4**.

Storm Surge and Wave Height

Storm surge, a dome of water pushed ahead of a cyclone by strong winds, can cause flooding, particularly when combined with high tides. Wave heights also increase as a result of cyclone activity and can cause coastal erosion and damage to infrastructure.

An Acoustic Doppler Current Profiler (ADCP) was deployed off Boyd Point between July 2006 and May 2008 (GHD 2008). The highest recorded level in this dataset was 3.55m above Lowest Astronomical Tide (LAT), which occurred during a low pressure system in the Gulf of Carpentaria (ex Tropical Cyclone *Helen*).

Modelling of storm surge at the proposed port has subsequently been undertaken using the Delft3D modelling system. The model uses a joint probability approach for tide level and cyclone-induced storm surge to identify design water level criteria for specified Annual Recurrence Intervals (ARIs). The ARI is the average value of the periods between exceedances of a given event, for example one in every 100 years.

The Queensland Department of Environment and Resource Management (DERM) operates a Waverider buoy system within Albatross Bay which measures wave height based on Mean Sea Level (MSL). The highest maximum wave height recorded was 6.96m on 9 March 1996 during the passage of Tropical Cyclone *Ethel*.

Waves at the proposed port site between Boyd Point and Pera Head have been modelled by Cardno Lawson Treloar (2009) using the SWAN wave model system and verified against measured data from the Waverider buoy. Based on a 1:100 year ARI high water level of 4.36mabove LAT, which reflects typical storm surge plus high tide conditions, the model predicted a maximum significant wave height (the average of the highest one-third of waves) of 7.1mabove LAT at the wharf end. The model also predicted a maximum breaking wave height of 11.9m at 1:100 year ARI.

The proposed port has been designed at a nominal level of 16.8m above LAT, which is 5m above the predicted 1:100 year ARI maximum breaking wave height. On-shore product stockpile pad levels would also be well above this level from 17.9 to 23.4m Australian Height Datum (AHD) (19.41 to 24.91m above LAT).

Modelling of storm surge in the Embley and Hey River systems was carried out in 1979 using the SURGE hydrodynamic model. From this model, the 1:100 ARI design level was determined to be approximately 3.6m above LAT.

A tidal station, operated by the BoM, is located at Weipa Port (near Humbug Point) in the Embley River. The highest recorded water level at the Weipa Port tidal station is 3.6m above LAT during Tropical Cyclone *Ethel* in 1996 (Harper 1998). This included a storm surge of 1.2m.

The proposed Humbug terminal, Hornibrook ferry terminal, and Hey River barge/ferry terminal would have fixed facilities designed to at least the Highest Astronomical Tide (HAT) level. Floating pontoons and ramps have been designed to move down to LAT level and up to a level higher than the 1:100 year ARI level. It is very unlikely the barge and ferry facilities would be used during levels higher than HAT, as operations would be limited during storm conditions. The facilities would incorporate foreshore protection designed to withstand water levels in excess of the 1:200 year ARI level.

Car parking areas for the ferry terminals would be above the 1:100 year ARI level. As previously stated, it is unlikely employees and contractors would utilise the ferry during storm or flood conditions.

Water level and design data are summarised in **Table 4-5**.

Table 4-5 Measured and Modelled Water Levels above Lowest Astronomical Tide

	Port	Humbug Barge Terminal	Hornibrook Ferry Terminal	Hey River Barge/Ferry Terminal
Lowest Astronomical Tide (LAT)	0	0	0	0
Australian Height Datum (AHD)	1.51m LAT [1]	1.75m LAT [2]	1.75m LAT [2]	1.75m LAT [2]
Mean Sea Level	1.76m LAT [1]	1.85m LAT [2]	1.85m LAT [2]	1.85m LAT [2]
Highest Astronomical Tide	3.09m LAT [1]	3.38m LAT [2]	3.38m LAT [2]	3.38m LAT [2]
Highest recorded level	3.55m LAT [1] (6 January 2008)	3.6m LAT [3] (including 1.2m surge from TC *Ethel* 1996)		
Design criteria	1:500yr ARI	1:100yr ARI	1:100yr ARI	1:100yr ARI
Modelled design water level*	5.14m LAT (3.63m AHD)	3.6m LAT	3.6m LAT	3.6m LAT
Approximate Relative Level (RL) of wharf facilities*	16.8m LAT	Sheet pile structure from 3.4 to 4.9m LAT. Floating ramp to move with water level	Covered walkway from 3.7m LAT to floating pontoon	Sheet pile structure from 4.9 to 3.4m LAT. Floating ramp to move with water level
Approximate RL of shore facilities*	19.4–24.9m LAT (17.9–23.4m AHD)		Car park 4.9m LAT (3.15m AHD)	Car park 9.7m LAT (8.0m AHD)

* The modelled design water level and relative levels of built infrastructure are approximate as the final heights are to be confirmed. The design criteria remains the same.

1. GHD (2008)
2. Cardno Lawson Treloar (2009)
3. Harper (1998)

Wind

High winds occurring as a result of cyclones can cause structural damage and present a safety risk from flying debris.

Rehabilitation is at risk of damage from high winds, including defoliation and windthrow of trees. Species adapted to the local climate would be utilised in rehabilitation to maximise the ability of revegetated areas to withstand these types of storms and regenerate quickly.

All plant and infrastructure facilities would be designed and constructed to the relevant Australian Standards to reduce the risk of structural damage caused by high wind speeds. These include key design codes such as Australian Standard *1170 Structural Design Actions Infrastructure*.

This Standard specifies the design criteria appropriate for various structures, depending on their use and the annual probability of exceedance for wind. Most of the proposed buildings in the Project area, including the beneficiation plant and workshops, are defined by the Standard as "Normal" structures with a design working life of 25 years. These buildings would be designed to withstand wind gusts with an ARI of 1:200 years in accordance with the Standard. In the Project area which, according to the Standard, lies within Region C, Terrain Category 2, this is equivalent to wind gusts of up to 64m/sec (230km/hr).

The proposed administration building is rated at a higher importance level under the Standard, given its capacity to contain many people. The administration building would therefore be designed to withstand wind gusts with an ARI of 1:500 year, which is equivalent to wind gusts of 69m/s (248km/hr).

Structural damage to buildings could occur if a Category 4 or Category 5 severe tropical cyclone was to directly impact the Project facilities. Only three such cyclones have been recorded in the Gulf of Carpentaria area over more than 100 years. It should be noted that not all of these directly impacted the Project area. The likelihood of a direct hit of a Category 4 or Category 5 cyclone on the Project facilities is estimated to be 1:200 years.

The existing RTA Cyclone Emergency Procedure includes detailed instructions for the requirements in each area in relation to evacuation of personnel, securing loose items, taping windows, and tying down conveyor belts and stackers. This procedure would be updated as required for the Project area.

RTA's existing Disaster Management Plan also addresses the maintenance of essential services (electricity, telecommunications, water and sewage), should these be affected as a result of a cyclone.

Rain

High intensity rainfall can occur as a result of cyclone events and can cause localised flooding. The highest daily rainfall recorded at Weipa was 223mm, recorded on 6 March 1996, in association with Tropical Cyclone *Ethel*. Potential erosion impacts are assessed in **Section 3.6.1**.

4.2.2 Flooding

Wet season inundation of flood plains resulting from overtopping of the main channel banks is a seasonal characteristic of the area. The main impact is restricted access for vehicles rather than flood damage.

The risk of flood damage to people, property and the environment would be mitigated by:

- maintaining safety of people in accordance with RTA Weipa's Disaster Management and Recovery Plan;
- minimising the potential for damage to land-based infrastructure by designing to appropriate ARIs for storms (refer **Table 4-6**). The flooding criteria are based on guidelines by Pilgrim (1998). The design of dams is based upon guidelines by the Australian National Committee on Large Dams (ANCOLD);
- ensuring hazardous materials storage areas are designed and constructed in accordance with Australian Standard *AS1940 The Storage and Handling of Flammable and Combustible Liquids*; and
- ensuring essential services (electricity, telecommunications, water and sewerage) maintain function during a flood event (refer **Section 19.3.2**).

These measures are consistent with *State Planning Policy 1/03 Mitigating the Adverse Impacts of Flood, Bushfire and Landslide*.

Table 4-6 Flood Design Criteria for Land-based Infrastructure

Relevant Infrastructure	Flood Design Criteria (ARI)
Mine Infrastructure Areas	1:100yr
Mine Access Road	>300mm over top once in 10yr
Creek crossings for conveyor and for water pipelines	1:100yr
Tailings storage facilities spillways	1:1,000yr
Water supply dam spillway	1:2,000yr
Sediment pond spillways	1:100yr

4.3 Climate Change Adaptation

The Queensland Office of Climate Change has published projections with regard to climate change in Queensland (EPA 2008a). This report is based on the Intergovernmental Panel on Climate Change Fourth Assessment Report (IPCC 2007) and a technical report prepared by the CSIRO and the BoM (CSIRO 2007).

RTA has conducted internal modelling to assess the potential for changed weather patterns of the Weipa area as a consequence of climate change up to 2049. These results are summarised in the following sections.

4.3.1 Temperature

The Queensland Department of Environment and Resource Management estimates that, by 2030, annual average temperatures in the Weipa area, relative to the climate of recent decades, will increase between 0.6 ºC and 1ºC (EPA 2008a). By 2050, the annual average temperatures are projected to increase between 1 ºC and 1.5ºC.

RTA's modelling of the Weipa area predicts a mean annual temperature rise in the order of 2.0ºC by 2049. The model also indicates the extreme maximum of 39ºC is likely to rise to the vicinity of 42ºC by 2049.

Increases in extreme temperatures have the potential to adversely affect germination and seedling performance in rehabilitated areas. There is potential that such extremes could require certain areas of rehabilitation to be re-sown if plant establishment is poor.

Any change in evaporation due to increased temperatures is unlikely to have an appreciable influence on water supply as the volume storage in the system has been sized to accommodate a wide range of climatic variability.

4.3.2 Rainfall, Water Supply and Flooding

There is greater uncertainty with rainfall projections than with temperature projections (EPA 2008a). The CSIRO modelling indicates Weipa's annual rainfall will vary only slightly (-2% to 2%) due to climate change over the life of the Project.

RTA's modelling of the Weipa area indicates a slight seasonal shift in rainfall with a slight increase during the summer months, lasting further into autumn, little change in winter rainfall and a tendency towards slightly higher extreme rainfalls in spring. Annual rainfall is expected to change only slightly, with a slight increase the most likely outcome and an increasing trend towards higher rainfall totals for the wettest seasons.

The Project would rely on surface water and artesian groundwater sources for its water supply (refer **Section 5.2.1**). The volume of rainfall runoff into the surface water storage or the Ward River is not expected to change significantly as a result of climate change.

Similarly, there is unlikely to be any significant change in flooding regimes in the Project area as a result of climate change.

4.3.3 Sea Level

The Fourth IPCC assessment report on climate change predicts a sea level rise of 0.18 to 0.59m by 2100, with a possible additional contribution from melting ice sheets of approximately 0.1 to 0.2m (IPCC 2007). RTA's modelling of the Weipa area indicates that sea levels could rise between 0.08m and 0.12m by 2049. Based on these predictions, sea level rise would not impact the Project.

4.3.4 Bushfires

Bushfires and grassfires are an intrinsic part of the Cape York environment. Natural ecosystems have evolved with fire, and the landscape, along with its biological diversity, has been shaped by both historic and recent fires. The extent to which the current fire regime of annual burning is human or naturally induced is difficult to determine. Indigenous Australians have long used fire as a land management tool, however fire can also be initiated by tourists, hunters, hazard reduction burning and lightning.

In areas where climate change causes higher temperatures combined with lower rainfall to produce a drier landscape, bushfires would be expected to increase in intensity. However, in the Project area predictions indicate overall rainfall will increase slightly, generally in the wet season, with little change in dry season rainfall. Therefore it is expected that the risk of bushfires will remain unchanged.

4.3.5 Tropical Cyclones

RTA's modelling of climate change indicated the following in relation to tropical cyclone events:

- there is a likelihood of no change in the overall frequency of tropical cyclones, with a reduction, possibly by up to 20%, of the risk of a Category 3 or higher tropical cyclone; and
- although Category 5 cyclones remain a low probability event, the severity of the most intense cyclones may increase, due to a possible 10% increase in maximum wind speed, compared to the current climate regime.

In a climate affected by global warming, two factors may act to increase the impact of storm surges:

- sea-level rise caused mainly by thermal expansion of the oceans; and
- possible changes in cyclone characteristics, such as intensities and frequencies (McInnes *et al.* 2000).

Similarly to cyclones, modelling of the Weipa area indicated that the overall likelihood of storm surge (as a result of Category 3 cyclones or higher) would reduce by as much as 20%. However if a Category 5 cyclone does occur, storm surge and maximum wave height could be more severe, arising from an expected sustained 0.08m to 0.12m sea level rise and 10% increase in wind speed.

The potential increase in severity of impact from a severe cyclone is offset by decreased likelihood, resulting in a similar level of overall risk compared to the current climate regime.

4.3.6 Mitigation Measures

During the life of the Project (i.e. approximately 40 years) the risk that climate change impacts would affect the commercial feasibility of the Project is considered to be low.

RTA would adopt best practice safety design for major infrastructure to minimise impact caused by extreme events and would continue to implement emergency procedures to protect the safety of personnel and the community.

RTA has considered the impact of climate change in the initial design of the Project and would also use adaptive management where required to mitigate any impact arising from climate change.

Environmental Impact Statement for South of Embley Project

Section 5
Water Resources

Environmental Impact Statement

for South of Embley Project

Section 5

Water Resources

5 WATER RESOURCES

5.1 Surface Water

The Project is located on a gently undulating bauxite plateau landform cut by a network of rivers and smaller creeks. The elevated bauxite plateau is fringed for most of the coastal margin by low cliffs and lateritic outcrop. A number of semi-perennial watercourses plus numerous smaller ephemeral creeks traverse the Project area and flow in a westerly direction eventually discharging into the Gulf of Carpentaria. In terms of primary surface water bodies, the Project area is bound by the Hey and Embley Rivers to the north, the Ward River to the south, and the Gulf of Carpentaria to the west. There are large estuaries associated with the Hey, Embley and Ward Rivers.

The Watson River is located south of the southern boundary of ML7024 and, while part of the river's catchment is within ML7024, the proposed footprint of the Project is outside the catchment boundary of the Watson River. The Archer River, a declared Wild River, is located south of the Watson River catchment and is not affected by the Project. The Wenlock River is a declared Wild River with a catchment north of the Project area. That catchment extends west–north-west across the Cape and the river discharges into the Gulf of Carpentaria north of Mapoon. The catchment boundaries of the main rivers surrounding the Project area are shown on **Figure 5-1**.

5.1.1 Surface Water Hydrology

Numerous catchments are located within the Project area. The northern part of the Project area contains Triluck Creek, Winda Winda Creek and a small part of the Hey River catchment. The Norman Creek catchment and the Ina Creek catchment are within the western central portion of the Project area. The Ward River catchment encompasses the eastern and southern project area and includes the following sub-catchments: Coconut Creek, Tappelbang Creek, Sandy Creek and Possum Creek.

The principal catchment boundaries in the Project area are shown in **Figure 5-2** and the associated catchment areas are presented in **Table 5-1**.

Table 5-1 Catchment Areas

Project Area Catchments	Area (km^2)
Embley River	1,000
Hey River	756
Triluck Creek	108
Winda Winda Creek	94
Norman Creek (all tributaries)	259
Ina Creek	65
Ward River (all tributaries)	666
Ward River sub-catchment	187
Coconut Creek	119
Tappelbang Creek	127
Sandy Creek	105
Possum Creek	130
Adjacent Catchments	
Watson River	2,872
Archer River	13,820

P:\RTA\Plans\SoE\EIS Report Figures\Chapter5\Fig 5-1 Weipa Region Catchment Boundaries.wor

Lease boundary
Township
River / Creek
Road / track
River catchment boundary

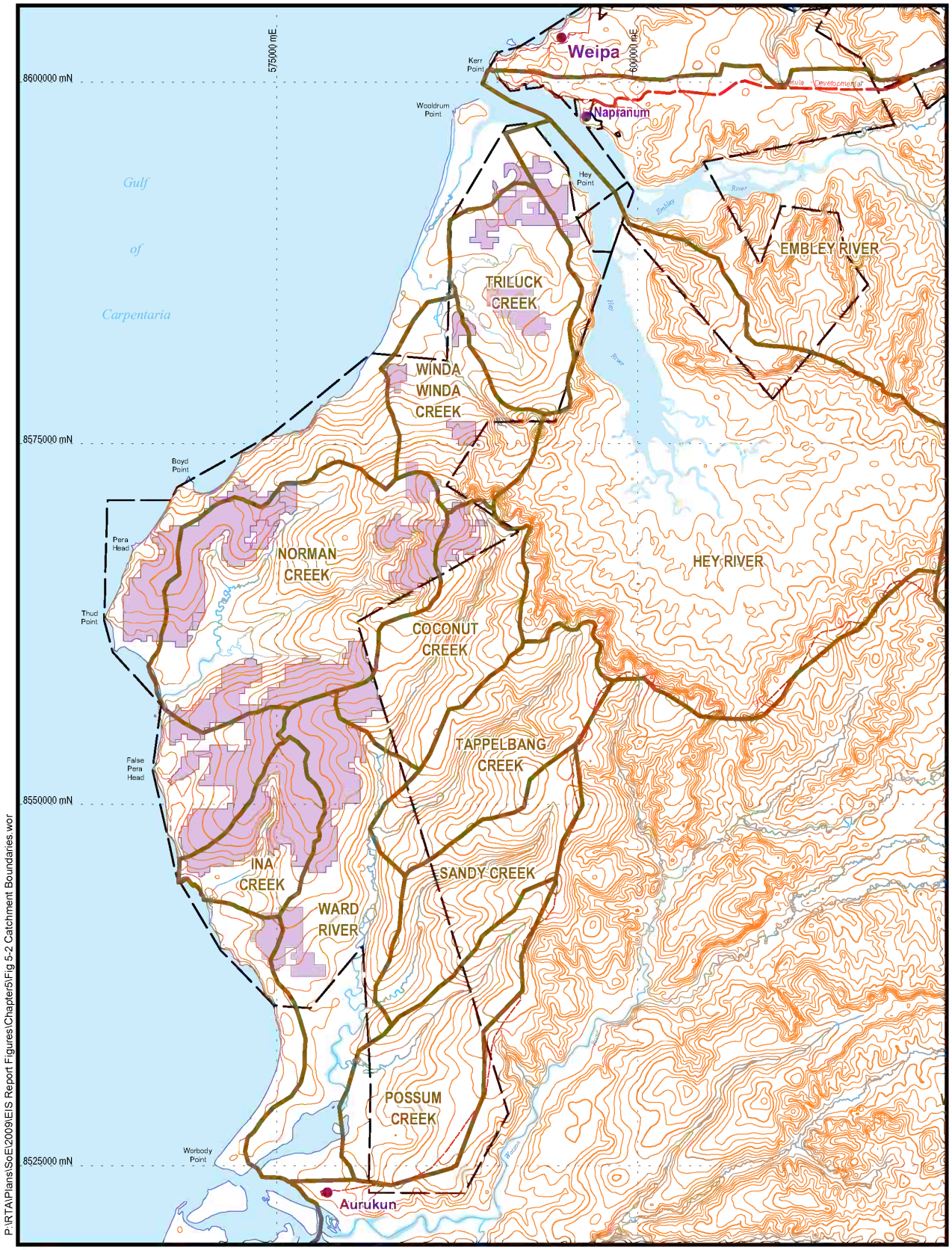
South of Embley Project

Fig. 5-1: Weipa Region Catchment Boundaries

N

0 50km

Datum/Projection: GDA94/MGA Zone 54 Date: 23/03/2011



P:\RTA\Plans\SoE\2009\EIS Report Figures\Chapter5\Fig 5-2 Catchment Boundaries.wor

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South of Embley Project

Fig. 5-2: Project Area Catchment Boundaries

The Watson River drains a relatively small area in the southern extremity of ML7024. The Embley River catchment is located north of the Project area and is partially within ML7024 (refer **Figure 5-1**).

The drainage patterns of the catchments in the Project area are dendritic (tree-like). These catchments are typified by confluences with one or more tributaries that join larger reaches at acute angles, which give way to broader flood plains downstream.

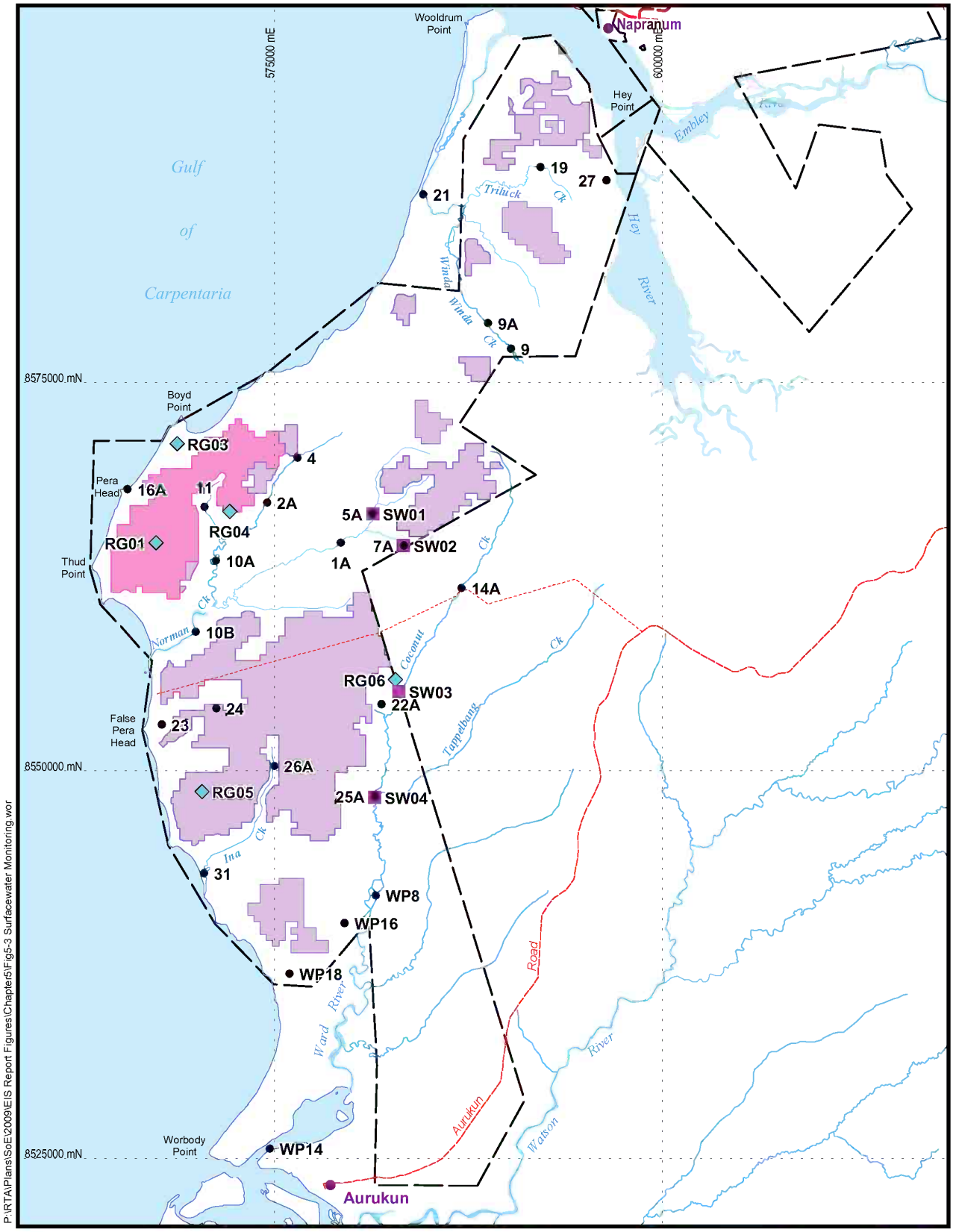
The characteristics of the creeks (including length, source and habitat) with catchments predominantly within the Project area are summarised in **Table 5-2**. Riparian vegetation associated with groundwater fed reaches of creeks is shown in **Figure 7-8**. Groundwater dependent ecosystems are discussed in more detail in **Section 7.5.1**, and **Table 7-4** and **Table 7-9**.

Table 5-2 Project Area Creek Characteristics

Creek	Approx. length (km)	Sampling Locations	Source	Habitat	Part of larger system?
Winda Winda Creek	13.8	9, 9A	Seasonal groundwater fed reaches with some isolated perennial pools (9)	Supports perennial pools /lagoons	Winda Winda Creek flows into Triluck Creek which discharges into the mouth of the Embley River estuary.
Triluck Creek	14.0	19, 21	Seasonal groundwater fed reaches with some isolated perennial pools (19)	Supports perennial pools /lagoons lower reaches (21) are tidal	Winda Winda Creek joins two branches of Triluck Creek which discharges into the mouth of the Embley River estuary.
Norman Creek	27.1	1A, 2A, 4, 5A, 7A, 10A, 10B, 11	Perennial stream with some seasonal/semi-perennial stream channels (4, 2A) and perennial groundwater fed reaches (7A)	Supports pools, lagoons and tree swamps (11) and lower reaches (10A and 10B) are tidal	Norman Creek has three main branches which join and discharge into the Gulf of Carpentaria.
Ina Creek	12.9	26, 31	Seasonal stream channel with isolated perennial pools	Supports perennial pools (26) and is tidally influenced at lower reaches (31)	Isolated. Discharges into the Gulf of Carpentaria.
Ward River	42.1	25A, WP8, WP16	Combination of seasonal surface flow and perennial groundwater fed reaches	Supports pools and tree swamp (WP16) and is tidally influenced at lower reaches (WP8, WP14)	Coconut Creek joins with Tappelbang Creek and becomes Ward River. Sandy Creek and Possum Creek enter downstream. Ward River estuary links to larger Watson and Archer estuary system.
Coconut Creek	21.2	14A, 22A	Seasonal stream channel	Supports tree swamp (22A), not tidally influenced	Coconut Creek is a tributary of Ward River which discharges into the Gulf of Carpentaria.

A network of stream gauging stations and rain gauges were installed in the Project area (refer **Figure 5-3**). The stream gauging stations were installed in October 2007 and were operational for various periods until the data was last downloaded in August 2009. Stations SW02 and SW03 use Level Troll 500 pressure transducer sensors and Stations SW01 and SW03 use Argonaut SW Acoustic Doppler sensors. The five rain gauges were installed for various periods throughout the Project area, starting in 2006.

The response of streamflow to rainfall at four various gauging stations (SW01, SW02, SW03, and SW04) is shown in **Figure 5-4.**



P:\RTA\Plans\SoE\2009\EIS Report Figures\Chapter5\Fig5-3 Surfacewater Monitoring.wor

RTA Mining Lease boundary
Road/track
Town
Surface water quality sampling sites
Stream Gauge (with data logger)
Rain Gauge
Mining Years 1 -13
Mining Years 14 - 40

South of Embley Project

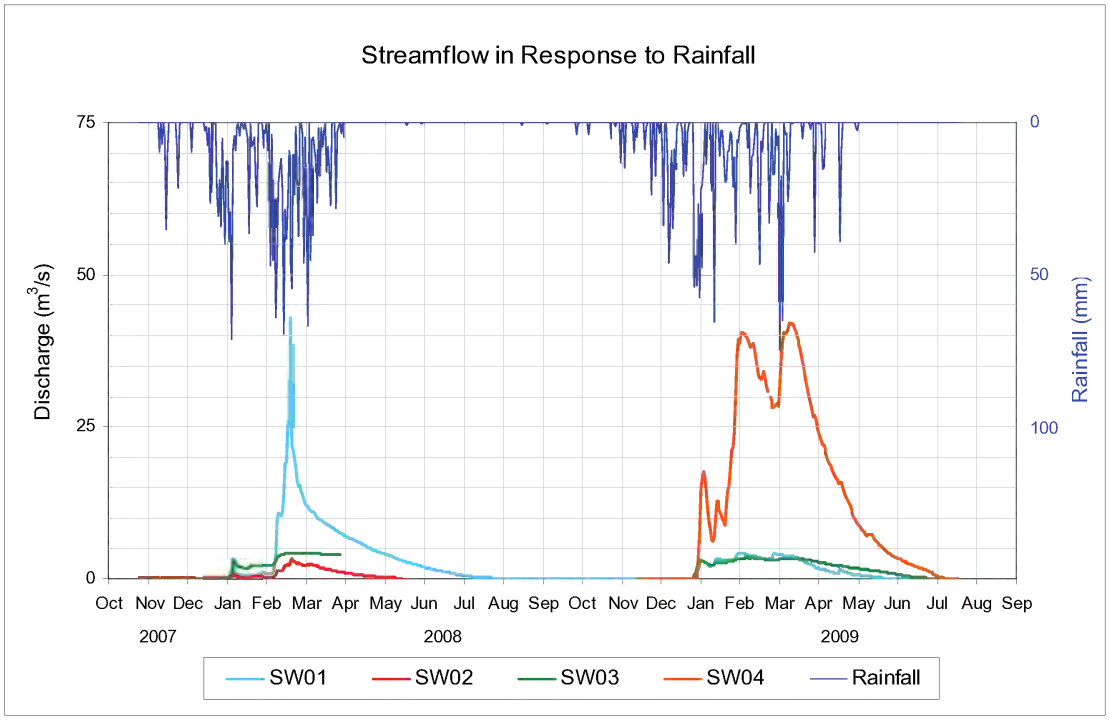
Fig. 5-3: Surface Water Monitoring Locations

N

0 10km

Datum/Projection: GDA94/MGA Zone 54 Date: 14/07/2010

Figure 5-4 Streamflow in Response to Rainfall



Rainfall–runoff relationships were derived using Boughton's Australian Water Balance Model (AWBM) (CRC for Catchment Hydrology, undated). AWBM is a catchment water balance model that relates runoff to rainfall, based on a conceptualised representation of a catchment's temporary surface and baseflow stores, rainfall loss to evaporation and gradual release of water from both stores to streamflow at the catchment outlet. The sum of water released from surface and baseflow stores provides an estimate of daily runoff (Boughton 1993).

The model was calibrated to establish representative model parameters to use for predictive model simulations of streamflow. The model parameters are catchment specific and it is therefore necessary to calibrate to gauged streams in close proximity to the Project area where possible.

The AWBM has been calibrated at two streamflow gauging stations:

- SW01 (upstream of proposed Dam C on a Norman Creek tributary); and
- SW04 (on the Ward River).

The input data for calibration included:

- catchment area;
- rainfall;
- runoff (streamflow); and
- evapotranspiration.

The catchment area reporting to SW01 is 33.02km^2 and to SW04 is 281.73km^2. Local rainfall data recorded at RG04 was used for the calibration of AWBM at SW01 and at RG06 for the calibration at SW04. Data gaps in rain gauge records were filled at RG04 with data from RG06 and at RG06 from RG05.

Streamflow data was recorded by Argonaut SW Acoustic Dopplers (Dopplers) located at SW01 and SW04. Evapotranspiration data was obtained from SILO data drill (BoM 2009d). Data drill is gridded interpolated data from point observations provided by the Bureau of Meteorology (BoM).

The calibration procedure is undertaken to determine the model parameters that provide the best fit of "modelled" to "measured" streamflow in terms of runoff from the surface and recession curve (baseflow) components, and the overall total flow volume.

The following calibration parameters are identified by the model:

- C1, C2 and C3 (surface storage capacities);
- A1, A2 and A3 (partial areas of surface stores);
- Ks (surface recession constant) – the rate of discharge of water from the surface store;
- BFI (baseflow index) – the amount of runoff that becomes baseflow; and
- Kb (baseflow recession constant) – the rate of discharge of water from the baseflow store.

An initial visual assessment of the runoff hydrograph showed the falling limb (representative of baseflow) meets the zero flow axis at a greater angle than is typically the case. The falling limb typically asymptotes to a point of lowest flow (or zero flow). It was concluded that a proportion of baseflow continues below the invert of the stream channel and the actual asymptote of the falling limb occurs at a point approximately 0.5mm/day (d) below the axis of the hydrograph. This value of up to 0.5mm/d has been concluded to be representative of "deep baseflow" (baseflow that does not enter the stream at the flow measurement point) and is included as part of the calibration. The AWBM calibration parameters are shown in **Table 5-3.**

Table 5-3 AWBM Calibration Parameters

Calibration Parameter	Value
A1	0.134
A2	0.433
C1	0
C2	0
C3	260
Ks	0.1
BFI	0.99
Kb	0.979

The AWBM was used to estimate the annual partitioning of incident rainfall into the following components:

- evapotranspiration (evaporation and water vapour from vegetation);
- surface runoff (water that does not infiltrate);
- baseflow (water that infiltrates and moves as saturated flow to the stream); and
- deep baseflow (water that infiltrates and moves as saturated flow below the stream bed).

Deep baseflow may emerge as streamflow at a lower point in the catchment, or may emerge as a freshwater upwelling in estuaries or off the coast in the Gulf of Carpentaria. A small proportion may become recharge to a deeper aquifer.

The partitioning of the annual incident rainfall (1,741mm) is shown in **Table 5-4.** The annual average evaporation rate for the Project area is 2,289mm.

Table 5-4 Partitioning of Annual Rainfall

Component	Annual Incident Rainfall	
	mm	%
Evapotranspiration	735	42.6
Surface runoff	10	0.6
Baseflow	843	48.0
Deep baseflow/recharge	153	8.8
Total	1741	100.0

The annual evapotranspiration rate is 32.1% of annual evaporation, which is comparable to the rate found by Hutley *et al* (2000) and Vardavas (1988) for other tropical savannah woodlands in northern Australia.

The proportion of surface runoff (<1%) is unusually small and reflects the flat topography and the very high infiltration rates of the soils and lateritic strata. The consequence of this is that streamflow does not respond quickly to incident runoff until after the catchment is "wetted up" and there is no "first flush" response to rainfall at the start of the wet season. Wet season rainfall typically commences in November but it is usually not until January, after soil moisture stores are filled, that streams show appreciable flow. Thereafter, flows rise until March or April in response to wet season rainfall and then decline once rainfall ceases (refer **Figure 5-4**). In lower catchment locations within the Project area, flow may persist until late in the dry season.

In typical "hard" ephemeral catchments there are short-term spikes in stream-flow volume following rainfall events. The response of streams on the bauxite plateau to rainfall is much more modulated given that the baseflow component is so dominant and direct surface runoff component is usually very small. The low surface runoff component also means streams carry a low concentration of suspended solids, even during high flows (refer **Section 5.1.4** for further discussion on turbidity).

The stream gauge data from Norman Creek (SW01) and Ward River (SW04) was analysed to determine the ARI of "bank full" flow. Once bank full flow is exceeded, over bank flow occurs and any adjacent floodplains and wetlands are inundated. The timing and frequency of bank full flows may have significant ecological implications. The AWBM was used to generate synthetic streamflow records from SILO rainfall records. The bank full flow at the Norman Creek site ($4.5m^3/s$) was found to have an ARI of 1:2.5 and the bank full flow at the Ward River site ($30.5m^3/s$) had an ARI of 1:1.5. The 1:100 ARI flood event flows for these respective sites are $7.4m^3/s$ and $65m^3/s$. The relatively small increment in flow rate between bank full flow and a 1:100 year flood reflects the relatively minor contribution of direct surface to flow. The streamflow data indicates that adjacent floodplains and wetlands are inundated almost every year and the ecology of these areas is not dependent on extreme flood events. The streamflow information has been used to evaluate the potential impact of a water storage dam on the hydrological regime (refer **Section 5.2.3**). The potential impacts of the Project on aquatic ecology are discussed in **Section 8.13** through to **Section 8.17**.

5.1.2 Existing Surface Water Users

There are no existing surface water dams or weirs in the Project area. The surface waters of the Project area are used by Traditional Owners and visitors for fishing, camping and recreation. RTA uses very small amounts of surface water during mineral exploration activities. There are no cattle in the Project area.

5.1.3 Stream Geomorphology

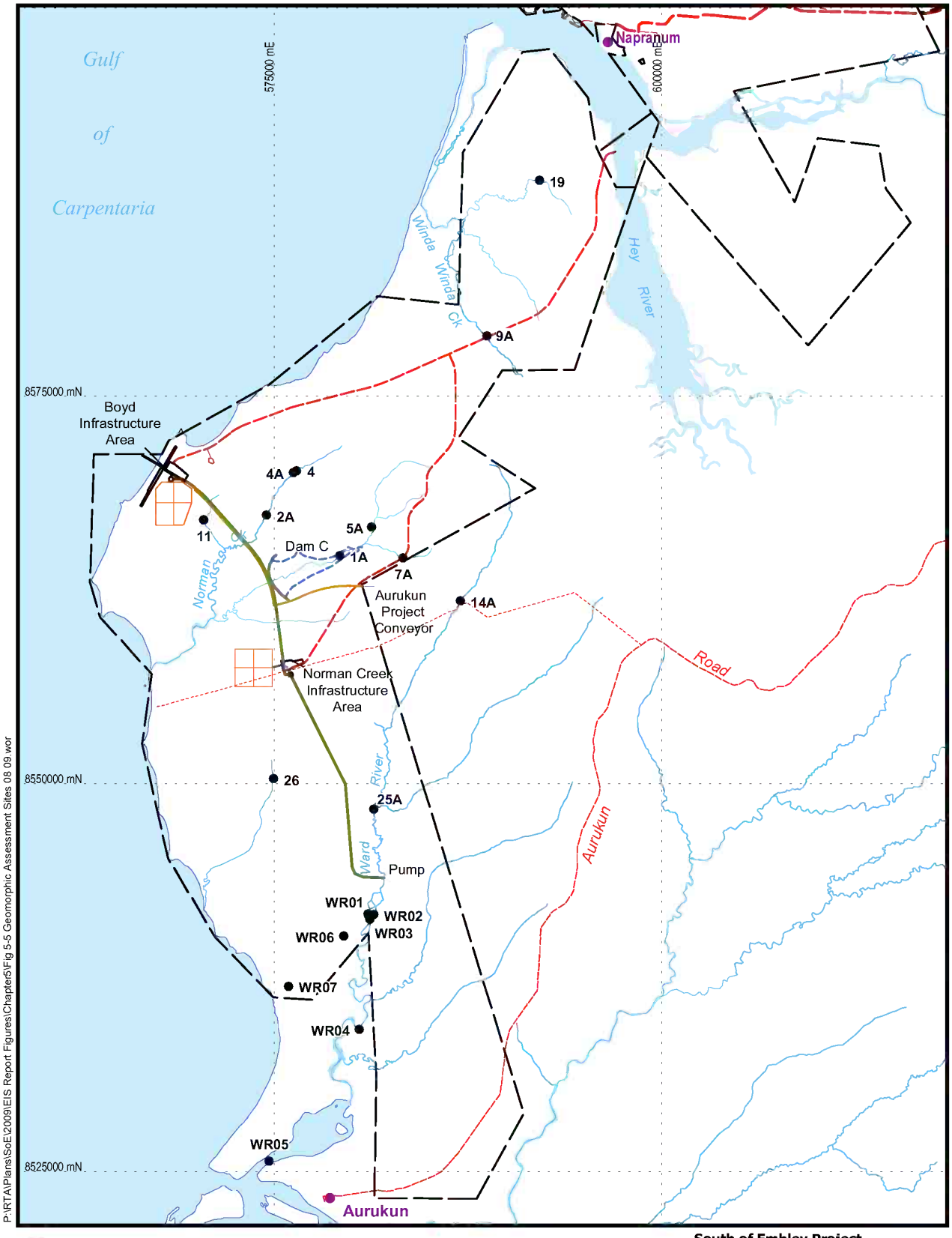
This section describes the Project area geomorphology in terms of methodology and survey results from two field events: the first within the northern region of the Project area (Norman Creek, Triluck, Winda Winda, Coconut and Ina Catchments) during May 2008 and the second within the Ward River catchment during May 2009. Representative sites were inspected to record the baseline geomorphic conditions of the Project area and assess any potential impacts from mining activities, particularly in relation to construction of Dam C.

Northern Region

A total of twelve locations located up stream, down stream and within northern mining areas were inspected during May 2008 to provide a representative sample of stream types and hydrological regimes. The locations of the study sites are shown in **Figure 5-5**. The northern region includes the area for proposed Dam C.

An in situ, site based assessment of channel stability was undertaken using methodology based on Pfankuch (1975), Rosgen (2001), and the Australian Index of Stream Condition. Descriptive data (e.g. channel size, stream type, bed and bank material, active hydrology) was recorded and assessments of characteristics to determine bank, bed and overall channel stability, the potential for adjacent mass failure and the erodibility of bed and bank materials. Sites were categorised according to their stability score and stream type (Rosgen 1996). Field data and site photos are provided in **Appendix 5A**.

Stream types were classified according to Rosgen (1994, 1996, 2001; **Appendix 5A**). While streams generally fitted into the hierarchy of streams developed by Rosgen, there were some outliers (e.g. unique streams within wetlands). As such, they were grouped in the Rosgen Stream Type that most resembled what was observed. A classification scheme specific to the Project area was established to ensure correct stream groupings.



P:\RTA\Plans\SoE\2009\EIS Report Figures\Chapter5\Fig 5-5 Geomorphic Assessment Sites 08 09.wor

RTA Mining Lease boundary
Road/track
Town
Drainage
Tailings Dam
Infrastructure corridor
Geomorphic assessment site

South of Embley Project

Fig. 5-5: Geomorphic Assessment Site Locations

N

0 10km

Datum/Projection: GDA94/MGA Zone 54 Date: 15/07/2010

General Geomorphic Description and Assessment

The stream types observed within the northern region of the Project area are listed in **Table 5-5**.

Table 5-5 Northern region Project area stream types

Stream Type	Valley Description	Stream Description
1	Broad, flat wetland / swamp	Small, incised stream within a swamp, with low width:depth ratio
2		Large incised meandering stream within swampy surrounds, with low width:depth ratio
3	Broad, flat wetland / swamp	Very wide, shallow depression within a swamp
4	Broad, flat floodplain	Generally slightly incised channel with varying degrees of sinuosity
5	Moderately confined valley	Incised channel with varying sinuosity
6	Moderately confined valley	Chain of ponds

General observations regarding the geomorphic nature of the streams within the northern region of the SoE Project area include:

- Streams are classified into six broad categories, however diversity of stream form within these categories was great. Similarly, diversity within catchments, streams and reaches was also considerable.
- Regardless of stream type, boundary material was variable. All sites consisted of bed material finer than gravel, with gravel-like clay conglomerates prevalent at many sites. Bank material was generally composed of sandy loams, silty clays and clayey silts, although rock outcropping was observed at three sites (Sites 2A – lateritic facies; 25A and 9A – weathered rock; refer **Plate 5-1**).
- Riparian vegetation was generally composed of largely "undisturbed" moderately dense trees with variable ground cover providing additional stability. Swamp-like stream types generally had sparser trees with denser ground cover (refer **Plate 5-2**). Vegetation density generally decreased markedly with distance from the bank.
- Most streams within the study area had high sediment transport potential – incised channels, with high velocities allow for great sediment transport, irrespective of slope.
- Climate was wet dry tropical, yet many of these streams were perennial, with flows of up to 2m/s observed during May 2008 in the larger, more incised streams (e.g. Site 25a). All study sites were flowing at the time of inspection.
- The point at which aquifer discharge occurred within the catchment (refer **Plate 5-3**) varies in time throughout the dry season, moving downstream as the water table drops. The different streams have adapted to these variable hydrological conditions within the constraints of the underlying topography and geology.
- Most sites were stable, with very little active bed incision / deposition or major bank scour / failure occurring. Site 4a was an exception – at the point of observation major head cutting was occurring due to the particularly erodible material at that point below the surface layer. However, upstream (Site 4) and downstream of this point the stream was stable (refer **Plate 5-4**). It is likely that stability is a consequence of a very old, inherently stable landscape with both lateral and vertical stability controlled to a large degree by the lateritic facies within which most of the stream channels sit.

(a)

(b)

Plate 5-1 **Bank material (a) fine silt/clay; (b) weathered rock**

(a)

(b)

Plate 5-2 **Riparian vegetation (a) Site 9a – dense trees and minimal groundcover; (b) Site 11 – denser ground cover and sparse trees**

Plate 5-3 **Shallow aquifer discharge point**

(a)

(b)

Plate 5-4 Site 4a (a) headcutting stream and upstream stability; (b) downstream stability

Detailed stability ratings for the study sites within Dam C are listed in **Appendix 5A** to provide the baseline required for future monitoring assessment. All sites were either moderately stable or stable. Vegetation protection was generally rated as moderate (due to the naturally moderately dense riparian vegetation communities), but still offered adequate additional stability. The channel types downstream of the proposed locations of the dam walls were both meandering incised systems. Both were, however, stable due to outcropping of the lateritic facies within the bank and bed and the stabilising effect of bank vegetation.

Ward River Catchment

The Ward River catchment was assessed in May 2009. The Ward River catchment was previously considered as a location for a water storage dam but this option has not been pursued. Some direct pumping of water from the lower Ward River is proposed (refer **Section 5.2.3**).

Aerial photographs were reviewed to understand the regional geomorphic setting and the long-term processes that have led to the current estuary and coastal form. Following the desktop assessment, the lower Ward River was navigated between WR1 and WR05 (refer **Figure 5-5**) to record field observations and provide an estuary-wide understanding of the general geomorphic condition, active low-flow (and tidal) processes and to understand high-flow condition and processes. At easily accessible points along the channel the adjacent floodplain was traversed to record floodplain characteristics and processes and to provide an in situ description of the valley sides bordering the floodplain. A total of 10 sites located upstream and downstream of the proposed Ward River pump location were inspected during May 2009. The locations of the study sites are shown in **Figure 5-5**.

General Geomorphic Description and Assessment

The Ward River flows into Archer Bay prior to entering the Gulf of Carpentaria. Archer Bay is an unrestricted, tide-dominated estuary. It is a branched bay with off-channel embayments. Freshwater input is dominated by that from the Archer River, although the Ward River is also a major tributary (OzCoasts 2008). The greater Archer–Ward estuary was observed to be dominated by several major features (refer **Figure 5-6**), including:

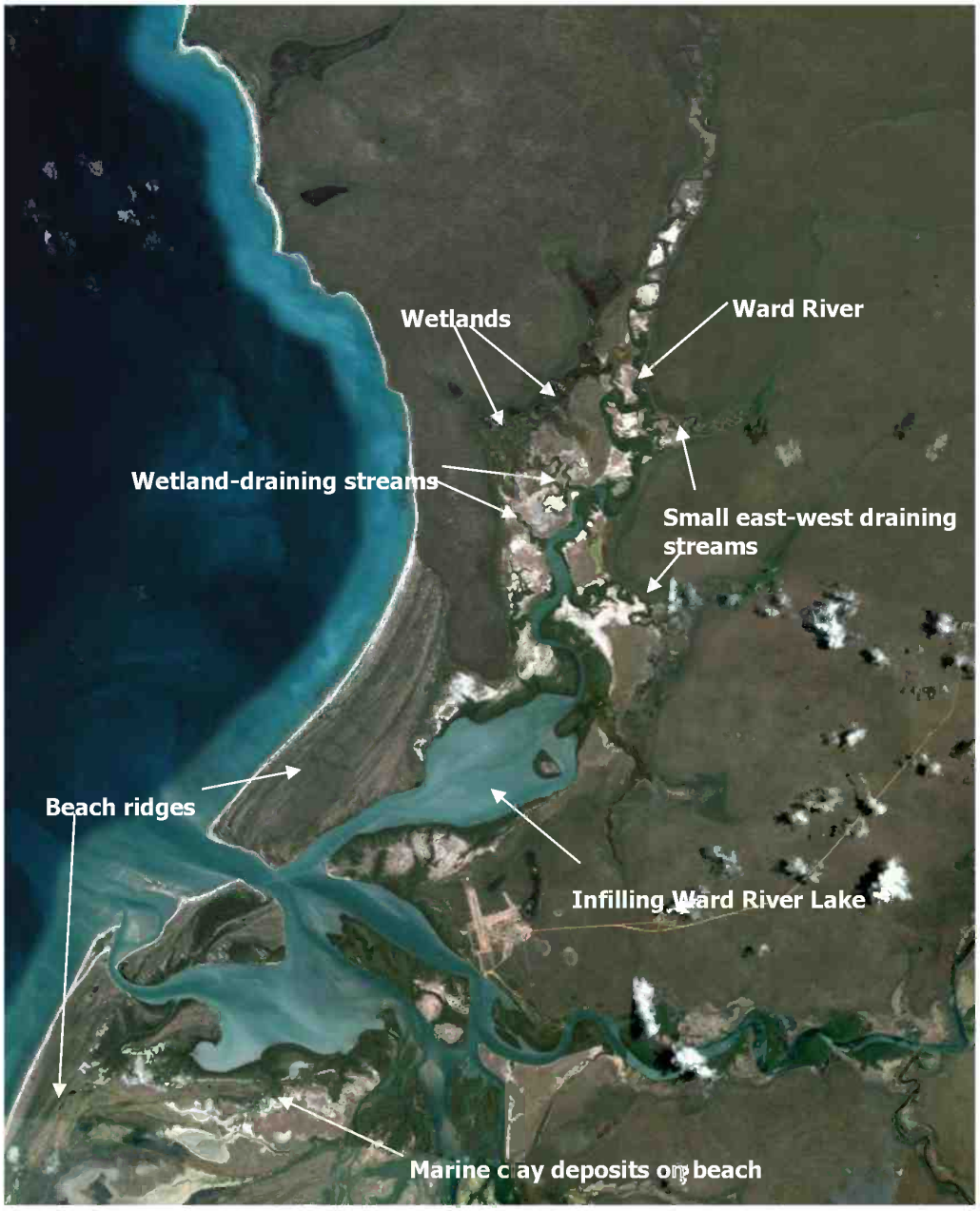
- beach ridges along the current coastline dissected by the Ward and Archer rivers. Historically these extended between about one and six kilometres inland and were a continuation of the Holocene beach ridges common to the eastern and southern

sections of the Gulf of Carpentaria (Eisma 1998, Smart 1976). These ridges have been shown to rise up to six metres above mean sea level. This elevation, along with the presence of shell layers within the ridges and the low variation in Holocene sea levels, suggests they were formed by storm surge and waves (Nott 2006). The deposition of these beach deposits appears to have redirected flow of the Ward River into Archer Bay from its previous mouth to the north;

- an infilling 'lake' at the most downstream point of the Ward River estuary (Ward River Lake) (refer **Plate 5-5a**), the condition and form of which appeared to be dictated by the "choke" point at its most downstream point created by the higher land adjacent to Aurukun on the east and the formed beach ridges to the west;
- an irregularly meandering river (Ward River) (**Plate 5-5b**) with a narrow floodplain comprised of marine-sourced sediments (**Plate 5-6**) set within the gradually sloping sides of the bauxite plateau (**Plate 5-7**). The meandering nature of the channel indicated homogeneous bank sediments (**Plate 5-8a**). Field observations supported this and active erosion was observed (**Plate 5-8b**), suggesting similarly homogeneous marine-sourced sediments within the greater floodplain (**Plate 5-6**). Windblown deposits of sands from coastal and terrigenous sources are expected to be mixed with the silts and clays, but these were not evident on the surface. The floodplain deposits that appeared to be recent have occurred as a result of more recent higher mean sea levels, backup of the Ward River flow by the Archer River, or a combination of the two. The deposits were assumed to be set within an old valley incised into the bauxite plateau. An extensive coring plan would be required for further understanding of the stratigraphy;
- small, irregularly meandering streams draining east to west that have cut into the bauxite plateau. The more downstream points of these consisted of similar (but smaller) floodplain features such as the Ward River;
- depressions along the western floodplain–plateau margins with small catchments draining the plateau, forming a combination of intermittent and perennial wetlands (**Plate 5-9**); and
- small, irregularly meandering streams draining from the depressions across the floodplain into Ward River.

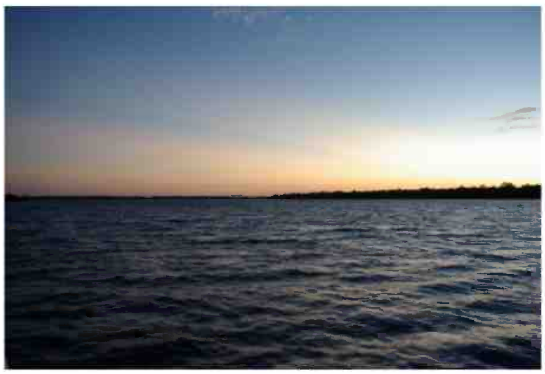
The Ward River section of the Archer–Ward estuary consists of two main sections: the Ward River Lake and the narrower meandering section within the floodplain. Within these systems there are two main active processes dictating the form and condition of the Ward River estuary:

- a wet season backup of the Ward River by the larger discharge of the Archer River, resulting in a poor flushing capability of the Ward River and a largely depositional environment within Ward River Lake. This explains the apparent general infilling of the Ward River Lake and in conjunction with the more recent higher mean sea levels has probably contributed to past deposition further upstream on what is now the Ward River floodplain. The choke point located at the most downstream point of the Ward River Lake has probably contributed to these processes; and
- dry season channel maintenance flows within the meandering section of the Ward River estuary, where freshwater input dominated over the tidal influence, resulting in high enough stream velocities to cause bed and bank erosion, particularly considering the non-cohesive nature of the bank sediments. These flows would also maintain the thalweg within the Ward River Lake.



Source Google Earth

Figure 5-6 Ward River Estuary Geomorphic Features



(a) WR05

(b) WR04

Plate 5-5 **Ward River estuary (a) Ward River Lake; (b) Ward River meandering channel**

Plate 5-6 **Floodplain extent and surficial sediment composition (WR02)**

Plate 5-7 **Floodplain–plateau margin (WR02)**

(a) WR03

(b) WR03

Plate 5-8 Meandering channel banks (a) homogeneous sediments; (b) minor undercutting

Plate 5-9 Western floodplain wetlands (WR06 and WR07)

Geomorphic Potential Impacts and Mitigation

Geomorphic attributes may be affected by dam construction and operation and the mining process, as discussed below.

Dam-Related Impacts and Mitigation

Sediment-related geomorphological impacts may occur during dam construction although they are expected to be generally of a local and short-term nature. Unplanned sediment runoff may occur without adequate controls. This runoff would be of a temporary nature and composed predominantly of fine (clays, silts) material, although some coarser material may also be released. Finer material would run off in plumes following heavy rain events. Coarser material would likely be transported downstream as slower-moving pulses, depositing temporarily on bars and in pools. Due to its temporary nature and the existing high sediment transport capacity of the two streams in question, sediment input from construction activities would not produce long-lasting impacts on sediment load.

Erosion and sediment control procedures would be prepared prior to construction to mitigate potential impacts during dam construction.

Potential impacts associated with a typical dam may include:

- siltation of bed and banks within the upstream sections of the proposed inundation area;
- formation of deposition zones (and macrophyte colonisation of these);
- contraction of channel and reduction of flow conveyance within the upstream reaches of the proposed inundation area;
- major reductions in fine and coarse sediment load immediately downstream of the proposed dam resulting from trapping of sediment within the dam;
- release of "clear" water during dry season environmental flow releases from the dam, due to the trapping effect of the dam. This issue should be minimal considering the existing low suspended sediment concentrations within dry season flows discussed above;
- alterations to bank and bed erosion processes immediately downstream of the dam resulting from changes to flow characteristics; and
- a gradual reduction in the magnitude of hydrological and sediment transport impacts with distance downstream, including concurrent impacts on erosional, depositional or habitat maintenance processes.

However, water flow within the streams of the Project area are naturally "clear" and channels have adapted to these conditions. As such, many of the geomorphic impacts expected to occur following dam construction either would not apply in this case or the impacts would be negligible.

The primary impact associated with dam operation is change to downstream hydrological and sediment transport regimes and concurrent impacts to in-stream geomorphic integrity and hydraulic habitat. Reducing these flows within the meandering section (where freshwater flows were prominent during the middle of the dry season) may move the saltwater–freshwater interface further upstream and bring its upstream movement earlier in the seasonal cycle and, as such, may shift this section of the estuary towards tide dominance compared with the current dominance of fluvial processes.

The degree of potential impacts would be largely dependent on dam size, environmental flow releases and trapping efficiency. The mean natural flow at the proposed Dam C location is summarised in **Table 5-6**. The dam would be fitted with a low level outlet pipe which would permit the controlled release of environmental flows when required (refer to **Section 5.2.3**). Sufficient water would be reserved for environmental flows to enable continued release in the driest months (August to October) of a volume equivalent to 25% of dam inflows. When natural dam inflows cease, environmental flow releases would cease. Once the dam is full following the onset of the wet season, the spillway would typically overflow on a regular basis. Given the comparable volumes, environmental releases are anticipated to mitigate the effects of altered surface water flow on the upper estuary during the dry season.

Table 5-6 Mean Streamflow at Dam C

Month	Mean Streamflow at Dam C(L/s)
July	459
Aug	84
Sept	2
Oct	4
Nov	48
Dec	462
Jan	2374
Feb	5646

Month	Mean Streamflow at Dam C(L/s)
Mar	6988
Apr	5229
May	2824
June	1279
Annual	2088

Ongoing monitoring of geomorphic assessment sites in Norman Creek downstream of Dam C would be conducted. The results of the monitoring would provide a baseline between pre- and post- construction. If water quality sampling results (refer **Section 5.5.1**) indicate sedimentation is an issue the sites would be further investigated to evaluate erosion. In addition, the following mitigation measures and monitoring would be implemented:

- an Erosion and Sediment Control Management Plan would be prepared prior to construction;
- streamflow gauging stations would be used to monitor streamflows upstream and downstream of Dam C, as well as two Norman Creek sub-catchments (one to be mined and one non-mined); and
- saltwater–freshwater interface mapping: mapping of representative vegetation ecotonal boundaries (e.g. sclerophyll, riparian/wetland/estuarine) from aerial photography to detect any long-term (decadal) shift; monitoring of surface water for salinity at monitoring points located in each of the major estuaries.

Mine-Related Impacts and Mitigation

With implementation of the riparian vegetation buffer system, as described in **Section 7.9.2,** most mine-related geomorphic impacts would be negligible, in terms of impacts on stream geomorphic integrity. Minor impacts to sedimentation within channels would be expected to some degree in the most heavily mined catchments as a by-product of reduced velocities, mine runoff, changed hydrological regime (perennial to intermittent / intermittent to ephemeral) and resulting alterations to the sediment transport regime.

5.1.4 Surface Water Quality

This section describes existing surface water quality conditions both upstream, downstream and within the Project area. Where applicable, results are compared with the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC/ARMCANZ, 2000).

A total of 25 locations within different catchments and habitat types were sampled over multiple seasons. The spatial and seasonal variation in sampling was designed to account for the variation in wet and dry season climatic conditions that influence surface water in the Project area. The locations of the sampling sites are shown in **Figure 5-3.**

Four rounds of sampling were initially undertaken for the EIS:

- mid dry season between 30 August and 1 September 2007 (10 locations);
- late dry season between 26 and 30 November 2007 (12 locations);
- wet season between 26 February and 3 March 2008 (19 locations); and
- early dry season between 22 and 25 May 2008 (19 locations).

After this sampling, an additional water supply dam in the Ward River catchment was proposed for the Project, and additional sampling was completed in this river system (along with some repeat sampling elsewhere). Three additional rounds of sampling were undertaken:

- late dry season between 4 and 11 December 2008 (12 locations);

- wet season between 24 February and 3 March 2009 including the additional Ward catchment sites (22 locations); and
- early dry season on 18 and 19 May 2009 (5 locations; Ward only).

The category and catchment of each sampling location are summarised in **Table 5-7**.

Table 5-7 Sampling Location by Category and Catchment

Category	Catchment	Locations
Freshwater	Norman Creek	1A, 2A, 4, 5A, 7A
	Triluck Creek	9, 9A, 19
	Ward River	14A, 25A
	Ina Creek	26, 31
	Norman Creek	11, 24
Tree swamps	Ward River	WP16, WP18, 22
	Hey River	27
	Norman Creek	23
Estuarine	Ward River	WP8
	Norman Creek	10A, 10B, 21
Lagoon (back dune)	Norman Creek	16A
Marine	Ward River	WP05

Representative habitat types were sampled at multiple locations in the main catchments. The characteristics of sampling locations are summarised in **Table 5-8**.

At each site, physicochemical conditions were measured using a multi-parameter water quality meter and water samples were collected for laboratory analysis. Sampling was conducted in accordance with the Queensland EPA *Water Quality Sampling Manual* (EPA 1999), except where noted below. Samples were analysed for physiochemical parameters, cations, anions, nutrients and a suite of total and dissolved metals. Select samples were also analysed for hydrocarbons.

For the analysis of metals, other than calcium, magnesium, potassium and sodium, field and laboratory procedures were modified to achieve ultra trace levels (below 1µg/L). Ultra trace levels were sought because the default low reliability trigger value of ANZECC/ARMCANZ (2000) for aluminium in freshwaters with pH below 6.5 (as are the waters in this area) of 0.8µg/L is less than commercial laboratory detection limits. The only laboratory in Australia that is able to achieve levels of resolution for aluminium at or below this level on a commercial basis is the CSIRO Centre for Environmental Contaminants Research (CECR) laboratory at Lucas Heights, NSW. This laboratory was contracted to undertake the trace metals analyses, with other parameters subcontracted to the National Measurement Institute (NMI) in Sydney. CECR prepared all sampling and sample filtration equipment for the Project, and shipped them to Weipa.

Field sample collection required two persons, using a "clean hands"–"dirty hands" procedure. The person taking the sample wore two pairs of unpowdered nitrile gloves, and only handled the trace metals sample bottles after the seal on the two zip-lock plastic bags that contained the bottle had been opened by the other person, who also wore unpowdered nitrile gloves. The samples were collected below the water surface, by placing the opened bottle into the water, initially with the opening facing downstream, and then rotating the bottle underwater to face upstream. The bottle was rinsed three times in site water, then filled and capped underwater before removal from the water and placement back into the two zip-lock plastic bags and resealing of the bags. A paper label was placed inside the outer plastic bag. Field filtration for filtered metal samples was conducted either in an air-conditioned room, or in a dedicated tent

Table 5-8 Sampling Location, Habitat and Catchment

Sampling Location	Habitat type	Catchment
1A	Perennial channel hosted pools/lagoons	Norman Creek (eastern tributary)
2A	Semi-perennial stream (flowing)	Norman Creek (northern tributary)
4	Seasonal stream channel (flowing)	Norman Creek (northern tributary)
5A	Perennial stream (flowing)	Norman Creek (eastern tributary)
7A	Perennial stream (flowing)	Norman Creek (eastern tributary)
9	Seasonal stream channel (flowing)	Winda Winda Creek
9A	Perennial channel hosted pools/lagoons	Winda Winda Creek
10A	Estuary (tidal)	Norman Creek
10B	Estuary (tidal)	Norman Creek
11	Seasonal tree swamp with perennial stream (flowing)	Norman Creek (northern tributary)
14A	Seasonal stream channel (flowing)	Coconut Creek
16A	Semi-perennial coastal lakes/lagoons (pool)	Pera Head Backdune lagoon
19	Seasonal stream channel (flowing)	Triluck Creek
21	Estuary (tidal)	Winda Winda Triluck Creek
22	Seasonal tree swamp (pool with seasonal flowing spring)	Coconut Creek / Ward River
23	Seasonal tree swamp (pool)	east of False Pera Head
24	Seasonal stream channel (flowing)	un-named drainage False Pera Head
25A	Seasonal stream with perennial channel hosted pools (tidally influenced in dry season)	Ward River downstream of Coconut and Tapplebang Creek confluence
26	Seasonal stream with semi-perennial channel hosted pools	Ina Creek
27	Seasonal tree swamp (pool)	Hey River
WP8	Estuary (tidal)	Ward River
WP14	Estuary (tidal)	Ward River
WP16	Seasonal tree swamp (pool)	Ward River
WP18	Seasonal tree swamp (pool)	Ward River

with dust-proof door seals, using acid washed and rinsed syringes and 0.45µm filters. All trace metal bottles and filtration equipment were acid washed, rinsed and sealed by CECR before shipment to Weipa. Bottles for other parameters were provided by NMI and were stored in eskies before and after sampling. Samples were kept cold in the field on ice bricks in an esky or a portable fridge/freezer, and kept in a refrigerator at or near 4°C until shipping in eskies containing ice bricks to Sydney for analysis. Nutrient samples were kept frozen where possible or at 4°C where not possible to freeze them.

It was recognised that the modified field and laboratory procedures are not feasible for long-term data collection and thus duplicate samples were collected in May 2009 for analyses by a commercial laboratory (ALS Environmental, a NATA-accredited laboratory) and commercial low-level detection limits were requested.

Results

Field and laboratory results are summarised in **Tables 5-9** to **5-11** by surface water category: freshwater streams, freshwater tree swamps and estuarine/marine, respectively. In general, freshwater stream locations (refer **Table 5-9**) were flowing at the time of sampling but this group contains some samples from pools (26A, 9A, 1A, 11 and 25A) whereas tree swamps (refer **Table 5-10**) represent stagnant water. The full water quality data set is available from RTA.

The 20th and 80th percentiles of measured parameters were calculated for categories with more than five data points and these are presented along with the median (50th percentile) value in **Tables 5-9 to 5-11**.

The *Environmental Protection (Water) Policy 2009* (Qld) (EPP (Water)) consists of a framework that identifies environmental values (EVs) and water quality objectives (WQOs) to enhance or protect EVs. However, WQO's have not yet been established for the Cape York region. Therefore, in conformity with the *Queensland Water Quality Guidelines* (DERM 2009a), the national guidelines (ANZECC) described below have been used for comparison purposes.

The results are discussed below and are compared with:

- Local data – other habitat categories in the Project area;
- Regional data – northern Australian tropical waters; and
- National guidelines – *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC/ARMCANZ 2000).

The following data from northern Australian tropical waters has been summarised in **Table 5-12**.

- metal concentration data from a reference stream in the Gove bauxite deposit area and general parameter data from the wider Gove area (RTA data and Zaar *et al.* 1999);
- streams from baseline sampling in the Ely bauxite deposit area, north of Weipa (RTA data);
- post- first flush wet season flows in Magela Creek in the Alligator Rivers Region in the Northern Territory (data from Hart *et al.* 1987);
- rivers in the southern Gulf of Carpentaria and the Mitchell River, southern Cape York Peninsula (Hydrobiology 2004a); and
- Mary River catchment, Northern Territory (Shultz *et al.* 2002).

ANZECC/ARMCANZ (2000) proposes water quality guidelines designed to protect the EVs of aquatic ecosystems. The guidelines are not mandatory standards; rather, they provide a risk-based decision framework, wherever possible, to enable the development of guideline trigger values for application at local and/or regional scales. The guidelines provide default water quality trigger values and a process to derive guideline trigger values tailored to the local environment, where required. In cases where baseline water quality parameters exceed default trigger values, it is recommended that local or regional trigger values are derived based on a statistical analysis of the baseline dataset. In some instances, default guidelines have not been developed due to data deficiencies and low reliability or interim working levels have been proposed for comparative purposes.

pH

The streams and tree swamps were generally acidic. The 20th percentile field pH of both streams and tree swamps was 4.6 and the 80th percentile pH was 5.8 and 5.5 respectively. The pH of Project area freshwaters is typically at the lower end of the range of other freshwater tropical streams and typically below the ANZECC/ARMCANZ default trigger value of 6.

The pH of marine waters ranged from 7.0 to 7.7 and was within the ANZECC/ARMCANZ range of 7 to 8.5. Estuarine waters exhibited a wider pH range of 5.1 to 7.7 owing to the seasonal inflow of freshwater.

Table 5-9 SoE Project Freshwater Stream Quality Statistics

	Parameter	units	Min	Max	Mean	Median	20th percent	80th percent	n	ANZECC Freshwater 95%	Hardness modified ANZECC guideline	Commercial laboratory LOR
Field	pH-fld	pH	4.0	6.9	5.3	5.4	4.6	5.8	44	6-8		
	EC	uS/cm	12	91	26	21	18	30	56	20-250		
	ORP	mV	-21.5	252	128	148	41.6	211	45			
	Turb	NTU	0.1	930	19	1.4	0.4	4.2	58	2-15		
	Temperature	°C	23.2	41.0	28.2	28.1	26.6	29.6	58			
	DOpc	% saturation	31.5	105	78.2	79.1	74.3	87.0	17	85-120		
	DO	mg/L	0.6	7.8	5.1	5.6	4.2	6.4	48			
Cations / Anions / Nutrients	Ca-F	mg/L	0.005	1.6	0.1	0.06	0.03	0.15	56			
	Mg-F	mg/L	0.09	1.6	0.4	0.3	0.2	0.4	56			
	Hard	mg CaCO3/L	0.4	9	1.9	1.3	0.82	2.0	56			
	Si-F	ug/L	1.1	3200	592	135	9.0	892	18			
	K-F	mg/L	0.003	1.2	0.09	0.03	0.03	0.03	56			
	Na-F	mg/L	0.6	8.8	3	2.4	1.5	3.2	56			
	Cl	mg/L	2.8	33	6	4.2	3.3	6.4	56			
	Alkalinity	pH	3	10	3.3	2.5	2.5	2.5	57			
	Total phosphorus	mg/L	0.01	0.06	0.03	0.03	0.03	0.03	27	0.01[a]		
	NH4-N	mg/L	0.003	0.45	0.02	0.003	0.003	0.01	48	0.01[a]		
	Total nitrogen as N	mg/L	0.03	1.1	0.10	0.03	0.03	0.09	49	0.2-0.3[a]		
	NOx	mg/L	0.01	0.01	0.01	0.01	0.01	0.01	49	0.01[a]		
	TDS	mg/L	9	280	21	13	10	20	56			
	TOC	mg/L	2	11	3.8	3	2	8.8	7			
	DOC	mg/L	0.5	10	1.8	1	0.5	2.4	19			
	SO4	mg/L	0.05	6.5	1	0.1	0.05	3.7	56			
Metals	Al-F	ug/L	0.1	668	40	18	6.2	40	57	0.8[d]		5
	Al-T	ug/L	19	1820	169	68	29	140	57	0.8[d]		5
	Fe-F	ug/L	2	553	46	11	5	65	57	300[b]		50
	Fe-T	ug/L	5	4940	276	36	10	179	57	300[b]		50
	Cr-F	ug/L	0.005	0.56	0.06	0.03	0.02	0.08	57	1[c]	0.078	1
	Cr-T	ug/L	0.005	0.47	0.09	0.05	0.02	0.13	57	1[c]		1
	Mn-F	ug/L	0.02	80	3.9	0.94	0.33	2.55	57	1900		1
	Mn-T	ug/L	0.1	213	7.6	1.03	0.49	2.80	57	1900		1
	Ni-F	ug/L	0.005	0.28	0.04	0.02	0.01	0.06	57	11	0.783	1
	Ni-T	ug/L	0.001	0.48	0.06	0.02	0.01	0.08	57	11		1
	Cu-F	ug/L	0.003	0.39	0.03	0.01	0.01	0.03	57	1.4	0.100	1
	Cu-T	ug/L	0.003	1.92	0.09	0.02	0.01	0.13	57	1.4		1
	Zn-F	ug/L	0.004	7.1	0.61	0.08	0.03	0.38	57	8	0.570	5
	Zn-T	ug/L	0.005	3.1	0.22	0.04	0.01	0.21	57	8		5
	As-F	ug/L	0.005	0.44	0.06	0.03	0.02	0.05	57	13[e]		1
	As-T	ug/L	0.003	0.43	0.06	0.03	0.02	0.06	57	13[e]		1
	Cd-F	ug/L	0.0002	0.02	0.003	0.002	0.001	0.003	56	0.2	0.013	0.1
	Cd-T	ug/L	0.0002	0.09	0.005	0.002	0.001	0.003	56	0.2		0.1
	Pb-F	ug/L	0.001	0.65	0.05	0.02	0.01	0.05	56	3.4	0.066	1
	Pb-T	ug/L	0.005	1.03	0.10	0.05	0.03	0.13	56	3.4		1

Notes:
*: LOR maybe elevated if matrix interference (e.g. salts) in sample
[a]: ANZECC Default trigger values for Tropical Australian Lowland Rivers
[b]: interim working level
[c]: assumes all as Cr(VI)
[d]: low reliability working level , pH<6.5
[e]: assumes all As(V)

Table 5-10 SoE Project Freshwater Tree Swamp Stream Quality Statistics

	Parameter	units	Min	Max	Mean	Median	20th percent	80th percent	n	ANZECC Freshwater 95%	Hardness modified ANZECC guideline	Commercial laboratory LOR
Field	pH-fld	pH	4.2	6.6	5.1	4.9	4.6	5.5	11	6-8		
	EC	uS/cm	15	136	43	26	22	29	12	20-250		
	ORP	mV	52	331	147	84	61	248	9			
	Turb	NTU	0.1	3.7	1.6	1.1	0.3	3.4	11	2-15		
	Temperature	°C	23.9	34.5	28.7	28.4	26.8	30.1	13			
	DOpc	% saturation	52	78	52	25	16	61	14	85-120		
	DO	mg/L	1.3	6.0	3.4	3.1	2.3	4.6	10			
Cations/Anions/Nutrients	Ca-F	mg/L	0.008	0.60	0.15	0.07	0.02	0.17	12			
	Mg-F	mg/L	0.08	2.0	0.55	0.30	0.27	0.46	12			
	Hard	mg CaCO3/L	0.36	9.7	2.6	1.4	1.2	2.3	12			
	Si-F	ug/L	46	3700	835	350	106	838	7			
	K-F	mg/L	0.03	0.36	0.09	0.03	0.03	0.13	12			
	Na-F	mg/L	0.55	16	4.6	3.4	1.9	3.8	12			
	Cl	mg/L	2.8	29	8.3	4.9	3.4	5.4	12			
	Alkalinity	pH	2.5	8.0	3.0	2.5	2.5	3	12			
	Total phosphorus	mg/L	0.03	0.025	0.03	0.03	0.03	0.03	7	0.01[a]		
	NH4-N	mg/L	0.003	0.02	0.01	0.003	0.003	0.01	12	0.01[a]		
	Total nitrogen as N	mg/L	0.03	0.41	0.1	0.03	0.03	0.23	12	0.2-0.3[a]		
	NOx	mg/L	0.01	0.005	0.01	0.01	0.01	0.01	12	0.01[a]		
	TDS	mg/L	10	3640	322	16	13	23	12			
	TOC	mg/L	NA	NA	NA	NA	NA	NA	NA			
	DOC	mg/L	0.5	10	3.7	2.5	1	6.2	8			
	SO4	mg/L	0.05	11	1.5	0.2	0.05	0.4	11			
Metals	Al-F	ug/L	3.0	108	44.7	40.5	19.7	73.1	12	0.8[d]		5
	Al-T	ug/L	13.0	189	84.5	72.6	37.7	135	12	0.8[d]		5
	Fe-F	ug/L	0.05	1920	251	11.5	2.4	32.2	12	300[b]		50
	Fe-T	ug/L	2.0	2450	334	12.5	7.8	32.7	12	300[b]		50
	Cr-F	ug/L	0.01	0.24	0.06	0.02	0.01	0.10	12	1[c]	0.078	1
	Cr-T	ug/L	0.01	0.29	0.1	0.03	0.015	0.12	12	1[c]		1
	Mn-F	ug/L	0.01	7.3	1.4	0.36	0.16	1.9	12	1900		1
	Mn-T	ug/L	0.01	7.1	1.4	0.47	0.18	2.0	12	1900		1
	Ni-F	ug/L	0.01	0.26	0.1	0.03	0.02	0.06	12	11		1
	Ni-T	ug/L	0.01	0.27	0.1	0.04	0.02	0.05	12	11		1
	Cu-F	ug/L	0.005	0.11	0.02	0.01	0.01	0.02	10	1.4	0.783	1
	Cu-T	ug/L	0.005	0.14	0.03	0.01	0.01	0.03	11	1.4		1
	Zn-F	ug/L	0.01	2.4	0.36	0.10	0.03	0.42	12	8	0.100	5
	Zn-T	ug/L	0.01	2.3	0.4	0.14	0.03	0.57	12	8		5
	As-F	ug/L	0.01	0.44	0.08	0.03	0.02	0.06	12	13[e]	0.570	1
	As-T	ug/L	0.01	0.49	0.09	0.03	0.02	0.06	12	13[e]		1
	Cd-F	ug/L	0.0002	0.006	0.002	0.002	0.001	0.003	12	11		
	Cd-T	ug/L	0.0002	0.009	0.003	0.003	0.001	0.003	12	11		
	Pb-F	ug/L	0.005	0.082	0.025	0.017	0.010	0.034	12	3.4		1
	Pb-T	ug/L	0.013	0.059	0.034	0.038	0.015	0.049	12	3.4		1

Notes:
*: LOR maybe elevated if matrix interference (e.g. salts) in sample
[a]: ANZECC Default trigger values for Tropical Australian Lowland Rivers
[b]: interim working level
[c]: assumes all as Cr(VI)
[d]: low reliability working level , pH<6.5
[e]: assumes all As(V)
NA: not analyzed

Table 5-11 SoE Project Estuarine and Marine Water Quality Statistics

Parameter	units	Estuary (WP8, 10A, 10B, 21)							WP14 Ward River Marine							16A Pera Head Back dune Lagoon							ANZECC
		Min	Max	Mean	Median	20th percent	80th percent	n	Min	Max	Mean	Median	20th percent	80th percent	n	Min	Max	Mean	Median	20th percent	80th percent	n	Marine 95%
pH-fld	pH	5.1	7.7	6.3	6.3	5.7	6.7	11	7.0	7.7	7.3	7.3	NA	NA	3	4.5	8.2	6.2	6.2	5.1	7.1	6	7-8.5
EC	uS/cm	50	51592	16600	2100	430	45300	11	19000	53233	35478	34200	NA	NA	3	13	14412	2889	287	69	2266	6	
ORP	mV	-104.1	366	79	69	-19	135	9	-32	322	110	41	NA	NA	3	-51.9	133	76.9	108	57.2	115	5	
Turb	NTU	1.2	5	2.7	2.6	1.54	3.3	12	5.9	16.5	10.6	9.5	NA	NA	3	0.8	14	4.7	3.0	1.1	6.2	6	1-20
Temperature	°C	25.1	32.2	28.6	28.6	26.4	31	11	29.4	30.2	29.8	29.9	NA	NA	3	22.4	42.9	30.5	29.6	26.6	31.6	6	
DOpc	% saturation	46	83	65	60	56	79	5	64	109	85	82	NA	NA	3	64	118	91	91	NA	NA	2	80-120
DO	mg/L	2.3	6.0	4.3	4.6	3.2	5.0	9	4.0	5.9	4.9	4.9	NA	NA	2	4.3	8.7	5.9	4.8	4.7	7.2	5	
Ca-F	mg/L	0.19	450	119	14.6	2.08	328	12	96	410	239	210	NA	NA	3	0.2	160	45	6.3	0.39	98	6	
Mg-F	mg/L	0.72	1390	376	49	6.4	1050	12	300	1310	750	640	NA	NA	3	0.78	340	117	18.4	1.5	320	6	
Hard	mg CaCO3/L	3.4	6848	2156	238	24	6049	10	1475	6418	3684	3160	NA	NA	3	3.7	1800	676	9.0	6.5	1610	5	
Si-F	ug/L	0.79	3500	1300	1150	2	2000	6	0.9	2600	1150	850	NA	NA	3	7.5	2600	1304	1304	NA	NA	2	
K-F	mg/L	0.16	430	112	14.6	2.2	299	12	110	420	237	180	NA	NA	3	0.17	97	33	6.9	0.41	87	6	
Na-F	mg/L	5.6	12700	3379	420	64.6	9502	12	2570	12100	6827	5810	NA	NA	3	7.7	2510	875	173	16	2370	6	
Cl	mg/L	12	18000	5151	1100	142	12940	12	5100	20000	13367	15000	NA	NA	3	15	4200	1403	385	31	3400	6	
Alkalinity	pH	2.5	96	26	15	3.2	33	12	3	110	51	40	NA	NA	3	10	24	15	12	10.6	17	4	
Total phosphorus	mg/L	0.02	0.14	0.05	0.03	0.03	0.06	7	0.03	0.14	0.06	0.03	NA	NA	3	0.03	0.18	0.08	0.03	NA	NA	3	0.02[a]
NH4-N	mg/L	0.003	0.04	0.008	0.003	0.003	0.013	11	0.003	0.03	0.02	0.03	NA	NA	3	0.003	1.8	0.36	0.003	0.003	0.37	5	0.015[a]
Total nitrogen as N	mg/L	0.06	0.72	0.22	0.17	0.14	0.22	9	0.12	0.26	0.18	0.15	NA	NA	3	0.025	4.8	1.2	0.18	0.025	1.6	5	0.25[a]
NOx	mg/L	0.01	0.03	0.01	0.005	0.005	0.005	11	<0.01	<0.01	<0.01	<0.01	NA	NA	3	0.005	0.01	0.006	0.005	0.005	0.006	5	0.03[a]
TOC	mg/L	3	5	4	4.00	NA	NA	2	4	4	4	4	NA	NA	1	52	52	52	52	NA	NA	1	
DOC	mg/L	0.5	5	2.2	2.00	1.4	2.6	8	2	4	2.7	2	NA	NA	3	1	52	19	3	1.8	32.4	3	
TDS	mg/L	33	32000	9495	2250	332	23000	12	9910	34000	21303	20000	NA	NA	3	44	8800	2940	860	77	7000	6	
Al-F	ug/L	0.1	15	4.8	4	1.8	7.4	13	0.5	3	1.8	2	NA	NA	3	1.7	850	268	50.5	3.6	650	6	0.5[d]
Al-T	ug/L	0.5	559	110	56	27	147	13	475	1980	1205	1160	NA	NA	3	12	68	29	21	12	40	6	0.5[d]
Fe-F	ug/L	0.5	85	24	13	3.8	31	13	1	4	2	1	NA	NA	3	25	718	219	104	33	327	6	
Fe-T	ug/L	0.5	742	267	218	174	409	13	279	1410	710	440	NA	NA	3	8.4	414	123	52.7	11.6	198	6	
Cr-F	ug/L	0.005	0.1	0.05	0.02	0.02	0.09	11	0.04	0.25	0.18	0.25	NA	NA	3	0.015	0.28	0.13	0.12	0.03	0.21	6	4.4
Cr-T	ug/L	0.005	0.7	0.18	0.11	0.05	0.21	12	0.4	1	0.7	0.7	NA	NA	2	0.015	0.61	0.28	0.23	0.08	0.50	6	4.4
Mn-F	ug/L	0.005	8.7	3.3	2.5	1.5	4.1	11	2.2	2.2	2.2	2.2	NA	NA	1	0.29	42.6	11.1	2.3	0.33	19.1	6	80[d]
Mn-T	ug/L	0.005	9.8	3.4	2.8	1.0	4.4	11	13	13	13	13	NA	NA	1	0.37	44.5	11.4	2.1	0.64	18.9	6	80[d]
Ni-F	ug/L	0.005	0.47	0.11	0.05	0.02	0.16	11	0.22	0.24	0.23	0.23	NA	NA	2	0.01	1.06	0.27	0.03	0.01	0.48	6	70
Ni-T	ug/L	0.01	0.43	0.14	0.09	0.03	0.23	12	0.34	0.69	0.52	0.52	NA	NA	2	0.01	0.98	0.32	0.06	0.02	0.81	6	70
Cu-F	ug/L	0.005	0.19	0.06	0.01	0.005	0.11	11	0.12	0.19	0.16	0.16	NA	NA	2	0.01	0.43	0.13	0.06	0.03	0.23	6	1.3
Cu-T	ug/L	0.005	0.2	0.09	0.08	0.01	0.15	12	0.19	0.36	0.28	0.28	NA	NA	2	0.01	0.99	0.25	0.12	0.02	0.26	6	1.3
Zn-F	ug/L	0.015	3.4	0.72	0.5	0.04	0.65	11	0.09	0.23	0.16	0.16	NA	NA	2	0.04	6.49	1.36	0.25	0.15	0.96	6	15
Zn-T	ug/L	0.015	1.2	0.40	0.33	0.06	0.66	12	0.33	0.93	0.63	0.63	NA	NA	2	0.04	6.33	1.65	0.27	0.04	2.98	6	15
As-F	ug/L	0.01	0.49	0.17	0.12	0.03	0.26	11	NA	NA	NA	NA	NA	NA	0	0.02	4.86	1.02	0.19	0.04	0.83	6	
As-T	ug/L	0.01	0.52	0.25	0.19	0.06	0.42	11	NA	NA	NA	NA	NA	NA	0	0.03	5.3	1.13	0.21	0.07	0.95	6	
Cd-F	ug/L	0.002	0.03	0.01	0.004	0.003	0.01	10	0.007	0.008	0.008	0.008	NA	NA	2	0.002	0.09	0.02	0.003	0.002	0.02	6	5.5
Cd-T	ug/L	0.003	0.04	0.01	0.004	0.003	0.01	11	0.01	0.02	0.02	0.02	NA	NA	2	0.002	0.06	0.01	0.002	0.002	0.005	6	5.5
Pb-F	ug/L	0.002	0.08	0.02	0.009	0.003	0.03	9	0.004	0.11	0.06	0.06	NA	NA	2	0.01	0.14	0.05	0.03	0.02	0.07	6	4.4
Pb-T	ug/L	0.002	0.15	0.06	0.05	0.04	0.09	11	0.14	0.39	0.26	0.26	NA	NA	2	0.01	0.50	0.18	0.12	0.04	0.28	6	4.4

Notes:

* LOR may be elevated if matrix interface (e.g. salts) in sample

[a] ANZECC Default trigger values for Tropical Australian Lowland Rivers

[b] Interim working level

[c] assumes all as Cr(VI)

[d] low reliability working level, pH<6.5

[e] assumes all As(V)

NA: not analysed/applicable

Table 5-12 Comparison of Fresh Water Quality in Tropical Streams

Location	South of Embley	Gove, NT	Ely, Qld.	Magela Creek, NT	Mitchell River, Qld.	Gregory River, Qld.	Nicholson River, Qld.	Mary River, NT
Reference	This project - all freshwater	RTA data and Zaar et al. 1999	RTA data	Hart et al. (1987)	Hydrobiology (2004)	Hydrobiology (2004)	Hydrobiology (2004)	Shultz et al. (2002)
Field Physico-Chemistry								
pH Field	4.0-6.9	5.4-7	4.5-6.6	4.8-6	6-9.6	6-9	6-9	6-8
EC (µS/cm)	12-136	9-390	3-11.8	5.4-50	36-400	55-700	33-700	12-342
Turbidity (NTU)	0.1-930		<0.1-4.7					0.7-40
Dissolved Oxygen (% saturation)	31.5-105		28-97					25-102
Dissolved Oxygen (mg/L)	0.55-7.8		3-7.9					2.2-8.8
Major Anions/Cations & Solids								
Ca filtered (mg/L)	0.005-1.6	1-144	<0.1-3.2	<0.1-1.8	0.7-53	5-104	1-34	
Mg filtered (mg/L)	0.08-2	0.5-1	0.2-10	0.2-2.7	0.1-12.3	2-58	1-54	
K filtered (mg/L)	0.003-1.2	0.7-2		0.2-1.1	0.5-5.4	0.3-6	1-9	
Na filtered (mg/L)	0.55-16	7-12		0.6-3.7	2-34	1-124	1-92	
Cl filtered (mg/L)	2.8-33			<1-9	0.78-34	1-165	2-165	
Hardness (mgCaCO3/L)	0.36-9.7	4-12	<1-3.6	~1.1-15.6	2-157	31-406	7-290	3.2-153
Alkalinity (mgCaCO3/L)	2.5-10	4-4.5			4.1-174	20-435	8-301	4-200
Silica (mg/L)	1.1-3700	3-29						
Sulphate (mg/L)	0.05-11	1-410		2-9	0.32-12.5	1-12	2-12	
Total Organic Carbon (mg/L)	2-4	1-5						
Nutrients								
Total Phosphorous (mg/L)	0.02-0.063	<2-3	<0.02	<0.01-0.03				0.001-0.036
Ammonium-N (mg/L)	0.003-0.45			<0.01				<0.01-0.04
Total Nitrogen (mg/L)	0.025-1.1	0.05-0.25	<0.05-0.18					<0.03-0.32
Oxides of Nitrogen (mg/L)	<0.01-0.01	0.2-2		<0.01-0.42	0.0005-141	0.2-11	0.4-2	
Metals								
Al filtered (µg/L)	3-668	<5-23						
Al total (µg/L)	13-1820							5-260
As filtered (µg/L)	0.005-0.44	<5-5						
As total (µg/L)	0.003-0.49		<1					
Cd total (µg/L)	0.0002-0.02		<0.1					
Cr total (µg/L)	0.005-0.47		<1-2	0.1-6				<1
Cu filtered (µg/L)	0.003-0.39			<0.2-1.2				
Cu total (µg/L)	0.0025-0.73		1-2					<1-12
Fe filtered (µg/L)	0.05-1920	50-420		34-2600				
Fe total (µg/L)	2-4940			110-3900				44-1200
Mn filtered (µg/L)	0.01-79.5			2-8				
Mn total (µg/L)	0.01-213		<1-94	11749				3.8-390
Ni total (µg/L)	0.001-0.48			0.1-0.4				<1-16
Pb filtered (µg/L)	0.0005-0.65	<1-1		<0.2-0.4				
Pb total (µg/L)	0.005-1.03		<1-1					<1
Zn filtered (µg/L)	0.004-7.1	<5		<0.5-1.8				
Zn total (µg/L)	0.005-3.1		<5-13					<1-200

Electrical Conductivity

The electrical conductivity of freshwaters ranged from 12 to 136 microsiemens per centimetre (µS/cm). The median conductivity for freshwater tree swamps was 27µS/cm, similar to the median for freshwater streams (21µS/cm). The fresh surface waters of the Project area were typically at the lower end of the conductivity range found in other tropical streams, although higher than Ely stream water. The ANZECC/ARMCANZ default conductivity trigger values for freshwater ranges from 20 to 250µS/cm for upland and lowland rivers. The single backdune lagoon (site 16A at Pera Head), was intermediate in its characteristics, but became brackish in December 2008, when king tides breached the dune system at its mouth, and it remained brackish in March 2009 with a conductivity of 2,266µS/cm.

During the late dry season, conductivity in pools within streams that became isolated from other surface or ground waters (e.g. isolated deep clay lined pools in Winda Winda Creek (site 9A)) increased moderately from 26µS/cm (September 2007) to 80µS/cm (November 2007).

The water quality characteristics of the Project area reflect the nature of water flowing through and within bauxite terraces, with the ferro-alluminosilicate matrix of the laterite layers acting as a physical and chemical filter for particulates resulting in very clear, almost salt-free surface waters. The low conductivity of the Project area surface waters presents challenges both to the accurate measurement of its chemical characteristics and comparison with appropriate guidelines (refer **Section 8.5.1**).

Conductivity in estuaries ranged from 50 to 51,590µS/cm, reflecting the tidal influence. Conductivity was less variable in marine waters, ranging from 19,000 to 53,200µS/cm.

During December 2008, at a time when the upper Ward estuary (site WP8) was tidally influenced, there appears to have been groundwater upwelling along the bed of the upper estuary. In places this was strong enough to maintain a slight lowering (11µS/cm) of salinity near the bottom, the reverse of the situation in the lower estuary (WP14) which had a layer of slightly more brackish water at the surface (refer **Figure 5-7**). This demonstrates the influence of groundwater inflows into the estuaries on water quality, particularly in the late dry season when surface freshwater flows have ceased in some streams.

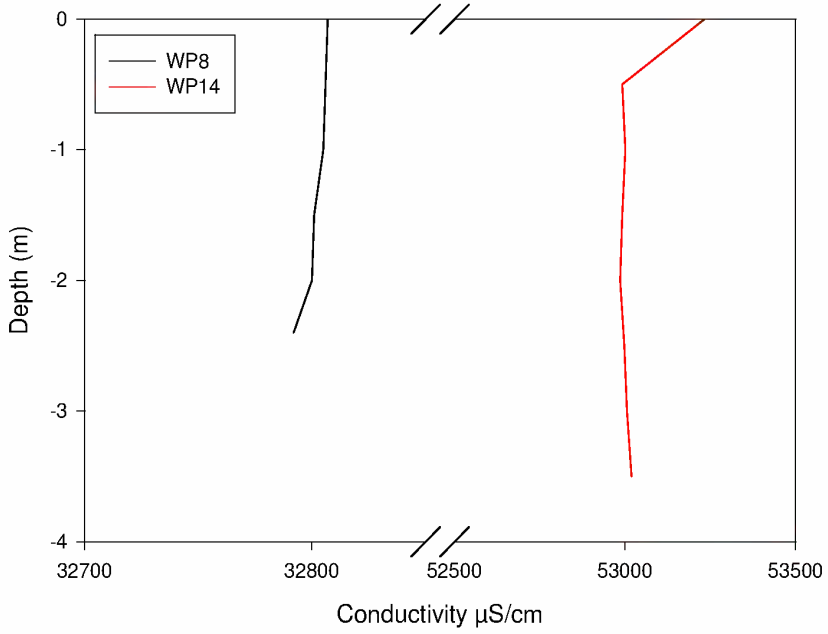


Figure 5-7 Conductivity Profiles in Upper (WP8) and Lower (WP14) Ward River Estuary

Turbidity

Freshwater turbidity was very low, with a median of 1.1NTU in tree swamps and 1.4NTU in streams. This is lower than most tropical streams, but comparable to that found in the Ely bauxite deposit area. The ANZECC/ARMCANZ range for turbidity is 2 to 15NTU in freshwater. The surface waters of the Project area are characterised by high clarity.

Turbidity in estuarine waters ranged from 1.2 to 5NTU, with a median value of 2.6NTU. Turbidity increased in marine waters, with a range of 5.9 to 16.5NTU and a median value of 9.5NTU. The ANZECC/ARMCANZ range for turbidity is 1 to 20NTU in marine waters and the Project estuarine and marine waters are within this range.

Nutrients

The ANZECC/ARMCANZ (2000) default guideline criteria for ammonium, total nitrogen and total phosphorus were exceeded by select freshwater and estuarine/marine samples and are discussed below.

A maximum concentration of 0.06mg/L total phosphorus, 1.1mg/L total nitrogen and 0.45mg/L ammonium was recorded for freshwater, which exceeded the ANZECC/ARMCANZ (2000) guideline for tropical lowland rivers of 0.01 total phosphorus, 0.2-0.3mg/L total nitrogen and 0.01mg/L ammonium.

Estuarine and marine waters had higher concentrations of total phosphorus, total nitrogen and ammonium when compared with project freshwater. The maximum concentration of total phosphorus estuarine/marine waters was 0.18mg/L. The maximum concentration of total nitrogen in estuarine/marine waters was 4.8mg/L and ammonium was 1.8mg/L.

The nutrient levels were generally at or near the level of resolution of the analyses for all other analytes in freshwater samples. Despite the generally low concentrations of solutes, surface waters contribute nutrient inputs into the drainage networks, thereby affecting downstream productivity (refer **Section 8.5.1**). Nutrient levels in the Project area freshwaters were generally as low as or lower than that of Ely, Magela Creek, Gove, and/or Mary River.

Dissolved Organic Carbon

The concentration of dissolved organic carbon ranged from 0.5 to 10mg/L in freshwater samples with a median of 1mg/L in stream samples and 2.5mg/L in tree swamp samples. The concentration of dissolved organic carbon in estuarine sample ranged from 0.5 to 5mg/L with a median of 2mg/L. Organic carbon can complex some trace metals, such as aluminium, copper, zinc and cadmium into non-biologically available forms (ANZECC/ARMCANZ 2000). Based on these results in the fresh surface waters of the Project area dissolved organic carbon is not considered an appreciable contributor to metal complexation.

Hardness

Freshwater hardness ranged from 0.4 to 9mg/L $CaCO_3$. Freshwater hardness was predominantly very low with a median of 1.4mg/L $CaCO_3$ in freshwater tree swamps and 1.3mg/L $CaCO_3$ in freshwater streams.

Hardness in estuarine waters ranged from 3.4 to 6,800mg/L $CaCO_3$, reflecting seasonal freshwater inflows, with a median value of 238mg/L $CaCO_3$. The range in marine waters was from 1,475 to 6,418mg/L $CaCO_3$, with a median value of 3,160mg/L $CaCO_3$.

The hardness for the Project area fresh surface waters was generally lower than for other tropical streams, but comparable to that for the Ely area, Gove and Magela Creek.

Hardness may affect metal toxicity in two ways: first, in terms of the competition for uptake sites between calcium and other metals; and second, as an indicator for the potential for inorganic complexation of metals in solution into forms of low bioavailability. Therefore, some metals have hardness dependent trigger values and the ANZECC/ARMCANZ (2000) guidelines provide a mechanism for adjustment of the trigger values for hardness. Weiner (2008) classifies soft waters as being waters with hardness below 75mg/L $CaCO_3$. The hardness of fresh surface waters in the Project area is less than 30mg/L $CaCO_3$ (with the exception of three outliers

December 2008 when king tides had caused saltwater intrusion into certain sites affecting both conductivity and hardness). All other hardness measurements were less than 10mg/L $CaCO_3$, with most below 3mg/L $CaCO_3$.

When the ANZECC/ARMCANZ (2000) hardness correction algorithms are applied to determine trigger values for relevant metals (cadmium, chromium (III), lead, nickel, zinc) in such soft waters the hardness modified trigger value is commonly below commercial laboratory detection limits. The applicability and limitations of hardness correction are discussed further in **Section 8.5.1**.

Metals in Freshwater

The maximum dissolved concentration of arsenic cadmium, chromium, copper, lead, manganese, nickel and zinc was less than the default ANZECC/ARMCANZ guideline trigger value in freshwater streams and tree swamps.

An ANZECC/ARMCANZ guideline for iron in freshwaters has not yet been developed and the Canadian criterion of 300µg/L has been adopted in the interim. Freshwater dissolved iron concentrations were usually below 300µg/L with the 80th percentile of stream samples being 65µg/L and tree swamps 32µg/L. The maximum concentration of dissolved iron in some freshwater stream and tree swamp samples exceeded the 300µg/L. Iron is a parameter that may be affected by natural or anthropogenic geochemical changes in water, as discussed further below in relation to seasonality.

The dissolved concentration of manganese in freshwaters did not exceed the ANZECC/ARMCANZ guideline of 1900µg/L. The median concentration of dissolved manganese in surface waters ranged from 0.94µg/L in streams to 0.36µg/L in tree swamps.

Aluminium concentrations for freshwater sites exceeded the ANZECC/ARMCANZ low reliability trigger value of 0.8µg/L (applicable to waters with pH below 6.5). The median concentration of dissolved aluminium ranged from 17.6µg/L in freshwater streams to 41µg/L in tree swamps.

Generally, the dominant metals in surface waters of the Project area are aluminium and iron. The concentration of dissolved aluminium, iron and manganese in surface water is seasonal. While for many sites concentrations of aluminium were above the default trigger values in all months, much higher values and greater variability was found for samples from the late dry season in November 2007 and December 2008. The median concentration of aluminium in freshwater streams ranged from 55µg/L in December (before onset of wet season flows) to 12µg/L in January, after the onset of streamflows. Similarly, the median concentration of iron and manganese in freshwater streams ranged from 162µg/L and 5.1µg/L in December to 10µg/L and 0.98µg/L in January, respectively.

Iron is much more soluble in anoxic water, and rapidly oxidises and flocculates out of solution when exposed to air. The presence of elevated dissolved iron concentrations late in the dry season indicates that, where surface waters could be sampled at that time of the year, they were influenced by surface expression of groundwater close to the point of sampling. While surface water flow post- wet season ultimately results from expression of groundwater, before the last months of the year the combined flow of the expressed waters results in aerated streamflow, and the removal of iron from solution with distance (and time) from the point(s) of surface expression of groundwater. In the late dry season, few streams receive sufficient inflows to form a continuous flow of water in any reach, resulting in a greater dominance of recently expressed groundwater in the existing surface waters, with higher dissolved iron. Therefore, the relatively higher dissolved aluminium concentrations in the late dry season reflect the higher proportion of recently expressed groundwater in the remaining surface waters.

For the perennially flowing sites 7A, 5A and 1A in the eastern branch of Norman Creek, the seasonality of dissolved aluminium and iron was much less marked, because longitudinal surface waters flows and aeration were maintained.

When iron flocculates out of solution the floc tends to adsorb other metals and remove them from solution. Although defined as dissolved, the water sample fraction that can be filtered

through 0.45µm filters can contain ultra-fine colloidal particles, particularly in the early stages of formation of iron and aluminium flocs. Much of the reported higher metal concentrations in the late dry season sampling may be associated with such colloidal material, and may be of limited bioavailability for most metals. Over time, these colloids would form flocs that settle, removing the metals from the water column.

The concentration of dissolved nickel, copper and zinc increases late in the dry season. The median concentration of dissolved nickel in freshwater streams ranged from 0.013µg/L in January to 0.06µg/L in August–September. The median concentration of dissolved copper in freshwater streams ranged from 0.005µg/L in January to 0.07µg/L in November. The median concentration of dissolved zinc in freshwater streams ranged from 0.078µg/L in January to 0.72µg/L in November.

The water quality guidelines note there is no good evidence for the toxicity of aluminium associated with colloidal material (ANZECC/ARMCANZ 2000, Section 8.3.7.1). Hydroqual (2006) states that some studies have suggested polymerisation or precipitation of aluminium at the gill surface may be responsible for some observed respiratory effects of aluminium. Rosselund *et al.* (1990) reported that precipitated Al-complexes can irritate the gills of fish and cause inflammation, oedema, swelling and sometimes irritation of the secondary lamella. Therefore, filterable aluminium should be regarded as being of potential ecotoxicological significance, even if colloidal material is included.

Metals in estuarine and marine waters

The concentration of dissolved aluminium in most estuarine and marine samples exceeded the low reliability default ANZECC/ARMCANZ trigger value for marine water of 0.5µg/L. The median concentration ranged from 2.5µg/L in marine waters (three samples only site WP14) to a median of 4.0µg/L in estuarine samples.

The median concentration of dissolved iron in marine and estuarine waters was 1µg/L and 13µg/L, respectively. There is no ANZECC/ARMCANZ marine guideline for iron.

The total and dissolved concentration of other metals analysed did not exceed applicable ANZECC/ARMCANZ guidelines in estuarine or marine samples.

Hydrocarbons

As the Project area is relatively undisturbed, hydrocarbons were not anticipated to be present in fresh, estuarine or marine waters but sampling was carried out to assess baseline conditions. During August–September 2007, ten locations were sampled for total petroleum hydrocarbons, benzene, toluene, ethylbenzene and xylenes. All results were below the corresponding laboratory detection limits.

Summary

These results suggest the Project area freshwater streams are not unusual in terms of conductivity and hardness compared with streams in other bauxite areas (e.g. Ely and Gove). However, they have lower solute concentrations and lower hardness compared to other waters in northern Australia. The Project area streams and tree swamps have naturally elevated dissolved aluminium concentrations.

5.2 Surface Water – Potential Impacts and Mitigation Measures

5.2.1 Water Supply

The Project's principal water requirements are for process water, haul road watering, vehicle wash-down, dust suppression and potable supplies. The average water demand for the Project is summarised in **Table 5-13** in both GL per annum and L/s.

Table 5-13 Average Annual Water Demand

Production Rate	Location of plant	Process	Haul Roads	Other*	Total Demand
		Average Annual Demand (GL)			
15Mdptpa	Boyd	15.4	0.5	0.5	16.4
30Mdptpa	Boyd	15.4	0.5	0.5	16.4
	Norman	15.4	0.7	0.5	16.6
	Total	30.8	1.2	1.0	33.0
50Mdptpa	Boyd	25.6	1.1	0.8	27.7
	Norman	33.8	1.4	0.9	36.1
	Total	59.5	2.5	1.7	63.7
		Average Annual Demand (L/s)**			
15Mdptpa	Boyd	535	17	17	570
30Mdptpa	Boyd	535	17	17	570
	Norman	535	24	17	576
	Total	1069	42	35	1146
50Mdptpa	Boyd	892	38	28	958
	Norman	1174	49	31	1253
	Total	2066	87	59	2212

* vehicle wash-down, dust suppression, potable

** L/s values are based on average of 8,000 hours of operating time per annum

The Project potable water requirements are small: 15ML per annum at 15Mdptpa rising to 30ML per annum at 50Mdptpa. A reverse osmosis potable water treatment plant would be used to treat raw water to a standard that meets the *Australian Drinking Water Guidelines* (NHMRC 2004).

The Project's sources of supply are recycled water from tailings storage facilities, surface water (water storage dam and direct pumping from stream), deep artesian groundwater and water recovered from slots adjacent to the tailings storage facilities. The average water supply for the Project is summarised in **Table 5-14** in both GL per annum and L/s.

Typically water would be drawn in order of preference from tailings recycle, recovery slots, surface water dam (Dam C), and artesian bores. Some supplementary surface water would be drawn directly from the Ward River to minimise the risk of inadequate supply from Dam C. The artesian demand would therefore fluctuate depending on whether there is above or below average rainfall runoff into the dam. The average annual artesian demand at 50Mdptpa would be 11.9GL per annum, with fluctuations up to 15GL per annum. RTA has an existing artesian Water Licence for 9GL per annum which allows abstraction from bores located on ML7024. RTA proposes to apply to increase the artesian allocation to cover the fluctuations in artesian demand. It is proposed that a five-year moving average of 12GL per annum be established, with a peak abstraction of 15GL in any one year. The impact of abstraction on the artesian aquifer has been modelled and is discussed in **Section 5.4.2.**

The impacts on streamflow of the proposed water storage dam and of direct pumping from Ward River are discussed in **Section 5.2.3.** The water supply infrastructure for the SoE Project would not be connected to the water supply infrastructure for the existing Weipa operations.

Table 5-14 Average Annual Water Supply

Production Rate	Location of plant	Recycle	Artesian	Dam	Slots*	River	Total Supply
		Average Annual Supply (GL)					
15Mdptpa	Boyd	4.7	3.1 (5.2 Peak)	7.8	0.8	0	16.4
30Mdptpa	Boyd	4.7	3.2 (5.8 Peak)	7.3	0.8	0.4	16.4
	Norman	4.7	2.8 (4.8 Peak)	6.5	0.8	1.9	16.7
	Total	9.4	6.0 (10.6 Peak)	13.8	1.6	2.2	33.1
50Mdptpa	Boyd	9.6	5.6 (7.1 Peak)	11.6	0.8	0	27.6
	Norman	12.5	6.4 (8.5 Peak)	13.8	0.8	2.5	36.0
	Total	22.1	11.9 (15 Peak)	25.4	1.6	2.5	63.5
		Average Annual Supply (L/s)**					
15Mdptpa	Boyd	163	108	271	28	0	570
30Mdptpa	Boyd	163	113	254	28	13	570
	Norman	163	96	226	28	65	578
	Total	326	209	481	56	78	1150
50Mdptpa	Boyd	332	193	403	28	1	958
	Norman	436	222	480	28	85	1250
	Total	768	415	883	56	87	2208

* Trenches dug adjacent to tailings storage facilities to recover water

** L/s values are based on average of 8000 hours of operating time per annum

5.2.2 Site Water Management

Water Management System

Schematic diagrams of the proposed water management systems are shown in **Figure 5-8** and **Figure 5-9**. The locations of water management infrastructure are shown in **Figure 2-7** and **Figure 2-8**.

The process water ponds have been designed to contain three days supply of water for the beneficiation plants, dust suppression and other industrial uses. Water would be recycled from the tailings storage facilities and the mine industrial area drainage slots and used preferentially as process water. More than 33% of the water used in the beneficiation plants will be recycled from these sources.

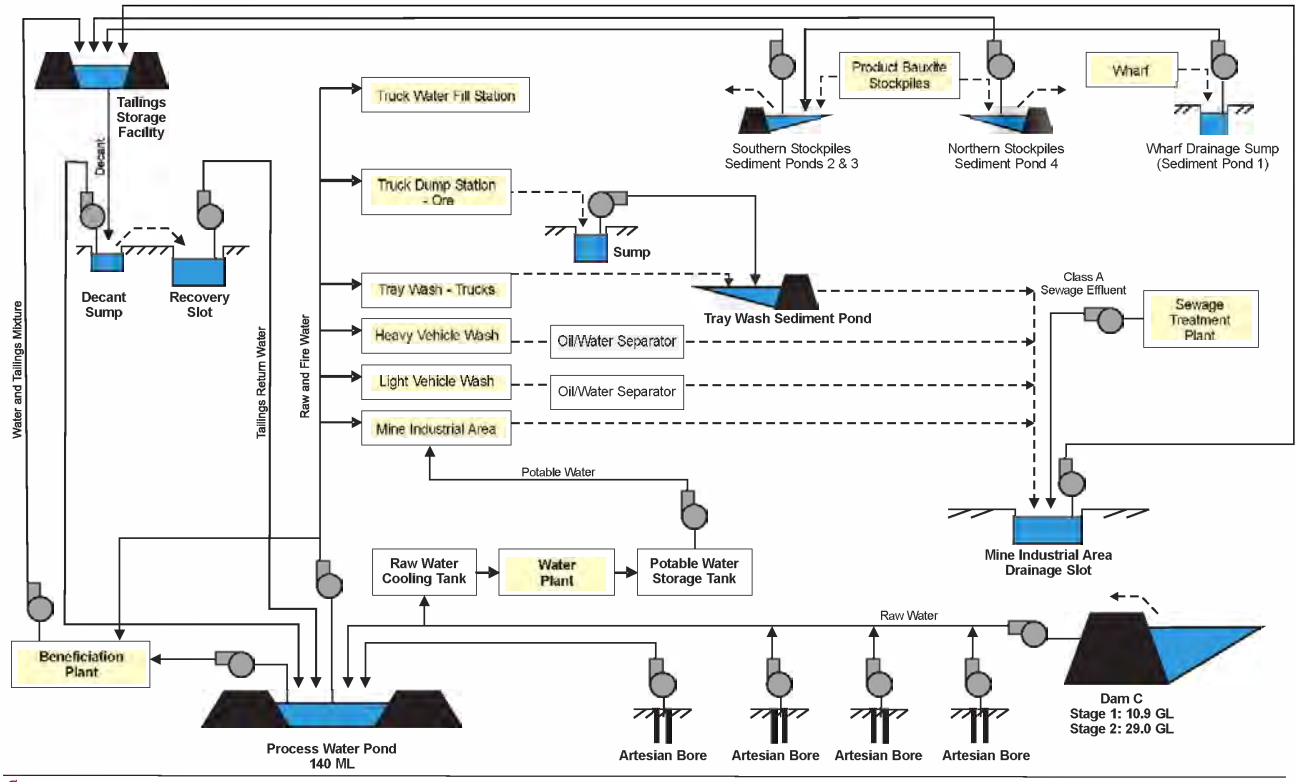
Water would be recycled from the tailings storage facilities, via the decant sump, to the process water pond. Water from the heavy and light vehicle wash bays would be treated in oil water separators prior to recycling.

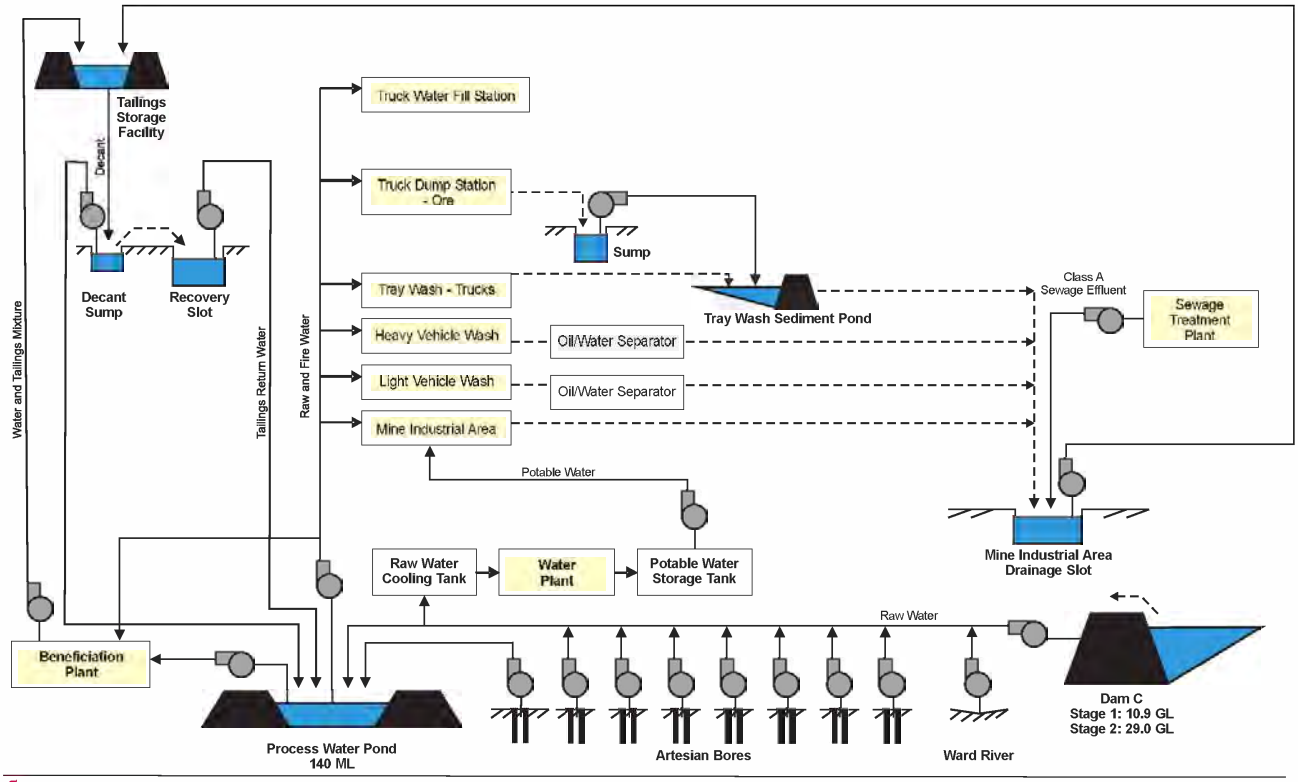
Stormwater runoff from product stockpiles and the wharf would be directed through sediment ponds. Provision would be made to recycle some of this water.

Treated effluent from the Boyd and Norman Creek sewage treatment plants (STPs) would also be recycled. Treated effluent from the construction camp STP would be used for irrigation of landscaping near the camp during the construction period. Management of STPs is discussed further in **Section 13.3.7**.

A reverse osmosis potable water treatment plant would be used to treat raw water from Dam C to a standard that meets the *Australian Drinking Water Guidelines* (NHMRC 2004).

The process water ponds and tailings storage facilities are constructed as "turkeys' nests", meaning they only capture the rainfall that falls directly on the dam impoundment. Neither of these dams contain contaminants in concentrations that are hazardous (refer **Section 13.3.4**).


Tailings Storage Facility
Decant
Decant Sump
Recovery Slot
Water and Tailings Mixture
Tailings Return Water
Raw and Fire Water
Truck Water Fill Station
Truck Dump Station - Ore
Sump
Tray Wash - Trucks
Heavy Vehicle Wash
Oil/Water Separator
Light Vehicle Wash
Oil/Water Separator
Mine Industrial Area
Potable Water
Raw Water Cooling Tank
Water Plant
Potable Water Storage Tank
Beneficiation Plant
Process Water Pond 140 ML
Southern Stockpiles Sediment Ponds 2 & 3
Product Bauxite Stockpiles
Northern Stockpiles Sediment Pond 4
Wharf
Wharf Drainage Sump (Sediment Pond 1)
Tray Wash Sediment Pond
Class A Sewage Effluent
Sewage Treatment Plant
Mine Industrial Area Drainage Slot
Raw Water
Artesian Bore
Artesian Bore
Artesian Bore
Artesian Bore
Dam C
Stage 1: 10.9 GL
Stage 2: 29.0 GL
Gravity flow
Pipeline
RioTinto Alcan
South of Embley Project
Fig. 5-8: Boyd
Water Management System
Date: 16/07/2010


Tailings Storage Facility
Decant
Decant Sump
Recovery Slot
Water and Tailings Mixture
Tailings Return Water
Raw and Fire Water
Truck Water Fill Station
Truck Dump Station - Ore
Sump
Tray Wash - Trucks
Tray Wash Sediment Pond
Heavy Vehicle Wash
Oil/Water Separator
Light Vehicle Wash
Oil/Water Separator
Mine Industrial Area
Class A Sewage Effluent
Sewage Treatment Plant
Potable Water
Raw Water Cooling Tank
Water Plant
Potable Water Storage Tank
Mine Industrial Area Drainage Slot
Raw Water
Beneficiation Plant
Process Water Pond 140 ML
Artesian Bores
Ward River
Dam C
Stage 1: 10.9 GL
Stage 2: 29.0 GL
Gravity flow
Pipeline
RioTinto Alcan
South of Embley Project
Fig. 5-9: Norman Creek Water Management System
Date: 16/07/2010

The hazard category of the tailings storage facilities has been rated in accordance with the DME/DEH (1995) *Site Water Management* guidelines. For the purposes of determining a design storage allowance, a conservative approach has been adopted and a "significant" hazard category assigned. The relevant design criteria from the DME/DEH (1995) *Site Water Management* guidelines are shown in **Table 5-15**. The design criteria would be reviewed whenever revised criteria are updated by the Department of Environment and Resource Management. Further information on management of tailings is provided in **Section 13.3.4**.

Table 5-15 Tailings Storage Facility Design Criteria

Location	Design Storage Allowance*	Spillway Critical Design Storm	Mandatory Reporting Level
Boyd tailings storage facility	0.02 AEP, 2 month wet season plus other inputs for the 2 month wet season, to be available on 1st November each year	0.001 AEP	72-hour 0.01 AEP
Norman Creek tailings storage facility	0.02 AEP, 2 month wet season plus other inputs for the 2 month wet season, to be available on 1st November each year	0.001 AEP	72-hour 0.01 AEP

AEP = Annual Exceedance Probability

* Even though the tailings are low toxicity, a conservative approach has been adopted and a "significant" hazard category assigned. The design criteria would be reviewed whenever the guidelines are updated by DERM.

The Australian National Committee on Large Dams (ANCOLD 2000) provides hydrologic design criteria for spillways based on downstream flood hazard. Dam C represents a low to significant incremental flood hazard category and, as such, the spillway should be designed to pass a 1:1,000 ARI storm event as a minimum. A 1:1,000 ARI storm event is considered a rare event (IE Aust 2001). The dam spillway would be designed to pass the peak flow from a 1:2,000 ARI flood event. The spillway would be at a low gradient (<3%) and be designed to facilitate fish passage during spillway flow events.

The process water ponds are "low" hazard category (DME/DEH 1995) and therefore would be designed for a spillway critical design storm of 1:100 year ARI. The process water ponds would be designed to operate a freeboard equivalent to a 24-hour 1:100 year ARI rainfall event.

Stormwater Management

The Mine Industrial Area drainage slots and the stockpile sediment ponds would receive stormwater runoff. These ponds would be sized to a volume equivalent to the runoff volume from a 1:10 ARI 24-hour rainfall event, plus 20% for sediment storage. The water from these ponds may be recycled, either via the process water pond or via the tailings storage facility.

Stormwater runoff generated within active mine areas is predominantly contained within the internally draining mine pits. The post-mining landscape effectively provides internally draining sumps that contain stormwater runoff, which then infiltrates through the pit floor and walls. In the event that the active pit or post-mining topography is not an internally draining pit, stormwater runoff would be directed via a sediment pond.

The Mine Access Road alignment follows elevated portions of the landscape wherever possible to enable all weather access; however, box culvert causeways would be required at certain watercourses. The Norman Creek access road and certain internal mine haul roads would also require box culvert causeways for a number of watercourse crossings. Sediment traps would be included as part of the drainage designs at points where haul roads cross watercourses. Further information on road drainage is provided in **Section 2.7.2**.

The following principles would be applied in the management of stormwater discharge:

- the *Engineering Guidelines for Queensland for Soil Erosion and Sediment Control* (IE Aust 1996) would be followed;
- land disturbance would be restricted to that necessary for the works;

- topsoil would be salvaged for use in rehabilitation;
- outflow would be passed from the sediment dams via engineered spillways to adjacent waterways;
- stormwater and runoff from upstream catchments would be diverted away from active mining and disturbed areas;
- drains would be protected to prevent scouring if necessary;
- sediment dams would be de-silted and cleaned periodically;
- hazardous materials would be stored in bunded areas or stored such that contaminated runoff is not generated; and
- traffic would be confined to maintained tracks and roads.

Erosion and Sediment Control

Erosion rates from active mining areas are higher than from unmined areas. In the wet season, increased erosion is expected to occur during mining operations from activities such as soil stripping, mining, and haul road construction. However, due to pit layout and topography, rainfall runoff would be predominantly retained within the mined areas.

Some elevated sediment concentrations are expected to occur in stormwater runoff from ore processing and stockpile areas.

An Erosion and Sediment Control Management Plan would be prepared prior to construction.

Areas disturbed by mining activities and infrastructure are to be rehabilitated to a stable landform with a self-sustaining vegetation cover. After overburden and soil are returned to mined-out pits the overall slope of the landform would be similar. Where mining leaves batters on the edges of the pit, these would be recontoured to a maximum slope of 20% (1 in 5). The final landform would not have any out-of-pit dumps of excavated wastes or soil. Rehabilitation methods are described further in **Section 3.10**.

Sediment laden runoff from ship loading activities has the potential to cause turbidity in the vicinity of the proposed port. Runoff and sediment collected from catch trays, belt scrapings, and the sealed maintenance area on the wharf would be pumped back to the wharf drainage sump on shore. Management measures to control product spillage are described in **Section 14.4.7**.

The water quality of natural surface drainage systems would be maintained by preserving riparian vegetation corridors. The buffer system, which is described in **Section 7.9.2**, would exceed the minimum requirements of the *Regional Vegetation Management Codes* (Qld) as they relate to clearing set-back distances from watercourses and wetlands (DERM 2009a). The retention of vegetation buffers around and adjoining surface drainage lines and wetland features provides effective management of elevated sediment load risks that would otherwise impact aquatic ecosystems (refer **Section 8.15.2**).

5.2.3 Surface Water Supply

Water Supply Dam

A water supply dam (Dam C) would be constructed on a freshwater tributary of Norman Creek (refer **Figure 1-3**). In determining that Dam C was the best option for water supply for the Project, alternate water sources were considered and a wide range of supply combinations utilising various proportions of these sources were investigated (refer to **Section 1.6.8**). Originally, two dams were considered, with the second dam being located on the Ward River. Following consultation with Traditional Owners and further feasibility studies, this was amended to only one larger dam (Dam C) on a freshwater tributary of Norman Creek.

Dam C would have a maximum storage capacity of 29GL and could be constructed in either two stages or a single stage. If constructed in two stages, the first stage would provide 10.9GL storage capacity and, later, the wall would be raised to provide 29GL storage capacity. The dam

would be constructed in a single stage (29GL capacity) should expansion of production above 15Mdptpa be anticipated to occur quickly, or should an initial production capacity of 22.5Mdptpa be adopted. This is the subject of ongoing feasibility studies. This EIS has assessed the impact of the dam at minimum, intermediate and maximum production rates of 15, 30 and 50Mdptpa. Details of both Dam C stages are summarised in **Table 5-16**.

Table 5-16 Water Supply Dam Summary

	Dam C	
	At 10.9GL capacity	**At 29.0GL capacity**
Total catchment area (km^2)	259.0	
Dam catchment area (km^2)	77.3	
Dam catchment as % of total catchment	29.8	
Maximum dam volume (GL)	10.9	29.0
Dam surface area (km^2) (at spillway)	3.6	6.5
Dam wall height (m) (at spillway)	8.0	12.0
Freeboard above spillway (m)	2.75	2.75

Dam C would be a conventional earth-fill dam. A cross section of Dam C is shown in **Figure 5-10**.

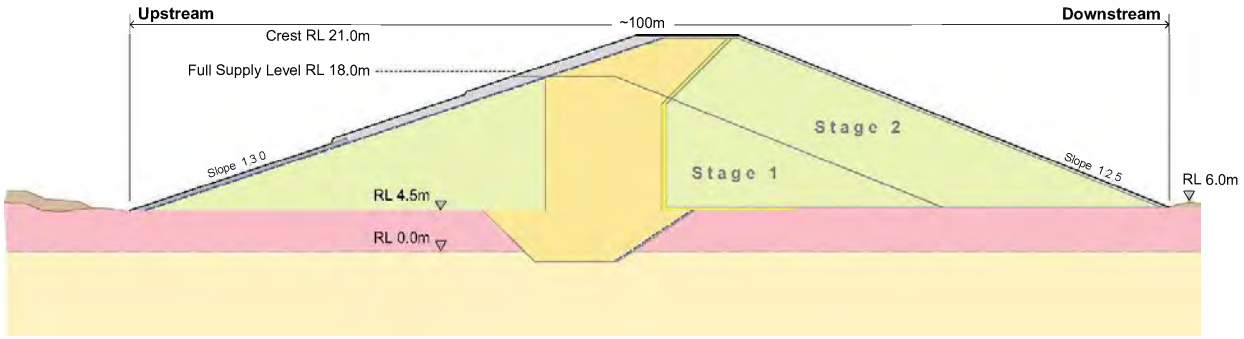
The Australian National Committee on Large Dams (ANCOLD 2000) provides hydrologic design criteria for spillways based on downstream flood hazard. Dam C represents a low to significant incremental flood hazard category and, as such, the spillways should be designed to pass a 1:1,000 ARI storm event as a minimum. A 1:1,000 ARI storm event is considered a rare event (IE Aust 2001). The dam spillways would be designed to pass the peak flow from a 1:2,000 year ARI flood event.

The spillways would be at a low gradient (<3%) and be designed to facilitate fish passage during spillway flow events. The conceptual design for the Dam C spillway and fish passage is shown in **Figure 5-11**. RTA would collaborate with TOs and the DEEDI (Fisheries Services) to ensure the most appropriate and best final design is selected for the circumstances. The final design would be submitted to DEEDI for approval under the *Fisheries Act 1994* (Qld). The dam would have a low level outlet pipe equipped with a valve to allow environmental flow releases when required.

Dam C supplies both the Boyd beneficiation plant and the Norman Creek beneficiation plant. The artesian borefield can supply water to both plants.

The impact of Dam C on downstream flow was modelled using a daily rainfall–runoff model (Boughton's AWBM) embedded in a GoldSim model that takes into account inputs (catchment runoff, direct rainfall) and outputs (pumped withdrawals, evaporation, seepage, spillway overflow and environmental releases).

The GoldSim model applies stochastic (Monte Carlo) trials to assess flows in streams and yield in dams of various sizes. For each trial or model realisation, rainfall was generated stochastically from the SILO rainfall recorded for the region using the Transition Probability Matrix (TPM) model. The record generated in the Monte Carlo approach has the same statistical character as the actual record (i.e. the parameters attaching to each record such as variance and standard deviation remain unchanged), but it would include instances of extreme behaviour such as long periods of low rainfall which are not captured using methods based on an average rainfall value method.



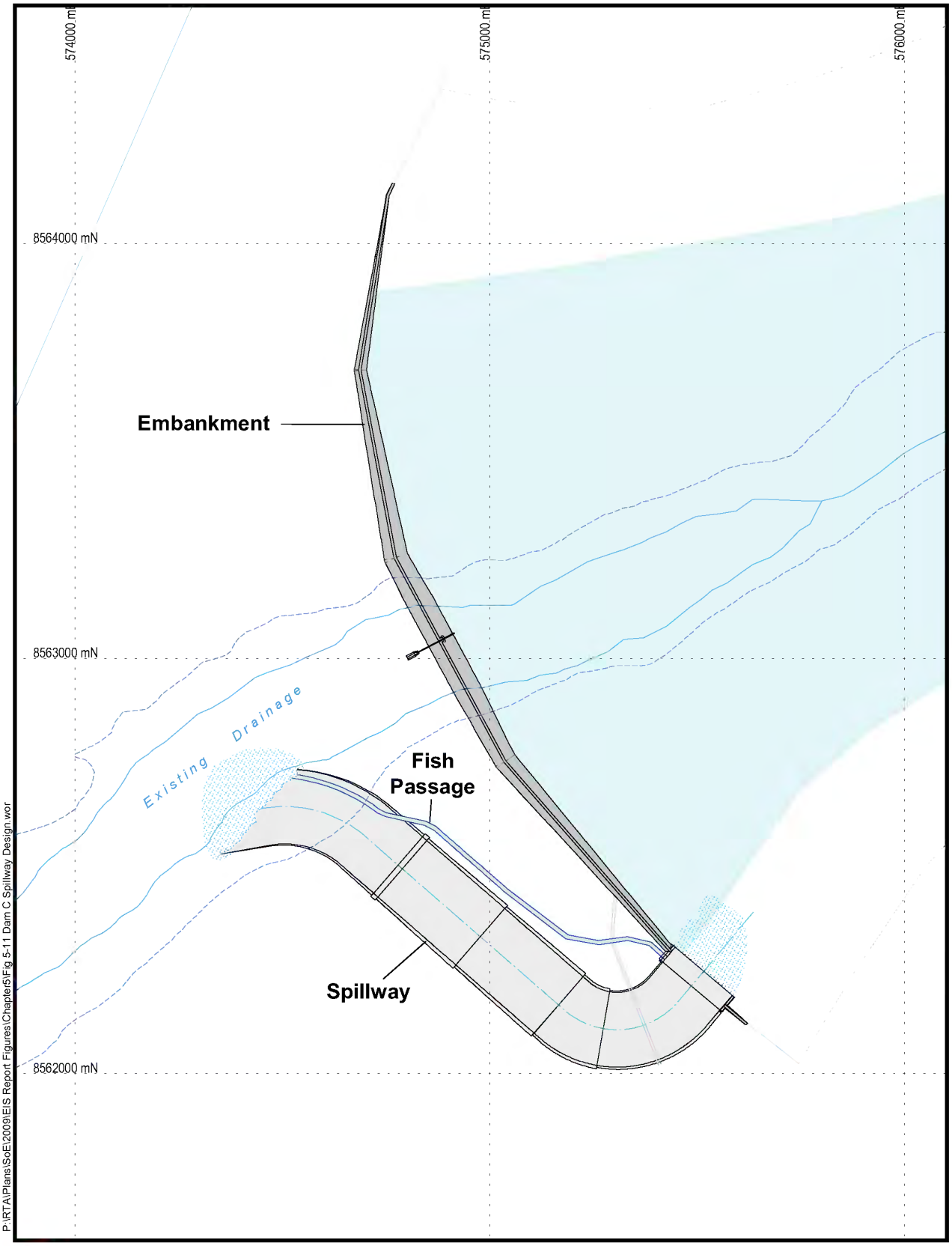
P:\RTA\Plans\SoE\2009\EIS Report Figures\Chapter6\Fig 5-10 Dam C Section

Top Soil
Laterite
Kaolin
Riprap (medium)
Riprap (fine)
Fine Filtered Sand
Kaolin and Gravelly Clay
General Fill
Filter Fabric

0 5 10 15
metres
Horizontal = Vertical

South of Embley Project

Figure 5-10: Dam C Cross Section



P:\RTA\Plans\SoE\2009\EIS Report Figures\Chapter5\Fig 5-11 Dam C Spillway Design.wor

Note: Design is conceptual

South of Embley Project

Fig. 5-11: Dam C Spillway Design

N

0 500m

Datum/Projection: GDA94/MGA Zone 54 Date: 19-01-2010

The TPM model allows a supply system to be tested over an extremely long period, which includes a wide spectrum of potential extreme conditions. It has been refined to incorporate climate change. Instances of extreme behaviour, as well as long periods of either higher or lower than average rainfall, have been incorporated into the model through use of recorded Southern Oscillation Index (SOI) data. The use of the data allows the generation of rainfall to be influenced by different consequences of the SOI that produce El Nino conditions, La Nina conditions or neither.

The GoldSim model was used to estimate dam inflow, spillway overflow and environmental releases. The downstream flow (spillway overflow plus environmental releases) was compared to the inflows into the dam to evaluate the effect of the dam on the hydrological regime. For the purposes of modelling, environmental releases were assumed to be 5% of daily dam inflows. The effect of rainfall variation was assessed by estimating the 10th and 90th percentile flows. The modelled effect of Dam C on flow immediately downstream of the dam and on annual flow from the whole Norman Creek catchment under production rates of 15 Mdptpa, 30 Mdptpa and 50Mdptpa is summarised in **Tables 5-17, 5-18** and **5-19** respectively**.**

Table 5-17 Effect of Dam C on Monthly Downstream Flow at 15Mdptpa

Month	Mean Monthly Inflow (GL)	Mean Downstream Flow (GL)	Downstream Flow at 15Mdptpa Production (as % of inflow)			
			Mean	10th percentile	Median	90th percentile
Flow Downstream of Dam C Wall						
January	6.15	2.31	37.5%	4.7%	13.2%	60.7%
February	14.63	13.01	88.9%	52.2%	91.8%	94.9%
March	18.11	17.00	93.9%	90.1%	93.7%	94.0%
April	13.55	12.10	89.3%	86.7%	88.4%	91.9%
May	7.32	5.31	72.6%	53.7%	70.9%	81.5%
June	3.31	1.54	46.4%	9.0%	38.5%	63.8%
July	1.19	0.18	15.0%	5.2%	4.8%	22.2%
August	0.22	0.06	25.4%	0%	25.0%	25.0%
September	0.01	0.002	25.0%	0%	0%	25.0%
October	0.01	0.002	25.0%	0%	0%	25.0%
November	0.12	0.01	4.7%	3.4%	4.6%	4.7%
December	1.20	0.06	5.1%	4.4%	4.6%	4.6%
Annual	65.84	51.58	78.3%	66.7%	77.3%	83.3%
Flow to Norman Estuary						
January	20.63	16.78	81.3%	71.6%	74.1%	88.3%
February	49.05	47.43	96.7%	85.7%	97.5%	98.5%
March	60.72	59.61	98.2%	97.0%	98.1%	98.2%
April	45.43	43.98	96.8%	96.0%	96.5%	97.6%
May	24.54	22.53	91.8%	86.2%	91.3%	94.5%
June	11.11	9.33	84.0%	72.9%	81.6%	89.2%
July	3.99	2.98	74.6%	71.7%	71.6%	76.8%
August	0.73	0.57	77.7%	0%	77.6%	77.6%
September	0.02	0.02	77.6%	0%	0%	77.6%
October	0.03	0.02	77.6%	0%	0%	77.6%
November	0.42	0.30	71.6%	71.2%	71.5%	71.6%
December	4.01	2.88	71.7%	71.5%	71.5%	71.5%
Annual	220.68	206.42	93.55%	90.15%	93.2%	95.0%

Table 5-18 Effect of Dam C on Monthly Downstream Flow at 30Mpdtpa

Month	Mean Monthly Inflow (GL)	Mean Downstream Flow (GL)	Downstream Flow at 30Mdptpa Production (as % of inflow)			
			Mean	10th percentile	Median	90th percentile
Flow Downstream of Dam C Wall						
January	6.15	1.50	24.5%	4.6%	4.7%	48.1%
February	14.63	10.81	73.9%	6.1%	69.2%	97.1%
March	18.11	16.02	88.4%	68.6%	90.2%	95.1%
April	13.55	11.06	81.6%	70.1%	80.2%	88.1%
May	7.32	3.79	51.7%	19.4%	47.7%	66.5%
June	3.31	0.65	19.7%	4.9%	8.9%	33.9%
July	1.19	0.29	24.7%	5.1%	4.6%	45.9%
August	0.22	0.06	26.3%	0%	25.0%	25.0%
September	0.01	0.002	25.0%	0%	0%	25.0%
October	0.01	0.002	25.0%	0%	0%	25.0%
November	0.12	0.01	4.7%	3.6%	4.8%	4.9%
December	1.20	0.06	4.7%	6.5%	4.7%	4.6%
Annual	65.84	44.25	67.2%	43.3%	63.7%	80.4%
Flow to Norman Estuary						
January	20.63	15.98	77.5%	71.5%	71.6%	84.5%
February	49.05	45.23	92.2%	72.0%	90.8%	99.1%
March	60.72	58.62	96.5%	90.6%	97.1%	98.5%
April	45.43	42.94	94.5%	91.1%	94.1%	96.4%
May	24.54	21.00	85.6%	75.9%	84.4%	90.0%
June	11.11	8.45	76.0%	71.6%	72.8%	80.3%
July	3.99	3.10	77.5%	71.7%	71.5%	83.9%
August	0.73	0.57	78.0%	0%	77.6%	77.6%
September	0.02	0.02	77.6%	0%	0%	77.6%
October	0.03	0.02	77.6%	0%	0%	77.6%
November	0.42	0.30	71.6%	71.3%	71.6%	71.6%
December	4.01	2.87	71.6%	72.1%	71.6%	71.5%
Annual	220.68	199.09	90.2%	83.1%	89.2%	94.2%

Table 5-19 Effect of Dam C on Monthly Downstream Flow at 50Mpdtpa

Month	Mean Monthly Inflow (GL)	Mean Downstream Flow (GL)	Downstream Flow at 50Mdptpa Production (as % of inflow)			
			Mean	10th percentile	Median	90th percentile
Flow Downstream of Dam C Wall						
January	6.15	0.58	9.4%	4.9%	4.8%	6.6%
February	14.63	6.24	42.6%	4.7%	22.8%	78.4%
March	18.11	12.87	71.0%	11.3%	74.0%	86.3%
April	13.55	9.99	73.7%	50.1%	74.0%	82.0%
May	7.32	2.42	33.0%	5.0%	26.0%	48.1%
June	3.31	0.26	7.9%	4.5%	4.6%	10.2%
July	1.19	0.13	10.9%	4.4%	4.6%	10.8%
August	0.22	0.05	25.0%	0%	25.0%	25.0%
September	0.01	0.002	25.0%	0%	0%	25.0%
October	0.01	0.002	25.0%	0%	0%	25.0%
November	0.12	0.01	4.1%	3.0%	4.2%	4.2%
December	1.20	0.06	4.7%	3.5%	4.6%	4.6%
Annual	65.84	32.61	49.5%	19.2%	46.9%	63.6%
Flow to Norman Estuary						
January	20.63	15.06	73.0%	71.6%	71.6%	72.1%
February	49.05	40.66	82.9%	71.6%	77.0%	93.6%
March	60.72	55.47	91.4%	73.5%	92.2%	95.9%
April	45.43	41.87	92.2%	85.1%	92.2%	94.6%
May	24.54	19.63	80.0%	71.6%	77.9%	84.5%
June	11.11	8.06	72.5%	71.5%	71.6%	73.2%
July	3.99	2.93	73.4%	71.5%	71.5%	73.4%
August	0.73	0.57	77.6%	0%	77.6%	77.6%
September	0.02	0.02	77.6%	0%	0%	77.6%
October	0.03	0.02	77.6%	0%	0%	77.6%
November	0.42	0.30	71.4%	71.1%	71.4%	71.4%
December	4.01	2.87	71.6%	71.2%	71.5%	71.5%
Annual	220.68	187.45	84.9%	75.9%	84.1%	89.1%

The key findings are:

- the effect of Dam C at 15Mdptpa, 30Mdptpa and 50Mdptpa production rates is to reduce mean annual flow immediately downstream in the Norman Creek tributary to 78.3%, 67.2% and 49.5% of original flow respectively; and
- considering the whole Norman Creek system catchment discharge (i.e. discharge into the estuary), the mean annual input into the estuary would be 93.5%, 90.2% and 84.9% of original flow respectively.

In summary, Dam C leads to an appreciable annual decline (>20%) in flows immediately downstream on that particular branch of the Norman Creek. However, when the catchment is considered as whole, the overall decline is less than 15% and well within the range of normal year-to-year variation.

The change in monthly flow in the Norman Creek tributary immediately downstream is shown at production rates of 15Mdptpa, 30Mdptpa and 50Mdptpa in **Figures 5-12 to 5-14.** The change in monthly flow into the Norman Creek estuary is shown in **Figure 5-15**.

The modelling shows that the onset of wet season flow immediately downstream of the dam is delayed by about a month as it fills following the dry season. However, there is little delay effect on the estuaries downstream due to contributing flows from other sub-catchments.

The effect of Dam C on the timing of downstream flow during the onset of the wet season was examined in relation to the timing of bank full flow. The bank full flow on the Norman Creek was estimated to have an ARI of 1:2.5 years (refer **Section 5.1.1**), which is equivalent to 8,300L/s at the dam site. GoldSim model output for typical flows with and without Dam C at 15Mdptpa, 30Mdptpa and 50Mdptpa are shown in **Figures 5-16 to 5-18.**

A statistical analysis shows that the onset of bank full flow downstream of Dam C is delayed on average only one day at 15Mdptpa, six days at 30Mdptpa and nine days at 50Mdptpa. The small time delay that the dam causes in downstream bank full flow is due to the nature of the rainfall–runoff relationship for the bauxite plateau:

- the surface runoff component of incident rainfall is very small (<1%) and therefore flows are unresponsive to incident rainfall unless the catchment is saturated already;
- the catchments must wet-up before there is any substantial baseflow into streams;
- the baseflow rises quite smoothly over time as the wet season progresses and is not highly variable like surface runoff in a "hard" catchment. Unlike a "hard" catchment, there is no conventional early wet season "first flush" or "pulses", rather a fairly sustained increase in flow over January, February and March to an April peak, followed by a decline, with cessation of flow around September (on average);
- the key factor is that the dam is typically already full by the time bankfull flow rates would normally be reached (mid-February on average), hence such inflows just pass over the spillway; and
- to the extent that timing of overbank flow may have an environmental influence, the installation of the dam would, on average, have negligible impact.

The ecological implication of the effect of Dam C on downstream flows is discussed in **Section 8.14.1.**

Dam C would be fitted with a low level outlet pipe which would permit the controlled release of environmental flows when required. Sufficient water would be reserved for environmental flows to enable continued releases in the driest months (August to October) of a volume equivalent to 25% of dam inflows. The pipe would be sized to enable peak discharge of up to 1,000L/s, if required. When dam inflows cease, environmental flow releases would cease. Once the dam is full following the onset of the wet season, the spillway would typically overflow on a regular basis. If environmental flow releases are required during the wet season, they would commence after the dam is full.

Impact of Dam C on Flood Events

Wet season inundation of floodplains resulting of overtopping of the main channel banks is a seasonal characteristic of the area. Dam C would not increase the risk of flooding as it would reduce the peak flow (as shown in **Figures 5-12 to 5-14**) during rain events.

Dam C has had a dam failure impact assessment in accordance with the *Guidelines for Failure Impact Assessment for Water Dams* (DNRW 2002). There are no buildings or public roads downstream of Dam C that would be at risk of flooding.

Figure 5-12 Flow Downstream of Dam C at 15Mdptpa

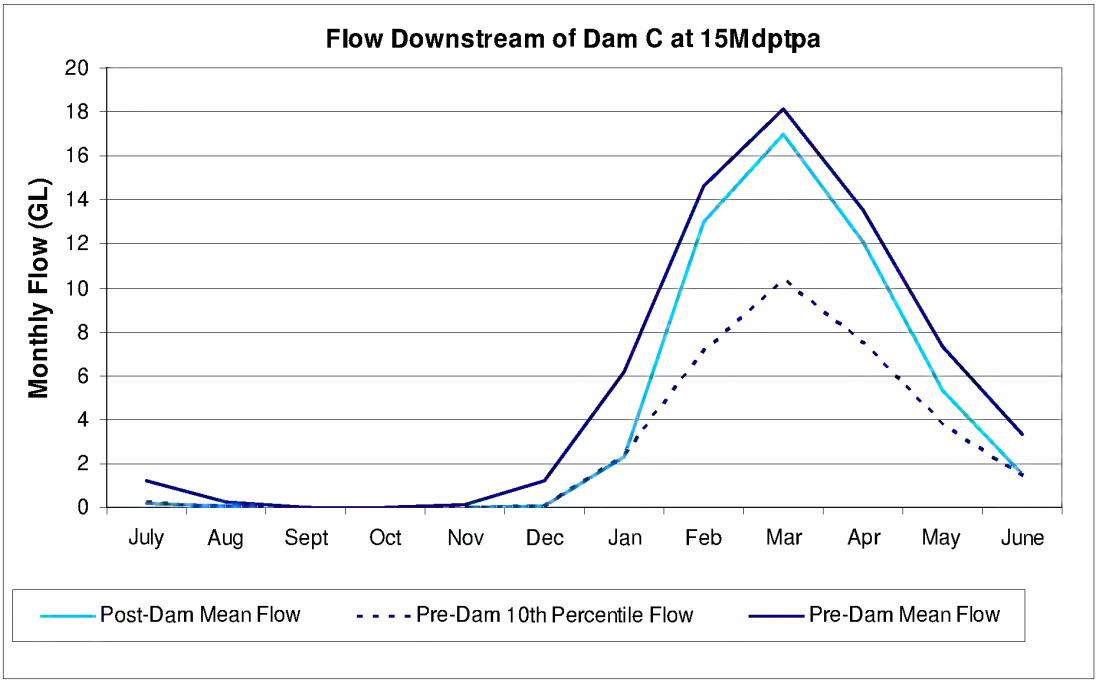


Figure 5-13 Flow Downstream of Dam C at 30Mdptpa

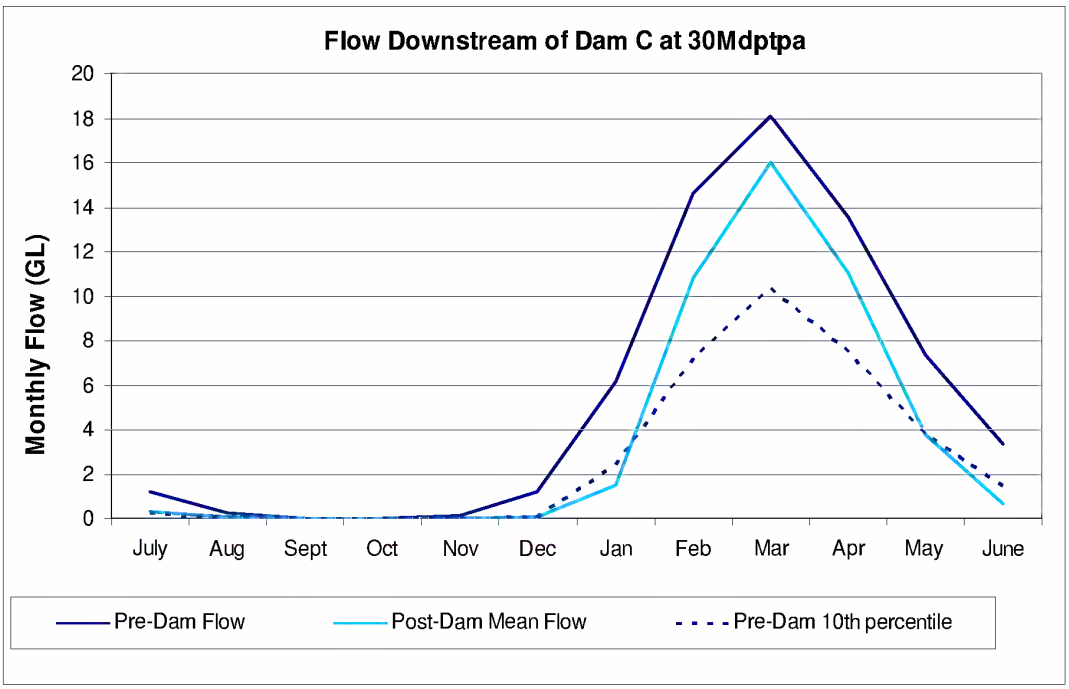


Figure 5-14 Flow Downstream of Dam C at 50Mdptpa

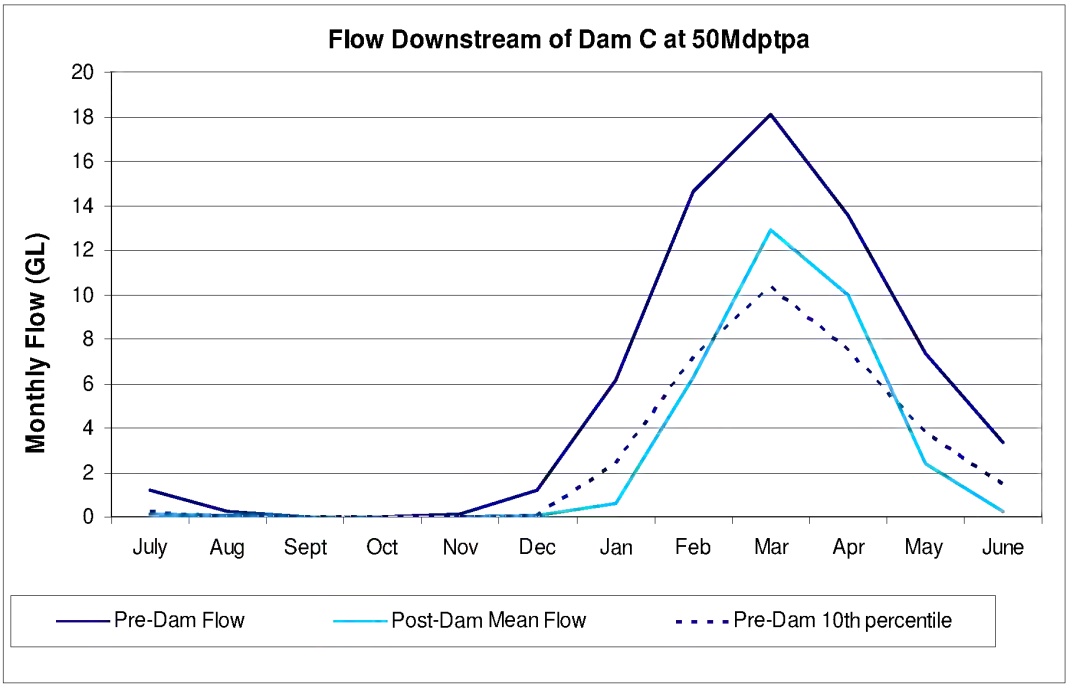


Figure 5-15 Flow from Norman Creek Catchment

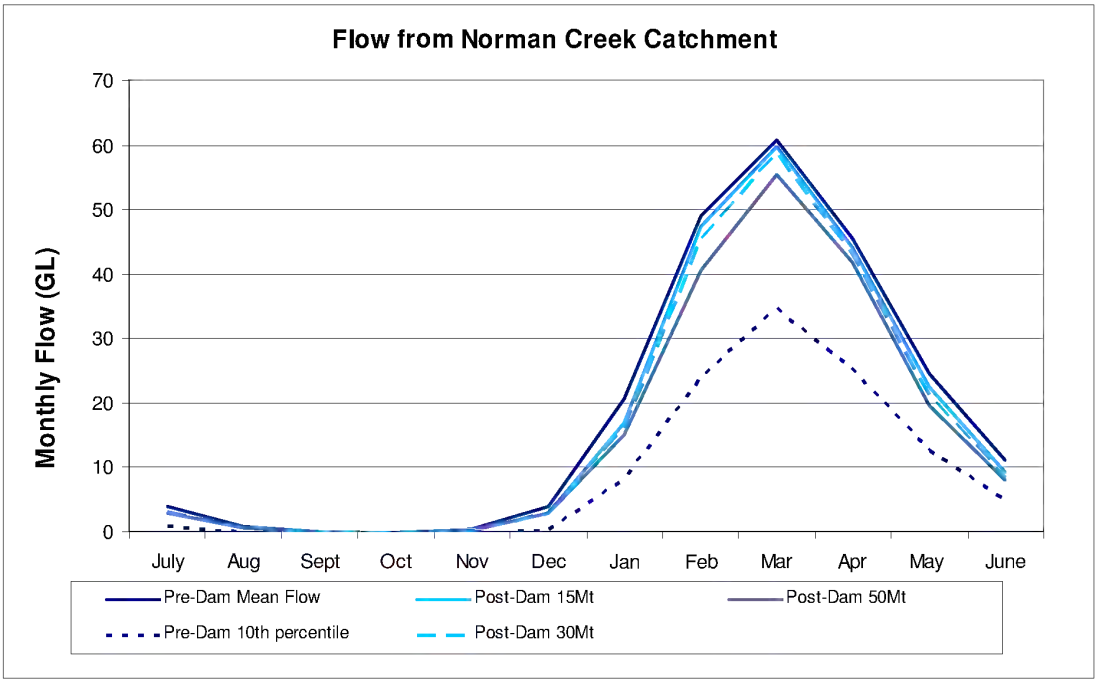


Figure 5-16 Norman Creek Flow at Dam C (15Mdptpa)

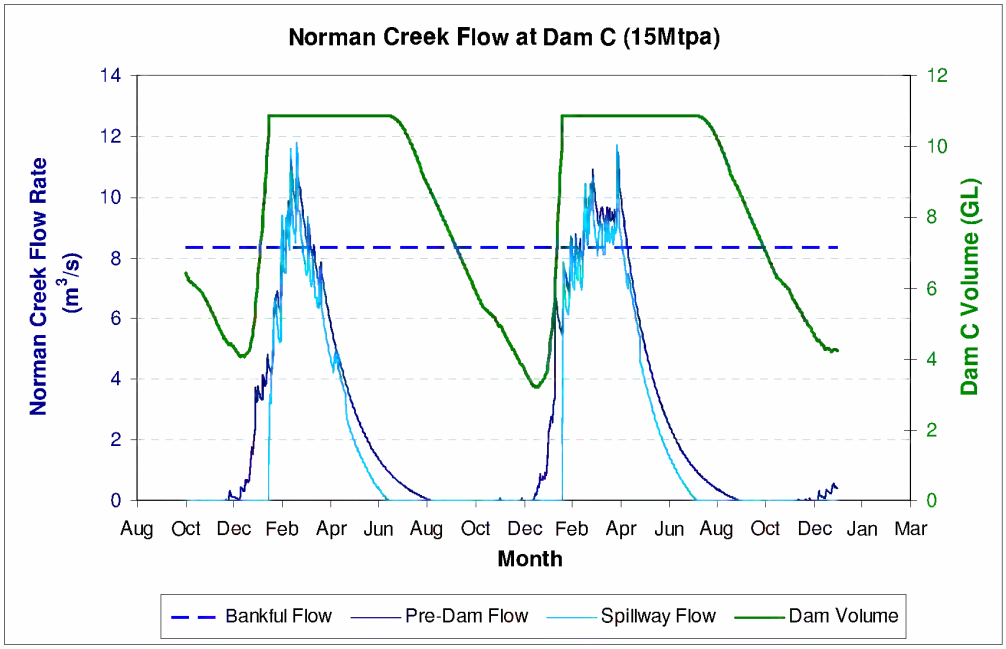


Figure 5-17 Norman Creek Flow at Dam C (30Mdptpa)

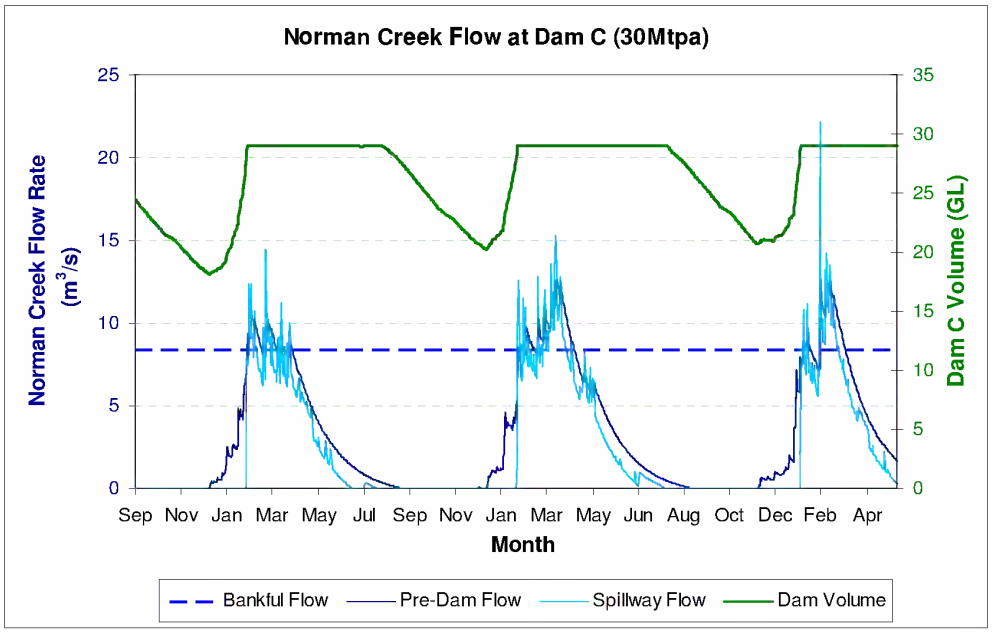
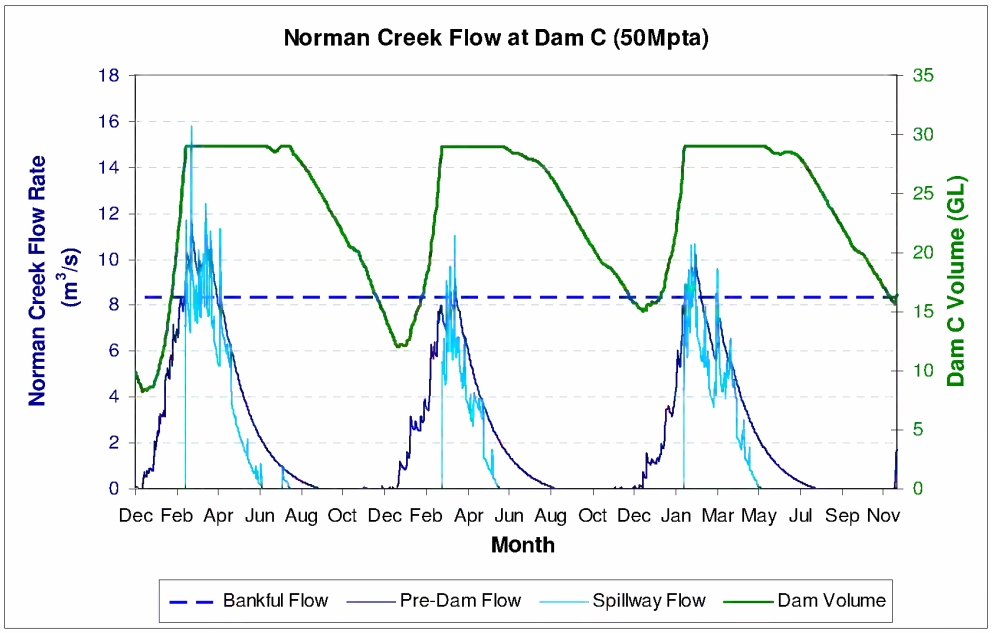


Figure 5-18 Norman Creek Flow at Dam C (50Mdptpa)



Direct Pumping

To maintain the reliability of the overall surface water supply at production rates between 30Mdptpa and 50Mdptpa and supplement the Dam C supply, some water would be pumped directly from the lower reaches of the Ward River (refer **Figure 1-3** for location of pump). The proposed pump station layout is shown schematically in plan view in **Figure 5-19** and cross section view in **Figure 5-20**. An in-stream weir or dam structure is not required. Water could be pumped via a pipeline corridor to either the Norman Creek or Boyd beneficiation plants.

The annual volume of water pumped from the Ward River would be capped at 1% of mean annual river flow at the pump station (2.67GL). In addition, no pumping would occur when Ward River flow was less than 1,000L/s and the rate of pumping at all times would be less than 20% of the river flow rate.

The GoldSim daily water balance model was used to estimate Ward River flow at the pump station and the pumped volumes. The downstream flow (river flow minus pumped volumes) was compared to the upstream flow to evaluate the effect of the pumping on the hydrological regime. The effect of the pumping on downstream monthly flow is summarised in **Table 5-20**.

July is the only month when pumped volumes exceed 10% of monthly river flow and this reduction is well within the normal seasonal monthly flow variation. The natural 10th percentile flow for July (0.96GL) is 80% less than mean flow (4.84GL). The effect of pumping at the 30Mdptpa and 50Mdptpa production rates is to reduce mean annual flow immediately downstream of the pump station by a very small amount (0.8% and 0.9% of original flow respectively). The overall impact of pumping on the Ward River hydrological regime is minor. The ecological implications of pumping on downstream flow are discussed in **Section 8.14.**

The proposed 6.5Mdptpa Aurukun Bauxite Project is within the catchment of the Ward River estuary (GHD 2007a). If the Aurukun Bauxite Project surface water demands were proportional to the 25Mdptpa Norman Creek beneficiation plant surface water demands, the demand for that project would be to 4.2GL per annum. If this demand was met from a dam on a tributary of the Ward River, the cumulative overall decline in mean annual discharge to the Ward River estuary would be very minor (<1%) and well within natural seasonal variation.

Monitoring and management commitments related to surface water supplies are described in Section 3.5 of the draft Environmental Management Plan (EM Plan) (**Section 21**).

Figure 5-19 Ward River Pump Station Schematic – Plan View

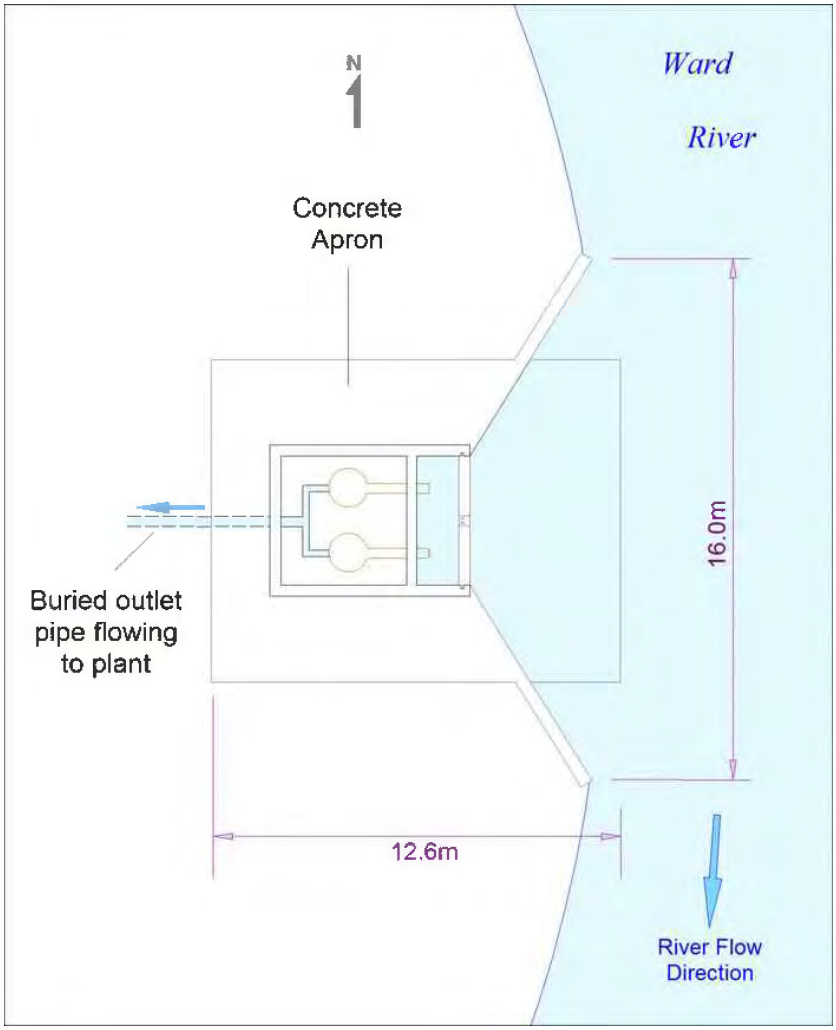


Figure 5-20 Ward River Pump Station Schematic – Cross Section View

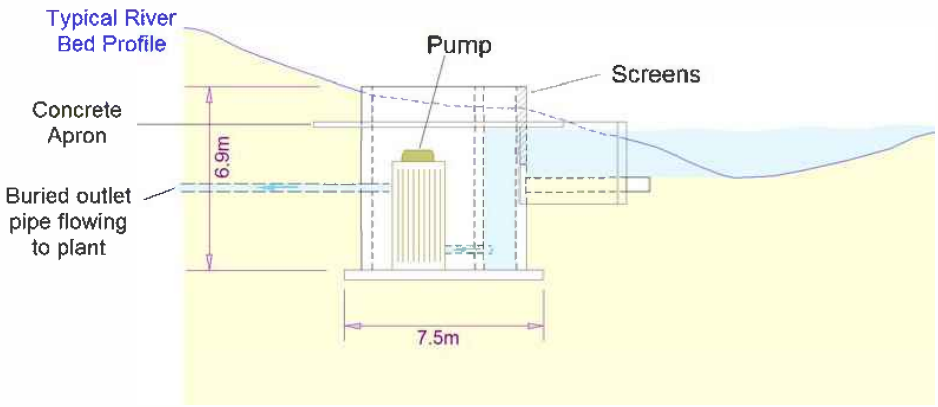


Table 5-20 Effect of Pumping from Ward River on Monthly Downstream Flow

Month	Upstream Mean Monthly Flow (GL)	Mean Volume Pumped (GL)	Decrease in Downstream Flow (at 50Mdptpa Production)			
			Mean	10th percentile	Median	90th percentile
January	25.01	0.49	–2.0%	–4.3%	–2.4%	–1.2%
February	59.46	0.36	–0.6%	–0.2%	–0.8%	–0.6%
March	73.60	0.11	–0.1%	0%	0%	–0.4%
April	55.07	0.02	0%	0%	0%	0%
May	29.75	0.08	–0.3%	0%	0%	–0.7%
June	13.47	0.35	–2.6%	–1.8%	–3.0%	–2.4%
July	4.84	0.80	–16.6%	–3.1%	–17.1%	–17.6%
August	0.88	0.03	–3.2%	0%	0%	–4.6%
September	0.03	0	0%	0%	0%	0%
October	0.04	0.001	–3.2%	0%	0%	0%
November	0.51	0.03	–5.3%	0%	0%	–3.1%
December	4.87	0.23	–4.8%	0%	–2.3%	–6.4%
Annual (at pump station)	267.51	2.50	–0.9%	–1.4%	–1.0%	–0.7%
Annual flow to estuary	567.30	2.50	–0.4%	–0.6%	–0.5%	–0.3%

5.2.4 Mining and Catchment Hydrology

To assess the effect of mining on the discharge from catchments subject to mining, rainfall–runoff characteristics of undisturbed, active mine and rehabilitated areas need to be estimated. The AWBM rainfall–runoff model was used to determine the water balance characteristics of the undisturbed catchment and of open mining areas. A study of recharge characteristics of undisturbed, mined and rehabilitated land at Weipa by Volker and Crees (1993) found there were no long-term major changes to the recharge of the shallow aquifer once vegetation was fully re-established. Hence, for the purposes of estimating impacts on catchment discharge, water balance characteristics for immature rehabilitation (<15 years old) and mature rehabilitation (≥15 years old) were interpolated between the undisturbed and fully disturbed AWBM cases. These characteristics are summarised in **Table 5-21**.

Table 5-21 SoE Project AWBM Water Balance Characteristics

Water Balance Component		Undisturbed	Open Mining Area	Immature Rehabilitation	Mature Rehabilitation
Evapotranspiration	mm	735	615	724	747
	%	42.6%	35.3%	41.6%	42.9%
Surface Runoff	mm	10	23	5	3
	%	0.6%	1.3%	0.3%	0.2%
Baseflow	mm	843	905	820	801
	%	48.0%	52.0%	47.1%	46.0%
Deep baseflow/recharge	mm	153	198	192	190
	%	8.8%	11.4%	11.0%	10.9%

The active mining area exhibits the largest change from the "undisturbed" situation. Internal in-pit surface runoff increases due to compaction from mining equipment traffic. However, although such runoff ponds in low spots, not much spills to the external catchment as the geometry of the pit provides a large sump. Rather, the extra in-pit runoff infiltrates and leads to increased baseflow. Without vegetation, annualised evapotranspiration declines.

In the "immature" rehabilitation situation, the rainfall partitioning pattern shifts partway back toward the "undisturbed" situation and this trend continues with the "mature" rehabilitation. However, the mature rehabilitation situation does not quite return completely to the "undisturbed" state because the residual post-mine topography still "traps" a little extra rainfall.

For each main catchment within which mining is planned, the annual discharge of the catchment was estimated for the following situations:

- undisturbed;
- maximum footprint of mining (i.e. largest footprint of open mining area and previously rehabilitated area); and
- post-mine closure (i.e. when all rehabilitated disturbed areas are mature).

The catchment discharge is the sum of the surface runoff and baseflow and is dominated by the baseflow component.

A summary of the annual catchment discharges is presented in **Table 5-22.**

The Ina Creek catchment has the largest proportion of area mined but the overall change to average annual discharge is very small (–1.4% at maximum mining impact; –2.2% post-closure). There are only very small changes to the discharge from the overall Norman Creek system (–1.0% at maximum mining impact; –1.8% post-closure) and overall Ward River system (–0.2% at maximum mining impact; –0.5% post-closure).

The proposed Aurukun Bauxite Project is located in the catchment of the Ward River estuary. While there are uncertainties as to whether this project would proceed, the operation of both projects simultaneously could give rise to a cumulative impact. In the absence of publicly stated areas of disturbance, estimations of mining disturbance associated with the Aurukun Bauxite Project were calculated using publicly available information on bauxite reserves. It is predicted this mining disturbance would total approximately 9,300ha. This would increase the potential aggregate mining disturbance in the Ward River estuary catchment to 14,900ha but would have a very minor change on the annual discharge from the overall Ward system (–0.6% at maximum mining impact; –1.2% post-closure).

The Ward River catchment makes up a minor part (3.8%) of the catchment of the Archer Bay Aggregation along with the Watson and Archer Rivers. The Project will not have any impact on the Watson River or Archer River and therefore the impact on discharge to the Archer Bay Aggregation would also be very minor, if any.

The modelling indicates the overall impact of mining on catchment discharge is very much less than the normal year-to-year variation driven by rainfall variation. This is consistent with the calibrated rainfall–runoff model which shows that surface runoff is extremely low and hence changes to surface drainage patterns have little impact on overall discharge into streams.

Impact of Mining on Flood Events

Wet season inundation of floodplains resulting of overtopping of the main channel banks is a seasonal characteristic of the area. There are no buildings or public roads downstream of the mining areas that would be at risk of flooding. The main impact of seasonal flooding is restricted access for vehicles rather than flood damage.

Mining would not increase the risk of flooding as the geometry of pits provides a large sump, resulting in infiltration rather than runoff to the external catchment.

Monitoring and management commitments related to catchment hydrology are described in Section 3.5 of the draft Environmental Management Plan (EM Plan) (**Section 21**).

Table 5-22 Impact of Mining on Catchment Discharge

Sub-catchment	Total Area (ha)	Undisturbed (ha)	Open Pit (ha)	Immature Rehabilitation (ha)	Mature Rehabilitation (ha)	Mean Flow From Catchment (GL)	Flow as % of Pre-Mine
Undisturbed Catchment (pre-mining)							
Triluck Creek	10,840	10,840	0	0	0	92.47	100%
Winda Winda Creek	9,385	9,385	0	0	0	80.06	100%
Whole Norman System	25,902	25,902	0	0	0	220.97	100%
Ina Creek	6,542	6,542	0	0	0	55.81	100%
Ward River Sub-catchment	18,687	1,8687	0	0	0	159.42	100%
Coconut Creek	11,918	11,918	0	0	0	101.67	100%
Whole Ward System	66,581	66,581	0	0	0	568.00	100%
Total	119,250	119,250	0	0	0	1,017.31	100%
Maximum Footprint within Sub-catchment							
Triluck Creek	10,840	8,783	540	759	759	92.30	99.8%
Winda Winda Creek	9,385	8,701	270	207	207	80.11	100.1%
Whole Norman System	25,902	17,618	810	3,737	3,737	218.71	99.0%
Ina Creek	6,542	2,838	540	1,582	1,582	55.00	98.6%
Ward River	18,687	14,544	540	1,802	1,802	158.44	99.4%
Coconut Creek	11,918	10,402	405	556	556	101.55	99.9%
Whole Ward System	66,581	60,973	945	2,332	2,332	566.92	99.8%
Total	119,250	98,913	3,105	8,616	8,616	1,013.03	99.6%
Post Mine Closure							
Triluck Creek	10,840	8,783	0	0	2,057	91.47	98.9%
Winda Winda Creek	9,385	8,701	0	0	684	79.73	99.6%
Whole Norman System	25902	17,618	0	0	8,284	216.93	98.2%
Ina Creek	6,542	2,838	0	0	3,704	54.00	96.8%
Ward River	18,687	14,544	0	0	4,143	157.40	98.7%
Coconut Creek	11,918	10,402	0	0	1,516	100.93	99.3%

Sub-catchment	Total Area (ha)	Undisturbed (ha)	Open Pit (ha)	Immature Rehabilitation (ha)	Mature Rehabilitation (ha)	Mean Flow From Catchment (GL)	Flow as % of Pre-Mine
Whole Ward System	66,581	60,973	0	0	5,608	561.18	98.8%
Total	119,250	98,913	0	0	20,337	1,007.40	99.0%

5.2.5 Surface Water Quality Impacts

The environmental values of waters to be protected are defined by the EPP (Water) as:

- biological integrity of a slightly modified aquatic ecosystem;
- suitability for recreational use;
- suitability for minimal treatment before supply as drinking water;
- suitability for agricultural use; and
- suitability for industrial use.

Proposed mining activities may result in impacts to surface water quality. The two potential impacts are sedimentation and contamination, which are discussed below.

Clearing vegetation cover for mining activities and associated infrastructure may result in elevated sediment loads in catchment runoff during some stages of mine development. The potential impacts of increased sediment in surface water on aquatic ecology are discussed in **Section 8.15**. As less than 1% of incident rainfall results in direct surface runoff (refer **Section 5.1.1**) and mining pits retain overland flow, the risk is considered low. However to mitigate risk, clearing and soil stripping would be scheduled following the wet season when the ground is moist and pit development would be underway during the following wet season. In addition, turbidity would be regularly monitored in surface waters (refer **Section 5.5.1**) to provide an early indicator of any potential impacts.

Mining activities may introduce contaminants to surface waters via the following:

- hydrocarbon spills;
- sewage;
- ore spills;
- mining activities altering the hydrology and thus the geochemistry of an area resulting in a change of metals concentrations; and
- mining, processing and handling. Increased metals via recycled process water from the beneficiation plant, tailings liquid, and runoff from ore stockpiles.

The potential impacts of contaminants in surface waters on aquatic ecosystems are discussed in **Section 8.15**. The process and potential risks are discussed below.

Hydrocarbons (fuel and lubricants) would be transported in road tankers via barge to the mine infrastructure areas. Small volumes would be stored on-site in accordance with Australian Standard *AS1940* (refer **Section 19.1**). Bauxite product spillage into the marine environment could occur during routine loading operations. Bauxite is non-hazardous and the risk of impact to marine ecology is considered to be low. Mitigation measures are proposed in **Section 14.4.7** to reduce the likelihood of spills.

The management of sewage and design of STPs are described in **Section 13.3.7**.

Mining activities may alter the geochemical (e.g. manganese and iron) makeup of surface waters by modifying the volume of contributing groundwater and surface waters. However, generally the mining pit floor is above the groundwater table (refer **Section 5.3.2**) and thus the risk to alteration of groundwater is considered minimal. The primary mechanism for this impact would be the effect of the dam on surface water flow volumes; however, releases from Dam C would mimic the natural cycle as described in **Section 5.2.3** and thus the risk is considered minimal.

Crude ore from the Project area, ore and tailings solids from existing Andoom and East Weipa operations, tailings liquid, water from tailings recovery slots, shallow aquifer groundwater, and runoff from existing product stockpiles were analysed (Rio Tinto 2009b; refer **Section 13.3.4** and **Section 8.15.1** for data). The results are summarised below in terms of potential contaminant impacts to surface water:

- The results suggest bauxite stockpiles are unlikely to be a significant contributor of aluminium to surface water ecosystems via runoff. Tailings liquid and some tailings seepage waters may contain aluminium concentrations greater than 80th percentile calculated for any freshwater site in the Project area, but within the range found in late dry season sampling of site waters.
- The following metals were not detected in tailings liquid at concentrations greater than the reporting limit: arsenic, boron, cobalt, copper, lead, nickel, selenium, zinc and mercury. This, combined with the lack of enrichment in the ore (Geochemical Abundance Index less than three) indicates these elements are not considered potential constituents of concern for the Project area.
- Tailings solid and ore samples were collected for leach analyses using two analytical methods. Based on these results, leaching from either is not anticipated to have an adverse effect on surface or ground waters.

A range of metals would be regularly monitored in surface waters (refer **Section 5.5.1**) to provide an early indicator of any potential impacts.

Monitoring and management commitments related to surface water quality are described in Section 3.5 of the draft Environmental Management Plan (EM Plan) (**Section 21**).

5.2.6 Regulatory Requirements

The *Water Act 2000* (Qld) regulates the use of surface waters and the interference with watercourses, lakes or springs. Pre-existing rights to build weirs or dams and take surface water for the Project are held under section 1037A of the *Water Act 2000* due to the *Commonwealth Aluminium Corporation Limited Agreement Act 1957* (Qld) (Comalco Agreement Act).

The Cape York Peninsula Moratorium Area has been declared under the *Water Act 2000*. It covers most of northern Cape York, including the Project area south of Boyd Point. The Moratorium restricts the type and volume of new Water Licences that can be issued under the *Water Act 2000.* The Moratorium recognises and does not affect the existing rights under the Comalco Agreement Act.

Certain watercourses would be crossed by roads, pipelines and conveyors. Riverine Protection Permits are required for any activities that destroy riparian vegetation, or excavate or place material in a watercourse to the extent that such activities are not authorised under an environmental authority (mining activities) or the *Water Regulation 2002* (Qld).

Dam C has had a dam failure impact assessment in accordance the *Guidelines for Failure Impact Assessment for Water Dams* (DNRW 2002). The dam does not have a population at risk located downstream of the dam wall and would not be a referrable dam under the *Water Supply (Safety & Reliability) Act 2008* (Qld).

Approval is required under the *Fisheries Act 1994* to construct a waterway barrier that obstructs fish movement. Such operational works are assessable development under the *Sustainable Planning Act 2009* (Qld). The dam spillway would include provision for fish passage and approval for the design would be required from DEEDI.

5.3 Groundwater

5.3.1 Regional Hydrogeology

Environmental Values

The EPP (Water) seeks to achieve the objective identified by the *Environmental Protection Act 1994* (Qld): to protect Queensland's waters while allowing for development that is ecologically sustainable. The EPP (Water) provides a framework for identifying EVs for Queensland waters and deciding and stating water quality guidelines and water quality objectives to enhance or protect the environmental values (EVs). The EVs relevant to groundwaters within the Project area are described in Section 6 subsection 2 of the EPP (Water) and include:

- biological integrity of an aquatic ecosystem;
- suitability for agricultural use; and
- suitability for industrial use.

Hydrogeology

This section describes the key sources of groundwater in the Western Cape region. The geology of the Project area is discussed in **Section 3.2**. The geology of the Project area is represented by the following geological units, which are listed in descending stratigraphic order:

- Coastal dunes
- Estuarine and delta deposits
- Ferruginous duricrust, including bauxite (the Aurukun Surface which is derived from laterised Bulimba Formation). This formation is part of the Wyaaba beds
- Bulimba Formation
- Rolling Downs Group
- Gilbert River Formation
- Garraway Beds
- Permian Basement Rock.

The contact between the bauxite and sandstone Bulimba Formation is a transitional zone consisting of kaolinite clay.

The groundwater bodies in the area have been differentiated as shallow aquifer and artesian aquifer resources. The artesian resources are hosted within the Gilbert River formation and Garraway Beds, and the shallow aquifer resources are those occurring within the formations above the Rolling Downs Group. A conceptual hydrogeological cross section for the superficial formations from east to west across the Project area is shown in **Figure 5-21**.

Groundwater dependent ecosystems in terms of regional ecosystems (REs) are detailed in **Table 8-3**.

Shallow Aquifers

The superficial geology associated with the shallow aquifer is shown in **Figure 3-2**.

The coastal dunes and estuarine and delta deposits do not provide a viable groundwater resource, as extraction is difficult due to the fine-grained nature of the sediments. Furthermore, the saline conditions and risk of saltwater intrusion are key factors against development of the coastal aquifers (CSIRO 2009).

The Ferruginous duricrust (bauxite) consists of medium to coarse ferruginous gravel in clayey matrix. This formation is highly permeable and is usually unsaturated, with the watertable residing in the underlying Bulimba Formation (CSIRO 2009).

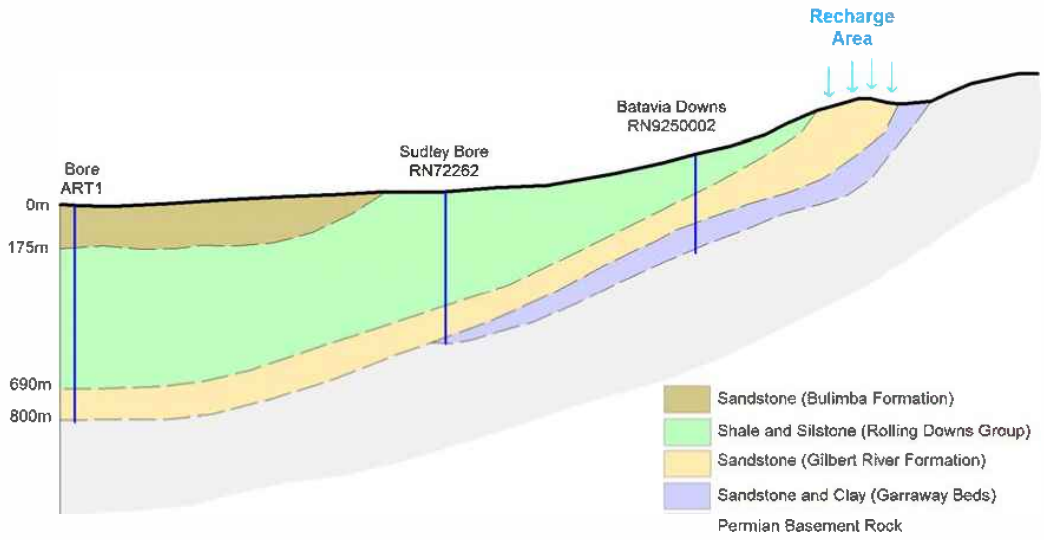


Figure 5-21 Cross Section through Artesian Host Formations

The bauxite overlies a kaolinite clay layer, which is part of the Bulimba Formation and contains kaolinite clay, to layers of fine clayey sand, to fine sands. This unit is generally of low permeability and is characterised as an aquitard, with some poor aquifer units of moderate permeability present. The kaolinite clays typically contain macropores which allow preferential flow.

The Bulimba Formation hosts a high yielding shallow aquifer which is an important resource over the Weipa Peninsula. It contains groundwater suitable for industrial and domestic use. Aquifers are typically constrained to old stream channels which trend easterly and meander through a matrix of clayey, less transmissive sediments and hence are not continuous and not always in hydraulic connection with one another. Recharge occurs where the Bulimba Formation outcrops and also potentially from underlying Great Artesian Basin (GAB) aquifers. Discharge occurs as baseflow to creeks, which helps maintain flow into the dry season (CSIRO 2009).

The shallow aquifers in the Project area are not as uniform as those used to supply existing RTA mining operations north of the Embley River and tend to be poorly developed and discontinuous.

The shallow aquifers are separated from the artesian aquifers by the 500m thick mudstones of the Rolling Downs Group.

Artesian Aquifers

The Gilbert River Formation is part of the GAB aquifers and is the main artesian groundwater resource in the region. The Gilbert River Formation aquifer is present across the entire Western Cape region, west of the Great Dividing Range. It comprises fine- to coarse-grained quartzose sandstone with pebble conglomerate and siltstone. Within the Project area this formation is artesian and is confined by the mudstones of the overlying Rolling Downs Group. The confining layer has low hydraulic conductivity and holds groundwater within the artesian aquifers under pressure. It is capable of supporting a large rate of abstraction.

The Garraway Beds underlie the Gilbert River Formation in the Project area. The Garraway Beds are similar to the Gilbert River Formation in lithology and artesian groundwater is also present in this unit. In relation to water resources management, the Gilbert River Formation and Garraway Beds are considered equivalents and are managed as one unit.

5.3.2 Shallow Aquifer

The shallow aquifer in the SoE Project area has been investigated through groundwater level monitoring and aquifer parameter tests. Investigative boreholes were installed in 2006 (25 bores) and 2007 (19 bores) in the Project area. A sub-set of bores has been selected for ongoing monitoring. The location of bores is shown in **Figure 5–22.** Four monitoring bores were equipped with dataloggers to monitor water level continuously (MB01, MB02, MB03, MB04) and the rest were manually measured.

The bauxite layer is present typically as a laminate overlying the kaolinite layer within which poorly developed and discrete aquifers are present. As a consequence, the shallow aquifers are not as uniform as those used to supply operations on the Weipa Peninsula. Aquifer parameter testing was carried out using airlift pump out tests and falling head tests. Low yields were recorded at all of the bores tested with the exception of MB04 and SOE10 where discharges of 0.5L/s and 1.0L/s respectively were measured over 30-minute trials. The low yields mean the shallow aquifer is not proposed to be used as a water supply source for the Project.

The hydraulic conductivities measured in falling head trials vary between 0.007 and 1.9m/d across the range of monitoring bores tested. Given the shallow aquifer depths, these conductivities indicate minimal transmissivities, which result in low groundwater flows and poor yields in the vicinity of the bores tested.

Localised semi-permanent baseflow into streams and tree swamps was observed, even at the end of the dry season. This indicates that although the extent of the shallow aquifers might be limited in places, the aquifer parameters such as storativity and transmissivity are highly variable, and are capable of supporting high baseflows at specific locations, including tree swamps.

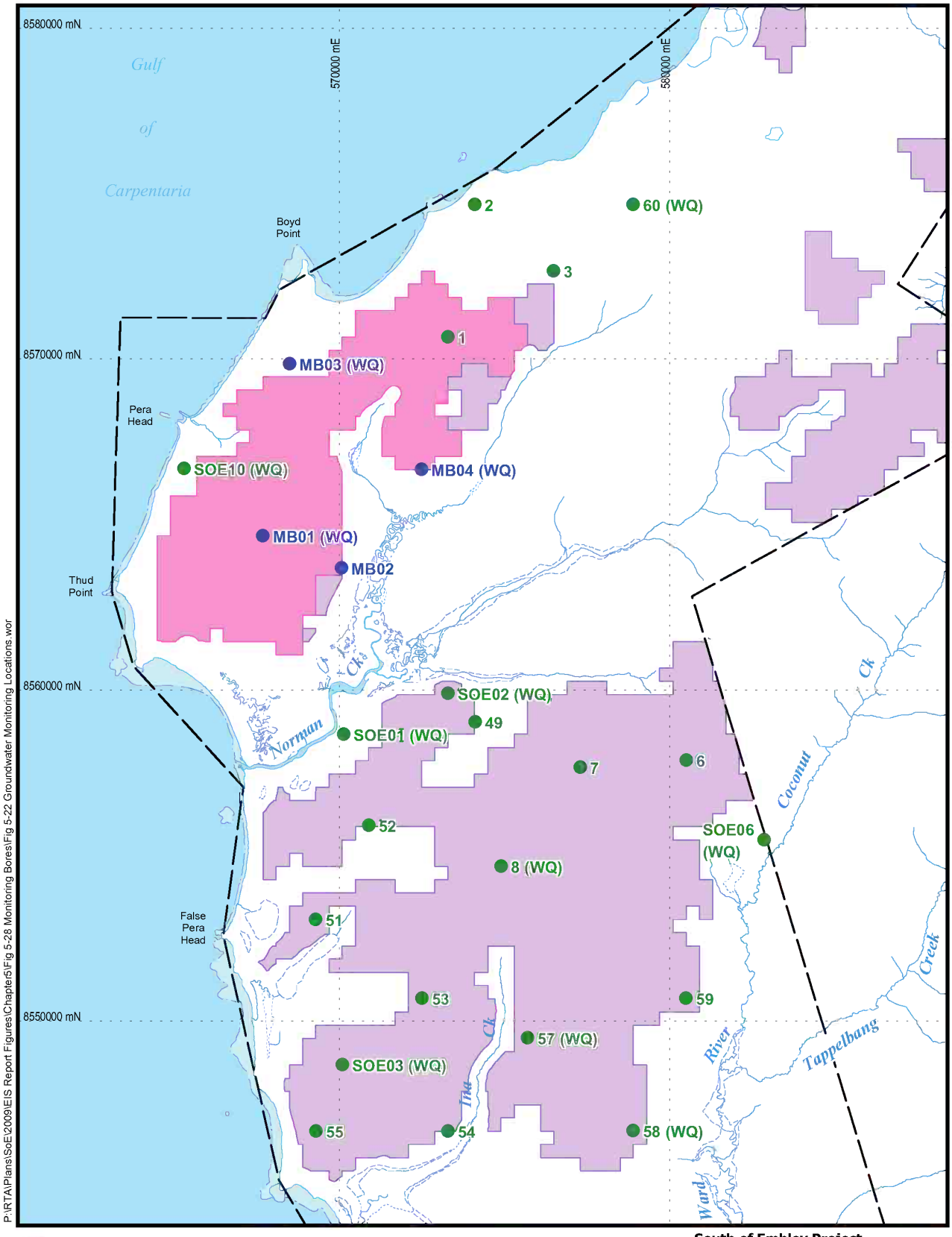
This is consistent with the explanatory notes for the Weipa 1:250 000 scale geological map sheet SD/54-3 from the Bureau of Mineral Resources, Geology and Geophysics, which suggests permeabilities across the area may be influenced by the original depositional conditions. Buried stream channels running east–west can be expected to provide zones of higher permeability.

Piezometric contour maps of the shallow aquifer were created based on dry season and wet season groundwater level measurements (refer **Figure 5-23** and **Figure 5-24** respectively).

The contour mapping indicates a general groundwater flow direction is from east to west. It should be noted that the shallow aquifer behaviour depends on highly variable parameter distributions and physical extent.

There is a large seasonal influence on the level of the water table. The difference between wet season (March 2008) and dry season (November 2007) levels is illustrated schematically in **Figure 5-25.** This cross section is from Boyd Point through the Boyd Bay mining area and it traverses two Norman Creek tributaries. The bauxite horizons are based on resource drilling. The wet season water table is below the base of the bauxite for the majority of the transect distance. The dry season water table level is always below the base of the bauxite.

The maximum and minimum water table levels recorded in each groundwater monitoring bore are shown in relation to the bauxite layer in **Table 5-23**. This data shows that the water table rises above the base of the bauxite infrequently.



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RTA Mining Lease boundary
Road/track
Groundwater level monitoring bore
Groundwater level monitoring bore (with data logger)
(WQ) Water quality sampling location
Mining Years 1 -13
Mining Years 14 - 40

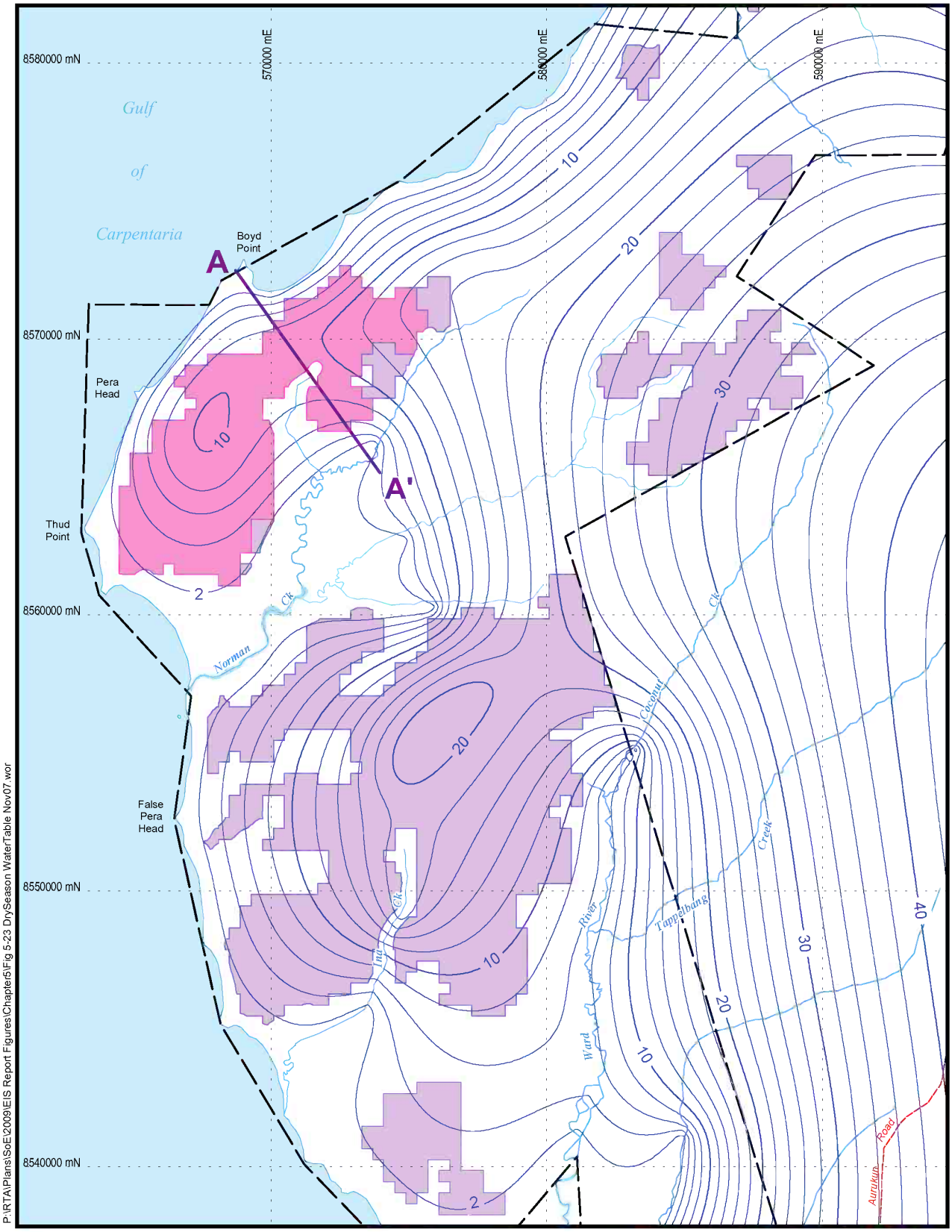
South of Embley Project

Fig. 5-22: Groundwater Monitoring Locations

N

0 5

Datum/Projection: GDA94/MGA Zone 54 Date: 21/07/2010



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RTA Mining Lease boundary
Road/track
Drainage
Groundwater level contour (mRL)

Mining Years 1 -13
Mining Years 14 - 40

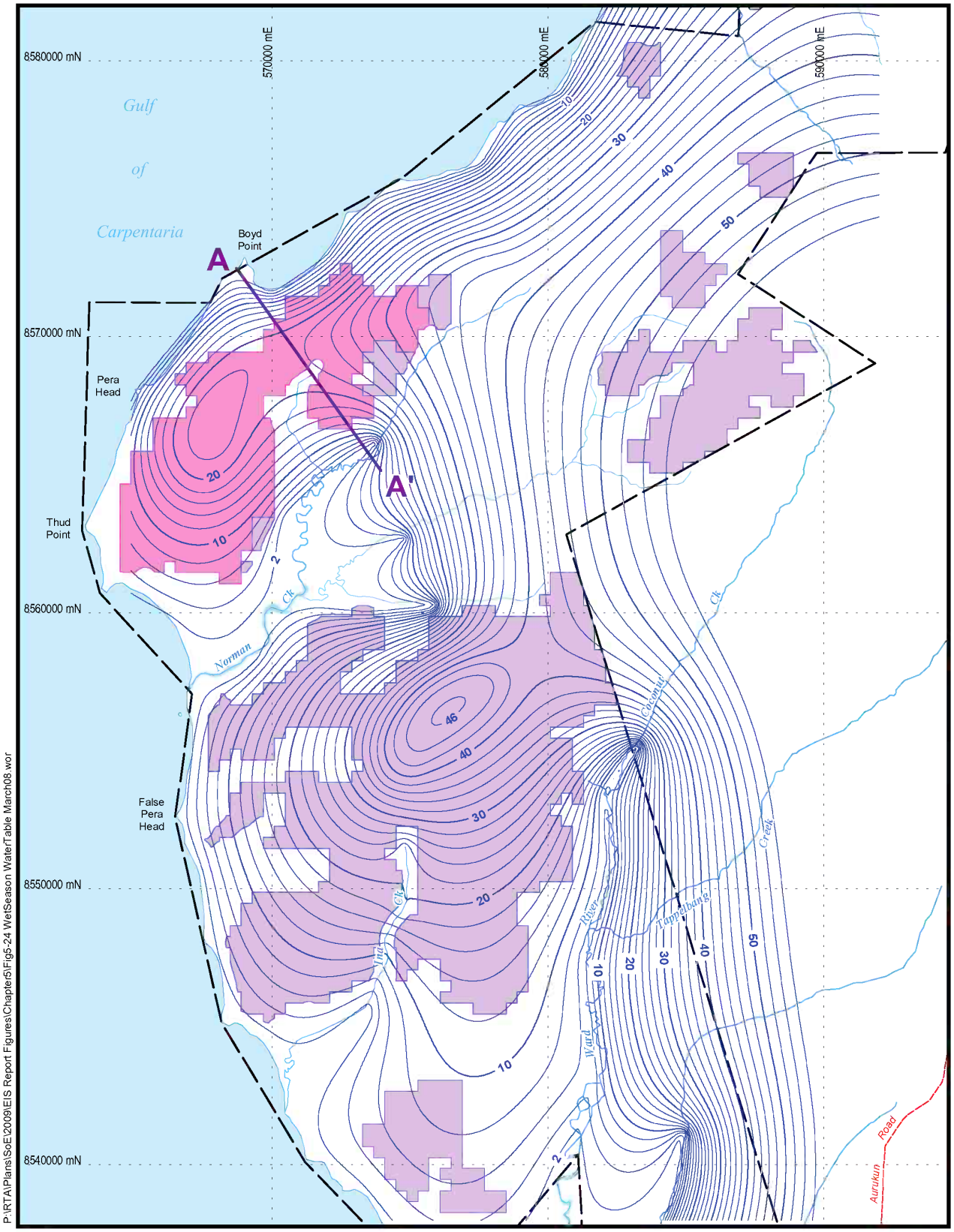
South of Embley Project

Fig. 5-23: Dry Season Water Table (Nov 2007)

N

0 5km

Datum/Projection: GDA94/MGA Zone 54 Date: 21/07/2010



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RTA Mining Lease boundary
Road/track
Drainage
Groundwater level contour (mRL)
Mining Years 1 -13
Mining Years 14 - 40

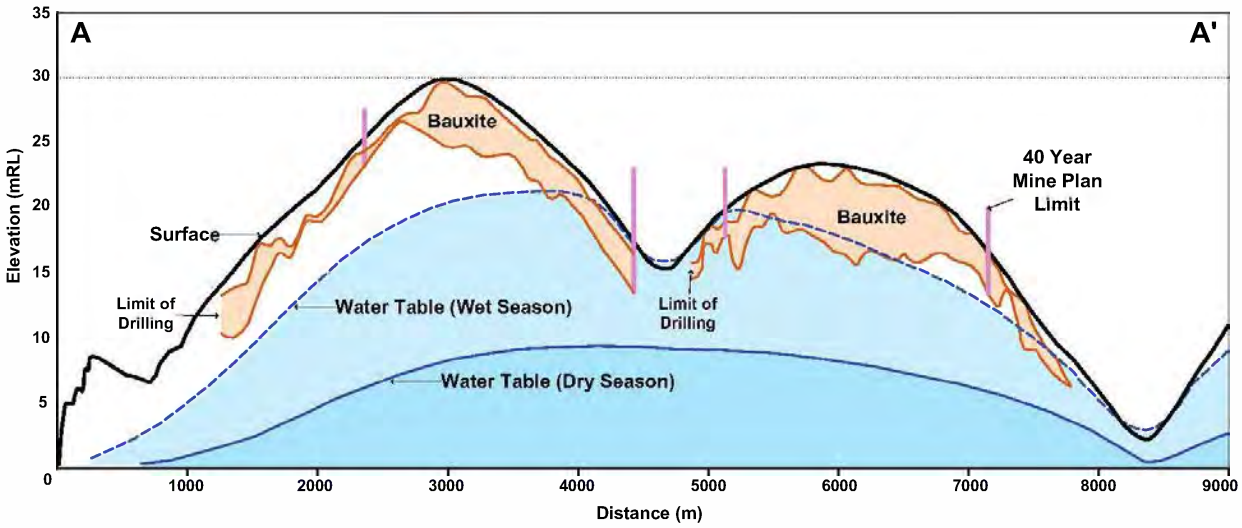
South of Embley Project

Fig. 5-24: Wet Season Water Table (March 2008)

N

0 5km

Datum/Projection: GDA94/MGA Zone 54 Date: 21/07/2010



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South of Embley Project

Figure 5-25: Water Table Cross Section

Table 5-23 Monitoring Bore Network

Bore ID	Easting (m MGA94)	Northing (m MGA94)	Date Completed	Bore Depth (mbRP)	Collar Ground Level (mRL)	Top of Bauxite (mRL)	Base of Bauxite (mRL)	Max Groundwater Level		Min Groundwater Level	
								mRL	Month*	mRL	Month*
1	573297	8570666	3 July 06	24.5	63.66	62.4	56.2	43.6	June 08	39.2	Sept 07
3	576494	8572656	4 July 06	25.1	42.15	41.9	40.7	22.3	June 08	20.4	Oct 07
6	580501	8557870	6 July 06	24.8	46.43	45.7	42.2	35.7	Mar 09	27.8	Sept 07
7	577290	8557654	6 July 06	24.3	42.96	41.5	39.5	31.0	June 08	18.2	June 06
8	574907	8554670	6 July 06	24.3	43.45	42.9	39.5	36.0	Mar 09	30.8	Nov 07
49	574116	8559026	8 July 06	24.6	20.44	20.2	14.7	6.2	June 08	4.6	Sept 07
51	569296	8553060	9 July 06	25.4	11.95	11.5	7.3	6.5	June 08	0.4	Sept 07
52	570901	8555906	9 July 06	25.2	20.85	20.6	17.4	14.9	June 08	8.9	Sept 07
53	572500	8550672	9 July 06	25.2	28.20	27.9	23.5	19.0	Mar 08	14.8	Oct 07
54	573294	8546664	10 July 06	24.3	12.86	No bauxite		3.4	June 08	1.2	Oct 07
55	568492	8546664	10 July 06	22.4	9.94	9.4	5.7	1.7	June 08	-1.1	Nov 07
57	575698	8549480	11 July 06	24.7	30.03	29.7	26.3	22.4	June 08	17.4	Nov 07
58	578893	8546668	11 July 06	25.1	27.80	27.3	21.1	15.1	June 08	11.5	Nov 07
59	580486	8550668	11 July 06	24.9	31.99	31.7	27.4	16.7	June 08	15.2	Oct 07
60	578889	8574664	13 July 06	25.1	45.00	No bauxite		30.3	Aug 09	28.7	Oct 07
MB01	567707	8564656	20 July 06	17.8	24.00	23.7	20.0	18.1	Mar 08	8.8	Feb 08
MB02	570084	8563676	20 July 06	25.5	7.20	6.9	3.9	4.3	Feb 08	–0.7	Nov 07
MB03	568505	8569852	04 Jul 06	21.2	27.02	25.8	25.3	20.0	Apr 08	8.3	Nov 07
MB04	572490	8566660	04 July 06	23.4	17.81	17.3	11.3	12.5	Mar 08	5.8	Feb 08
MB05	574102	8574656	04 July 06	~25	9.52	9.3	4.5	1.9	Aug 09	0	Mar 09
SOE01	570143	8558682	5 Oct 07	38.0	7.31	6.3	1.3	1.0	June 08	0	Nov 07
SOE02	573293	8559886	6 Oct 07	28.0	8.07	7.1	3.1	3.3	June 08	–0.1	Nov 07
SOE03	570101	8548670	21 Oct 07	26.0	16.74	16.2	10.7	8.0	Mar 09	0.1	Nov 07
SOE06	582855	8555462	8 Oct 07	23.0	23.28	22.5	17.3	23.0	Mar 09	9.0	Nov 07

Bore ID	Easting (m MGA94)	Northing (m MGA94)	Date Completed	Bore Depth (mbRP)	Collar Ground Level (mRL)	Top of Bauxite (mRL)	Base of Bauxite (mRL)	Max Groundwater Level		Min Groundwater Level	
								mRL	Month*	mRL	Month*
SOE10	565313	8566680	26 Oct 07	31.0	18.81	18.6	13.6	8.4	June 08	4.5	Mar 09

The seasonal response of groundwater level to rain in the continuously monitored bores (MB01, MB02, MB03 and MB04) is shown in **Figures 5-26** to **5-29**.

Figure 5-26 Groundwater Level in Response to Rainfall – MB01

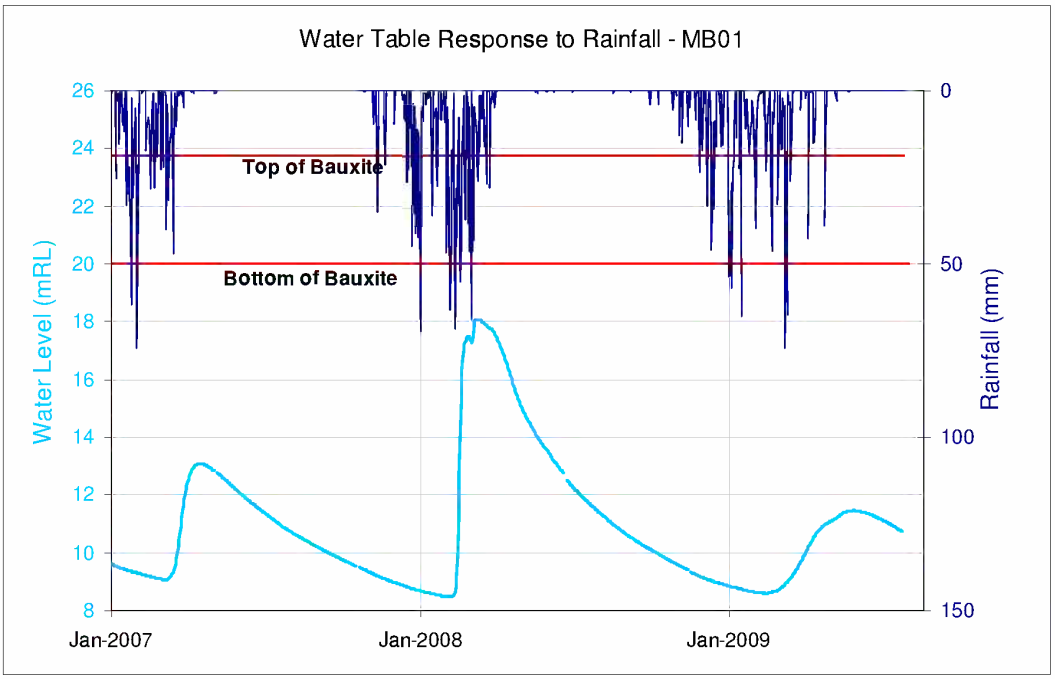


Figure 5-27 Groundwater Level in Response to Rainfall – MB02

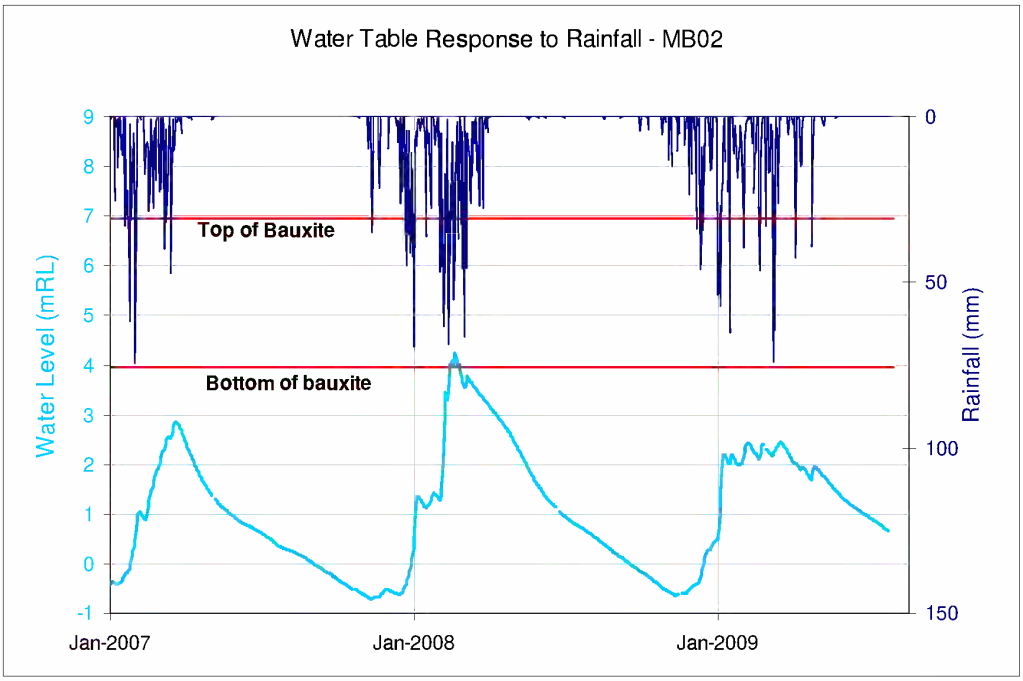


Figure 5-28 Groundwater Level in Response to Rainfall – MB03

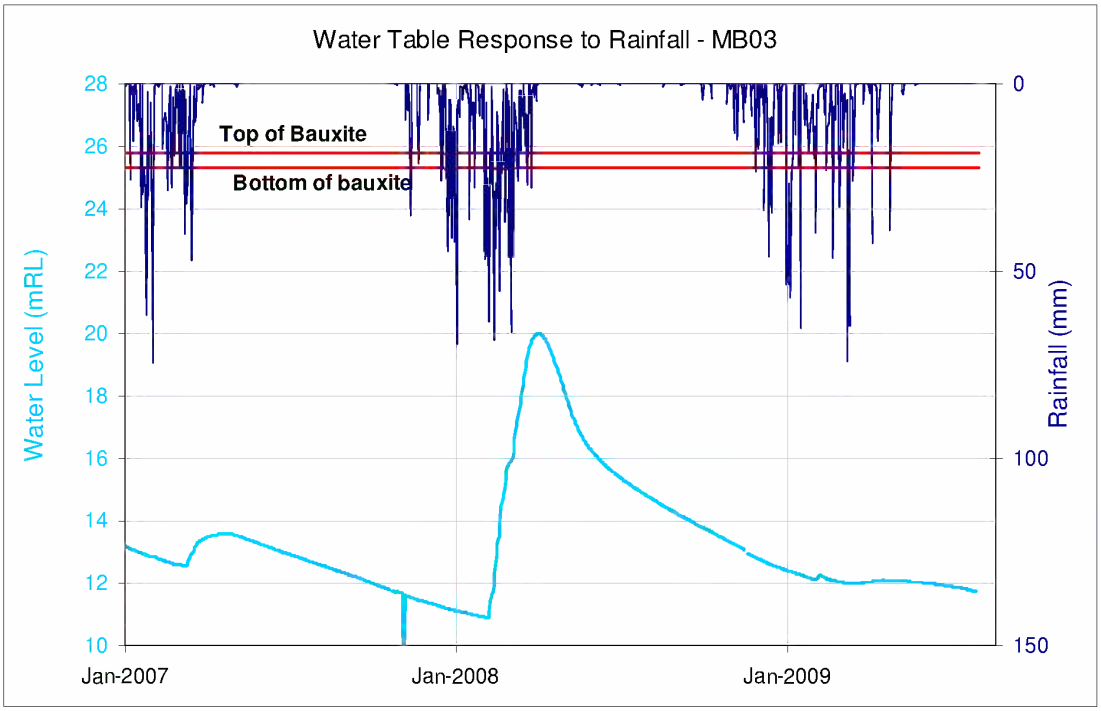
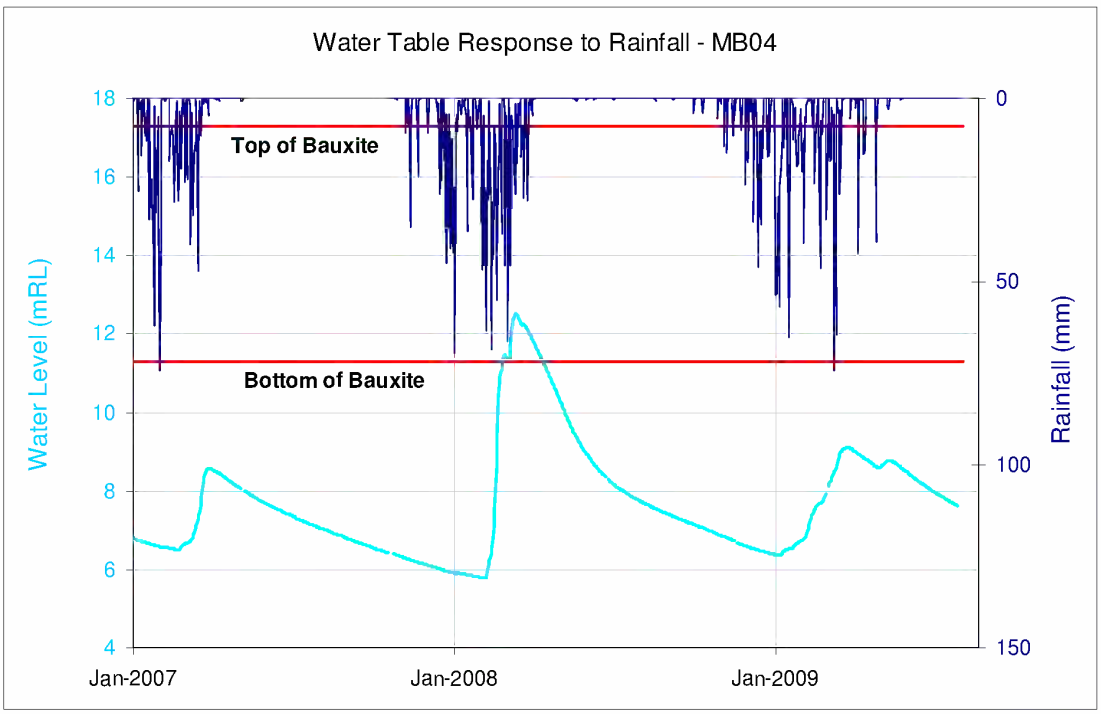


Figure 5-29 Groundwater Level in Response to Rainfall – MB04



The 2007–2008 year was one of average rainfall (1,758mm) and the water table rose above the base of the bauxite temporarily, at the height of the wet season, in two of the four monitoring bores. The 2006–2007 and 2008–2009 years had below average rainfall. The response of the water table to rainfall is very similar to the response of streamflow to rainfall and shows:

- the "soil" water store has to "wet up" before there is a rise in the water table;
- once that happens, there is a rapid response to incident rainfall; and
- peak wet season water table levels vary with incident rainfall, but the end of dry season water table levels are less variable and tend to return to a similar level each year.

The available data on groundwater levels indicates the kaolinitic layer below the bauxite is generally hosting the shallow aquifer during the dry season. Hence, in situations where streamflow extends well into the dry season, it is unlikely this is due to baseflow originating from the bauxite.

5.3.3 Shallow Groundwater Quality

This section describes existing shallow groundwater quality conditions in the Project area. To provide a spatial representation of groundwater quality across the Project area, 13 monitoring bores were selected for sampling. Locations are shown in **Figure 5-22**. All bores were sampled at the end of the dry season in November 2007. Two bores were sampled again in June 2008.

Prior to sampling each bore, the water level was measured, appropriate bore volumes were purged and physicochemical conditions were measured using a multi-parameter water quality meter. Water samples were collected for laboratory analysis by Australian Laboratory Services (ALS) of physicochemical parameters, total dissolved solids, total suspended solids, cations, anions, and a suite of total and dissolved metals. All samples were field filtered for analyses of dissolved metals with the exception of SoE06 and SoE02 due to excessive sediments – these were later filtered by the laboratory upon receipt.

Two of the June 2008 samples (MB03 and MB04) were selected for further, ultra-trace sampling by the CSIRO. The purpose of this ultra-trace sampling was to obtain results that would be comparable with those obtained for the surface water

Laboratory results are summarised in **Table 5-24**.

Generally, the pH of water in all bores was acidic to slightly acidic, with a range of 3.9 to 6.5. Such acidic groundwater is typical of leached, tropical environments that have a relatively rapid recharge through rainfall and a low residence time, such as the Project area.

Generally, all bores contained freshwater, with exceptions noted below. Bore SOE01 was saline with a field EC measurement of 21,600µS/cm. This bore is located about 3.5km from the coast upstream along Norman Creek, a section that is still tidally influenced. Bores MB05, SoE02, SoE06, SoE03 and 57 were brackish with a measured EC of 635 to 1,330µS/cm.

In freshwater bores sampled, hardness ranged from <1.0 to 6mg/L $CaCO_3$. The soft water is consistent with Project area fresh surface waters where hardness ranged from 0.4 to 9mg/L $CaCO_3$. Hardness ranged from 14 to 168mg/L $CaCO_3$ in brackish groundwaters with a maximum of 54,530mg/L $CaCO_3$ in the saline groundwater of bore SoE01. These ranges are comparable to Project area surface waters with corresponding salinities.

Mercury was not detected at concentrations greater than the laboratory reporting limit in any samples. The concentration of dissolved arsenic, chromium and lead was less than the laboratory reporting limit or very low. The following maximum concentrations in groundwater samples were recorded: arsenic of 3µg/L, chromium of 0.5µg/L and lead of 1.0µg/L.

Table 5-24 SoE Project Groundwater Quality Results

Analyte	Lab/ Units	SOE10	MB01	MB03			MB04			MB05	SOE02	SOE01	8	SOE06	58	57	60	SOE03
		Nov 07	Nov 07	Nov 07	Jun 08		Nov 07	Jun 08		Nov 07	Nov 07	Nov 07	Nov 07	Nov 07	Nov 07	Nov 07	Nov 07	Nov 07
		ALS	ALS	ALS	ALS	CSIRO	ALS	ALS	CSIRO	ALS	ALS	ALS	ALS	ALS	ALS	ALS	ALS	ALS
ph field	pH Unit	5.15	5.12	4.75			5.08			4.87	4.58	6.48	4.59	5.55	4.55	2.58	5.11	3.54
pH Value	pH Unit	6.19	6.16	5.84	4.95		6.08	5.53		6.01	5.76	6.96	5.96	6.52	5.79	5.76	6.18	3.89
Field EC	µS/cm	89	58	66			47			920	960	21600	31	1330	53.	890	68	635
Lab EC	µS/cm	65	44	49	53		29	28		729	682	11000	23	1050	21	18	54	499
TDS	mg/L	34	2.0	20	35		12	20		422	348	15800	4	1220	68	34	174	268
Suspended Solids (SS)	mg/L	27	432	3020	59		581	75		287	174	110	80	564	738	78	1540	10
Turbidity	NTU	1.1	200	700	2.5		120	3.5		60	17	33	26	28	800	31	1000	2.9
Field Temp.	°C	28.5	29.1	29.2			28.8			28.6	28.6	29.3	30.8	30.1	29.2	28.9	31.1	29.1
Total Hardness	as mg/L CaCO3	<1	6	4	<1		5	<1		94	14	5430	<1	168	<1	<1	<1	45
Hydroxide Alkalinity	as mg/L CaCO3	<1	<1	<1	<1		<1	<1		<1	<1	<1	<1	<1	<1	<1	<1	<1
Carbonate Alkalinity	as mg/L CaCO3	<1	<1	<1	<1		<1	<1		<1	<1	<1	<1	<1	<1	<1	<1	<1
Total Alkalinity	as mg/L CaCO3	8.0	13.0	6.0	2.0		9.0	3.0		9.0	5.0	123.0	6.0	144	4.0	4.0	20.0	<1
Major Anions																		
Sulphate as SO4 2-	mg/L	<1	<1	1.0	<1		<1	<1		27.0	8.0	800	<1	128	<1	<1	1.0	42.0
Chloride	mg/L		14.0	14.0	9.0		8.0	6.0		196	182	6460	8	201	8.0	8.0	8.0	108
Major Cations																		
Ca	mg/L	<1	2.0	2.0	<1		2.0	<1		8	2.0	1280	<1	31	<1	<1	<1	12.0
Mg	mg/L	<1	<1	<1	<1		<1	<1		18	2.0	545	<1	22	<1	<1	<1	4.0
Na	mg/L	1.0	8.0	9.0	6.0		4.0	2.0		106	26.0	2440	5	203	4.0	4.0	13.0	71.0
K	mg/L	<1	<1	<1	<1		<1	<1		<1	<1	44.0	<1	2.0	<1	<1	1.0	1.0

Analyte	Lab/ Units	SOE10	MB01	MB03			MB04			MB05	SOE02	SOE01	8	SOE06	58	57	60	SOE03
		Nov 07	Nov 07	Nov 07	Jun 08		Nov 07	Jun 08		Nov 07	Nov 07	Nov 07	Nov 07	Nov 07	Nov 07	Nov 07	Nov 07	Nov 07
		ALS	ALS	ALS	ALS	CSIRO	ALS	ALS	CSIRO	ALS	ALS	ALS	ALS	ALS	ALS	ALS	ALS	ALS
Metals*																		
Al – F	µg/L	34.0	27.0	<5	50	7.0	<5	50	5.0	10.0	90.0	5.0	88.0	62.0	<5	72.0	287.0	186.0
Al – T	µg/L	291.0	1370	3100	50	247. 0	485	240	13	980.0	252.0	8120	414	236.0	1550	688.0	2010.	353.0
As – F	µg/L	<0.2	<0.2	<0.2	<1	<0.02	<0.2	<1	<0.02	0.50	<0.2	<0.2	<0.2	3.00	<0.2	<0.2	0.40	0.20
As – T	µg/L	<0.2	0.20	0.30	<1	<0.02	<0.2	<1	<0.02	0.20	0.20	1.70	<0.2	3.10	0.30	<0.2	1.70	0.30
Cd – F	µg/L	<0.05	<0.05	0.27	0.10	0.003	<0.05	0.20	0.003	<0.05	<0.05	0.12	<0.05	<0.05	<0.05	13.40	<0.05	0.80
Cd – T	µg/L	<0.05	<0.05	<0.05	<0.1	0.005	0.05	<0.1	0.003	<0.05	<0.05	1.15	<0.05	<0.05	<0.05	<0.05	0.16	0.67
Cr – F	µg/L	<0.2	<0.2	<0.2	<1	0.020	<0.2	<1	<0.02	<0.2	<0.2	<0.2	<0.2	0.50	<0.2	<0.2	<0.2	0.20
Cr – T	µg/L	0.60	2.50	5.70	<1	0.170	1.30	<1	0.020	2.00	0.50	4.60	0.40	0.60	2.80	0.60	2.80	0.50
Cu – F	µg/L	<0.5	2.50	6.90	9.00	8.740	<0.5	16.00	12.40	<0.5	<0.5	<0.5	<0.5	2.60	1.00	<0.5	0.60	0.60
Cu – T	µg/L	<0.5	24.10	38.20	11	15.5	14.40	18.00	15.60	<0.5	<0.5	1.00	<0.5	3.50	1.40	<0.5	11.70	<0.5
Iron – F	µg/L	38.00	6.00	<2	<50	1.00	<2	<50	2.000	78.00	28.00	3.00	9.00	746	5.00	25.00	107.00	1030
Iron – T	µg/L	160	490	833	200	55.00	149	60.0	2.000	584	128	2030	85.00	496	610.00	162	1190	960.00
Lead – F	µg/L	<0.1	<0.1	<0.1	<1	0.043	<0.1	<1	0.026	<0.1	<0.1	<0.1	0.10	1.00	<0.1	0.30	<0.1	0.30
Lead – T	µg/L	0.20	2.80	7.30	<1	1.280	1.50	<1	0.035	0.70	<0.1	2.20	0.40	1.30	2.10	0.30	3.10	0.50
Mn – F	µg/L	5.20	11.70	5.80	6.00	3.210	0.60	1.00	0.520	867	23.50	7.80	<0.5	56.80	5.40	8.70	4.30	24.70
Mn – T	µg/L	9.00	23.80	10.50	<1	7.620	2.70	18.00	0.720	11.70	16.70	954.00	2.10	42.60	15.20	13.40	44.80	23.30
Nickel – F	µg/L	<0.5	1.50	0.80	<1	0.260	<0.5	<1	0.270	39.20	1.80	0.60	<0.5	7.90	<0.5	<0.5	<0.5	<0.5
Nickel – T	µg/L	<0.5	1.90	1.20	<1	0.510	<0.5	<1	0.034	0.60	1.10	38.40	<0.5	7.50	<0.5	<0.5	4.20	<0.5
Zinc – F	µg/L	15.00	49.00	35.00	73	46.2	28.0	59.0	33.2	70.0	27.0	58.0	6.0	132	14.0	260. 0	18.00	183.0
Zinc –T	µg/L	26.00	410.00	253.00	87.0	1000	153	56	59.8	56.0	10.00	79.00	35.00	30.00	72.00	89.00	78.00	70.00

* T = Total F = Filtered

Note: Location MB05 is not shown on **Figure 5-22**, located west of 60

The concentration of dissolved cadmium in groundwater was less than the laboratory reporting limit in samples from eight locations and reported at low levels in samples from four locations, with a maximum of 0.27µg/L. A concentration of 13.4µg/L dissolved cadmium was reported in the sample from location 57. This is one of the samples that was not filtered until the sample arrived at the laboratory and the result is suspected to be anomalous.

The concentration of dissolved iron in brackish samples was generally greater than that of fresh groundwaters. The concentration of dissolved iron in brackish groundwater ranged from <2 to 1,030µg/L, which is also greater than the range for Project estuarine surface waters (0.5 to 86µg/L). The concentration of dissolved iron in fresh groundwater ranged from <2 to 107µg/L, which is less than the range of Project area fresh surface water streams (2 to 553µg/L).

The concentration of dissolved manganese in fresh groundwater ranged from <0.5 to 11.7µg/L, comparable to the range of Project area fresh surface waters (0.02 to 80 µg/L). The concentration of dissolved manganese in brackish groundwater ranged from 8.7 to 867µg/L, greater than the maximum estuarine surface water value of 8.7µg/L.

The concentration of dissolved aluminium ranged from <5 to 287µg/L in samples from fresh shallow groundwater bores and 10 to 186µg/L in samples from brackish groundwater bores, both consistent with the range recorded for Project area fresh surface waters.

The maximum concentration of dissolved copper, nickel and zinc in all groundwater samples was greater than that of surface waters. The concentration of dissolved copper in all groundwater samples ranged from <0.5 to 16µg/L, compared with a maximum surface water value of 0.43µg/L. The concentration of dissolved nickel in fresh groundwater ranged from <0.5 to 1.5µg/L, slightly greater than the maximum surface water value of 0.28µg/L. The concentration of dissolved nickel in brackish groundwater ranged from 1.8 to 39µg/L, greater than the maximum estuarine surface water value of 0.47µg/L. The concentration of dissolved zinc in fresh groundwater ranged from 6 to 73µg/L, greater than the maximum surface water value of 7.1µg/L. The concentration of dissolved zinc in brackish groundwater ranged from 27 to 260µg/L, greater than the maximum estuarine surface water value of 3.4µg/L.

The values of parameters measured in the groundwater generally tend to reflect those recorded for the surface waters with the exception of higher concentrations of copper, nickel and zinc in the groundwater. However it should be noted that the most groundwater samples were collected during one event at the end of the dry season (November 2007) when the residence time of groundwater would be at its longest. These results have been compared with medians and ranges from the surface water program which generally covered multiple sampling events over wet and dry seasons.

5.3.4 Artesian Aquifer

The hydrology and current uses of the artesian aquifer in the vicinity of the Project area are described in the sections below.

Hydrogeology

Typically, water-bearing formations in the Project area are located at depths of between 750 and 1,000m below ground level. Groundwater moves in a westerly direction from what are known as "recharge beds" or "intake beds" to the Gulf of Carpentaria (CSIRO 2009). Artesian conditions occur from the coastal margin inland to areas where topography lies below 30 to 40m above sea level. Experience of similar aquifer conditions in the Weipa area, and test pumping in the Aurukun area, indicates the aquifer transmissivities tend to lie in the range 180 to 300m^2/d, and storativities in the range ~10^{-4} (dimensionless).

Large supplies (>60L/s) of medium quality groundwater can be obtained from the Gilbert River Formation aquifer from bores that intersect the entire sandstone sequence (CSIRO 2009). Shallow bores that intersect the unconfined Gilbert River Formation typically provide yields of 1 to 5L/s of groundwater (DNRM 2005a).

The GAB aquifers are recharged primarily by direct infiltration of rainfall where the GAB sandstone outcrops along the eastern margin of the region (the recharge area) – along the

flanks of the Great Dividing Range, particularly along watercourses. During the wet season stream leakage recharges the unconfined aquifers through which the streams are incised.

Springs

The Great Artesian Basin Resource Operations Plan (GAB-ROP) (DNRW 2007) defines three spring types being recharge, watercourse and discharge springs. The GAB ROP specifies criteria to protect the flow of water to springs and includes The Springs Register, which lists springs that support significant cultural and environmental values.

The majority of the Western Cape region, including the Project area, is represented in the GAB ROP by the Cape Management Area. The Project area is located within the Cape 1 Management Unit. The Cape Management Area serves to protect the groundwater resources of the GAB sediments in the Carpentaria Basin north of the Holroyd River. Spring locations derived from the DERM spring register for the Cape Management Area are shown on **Figure 5-30**. There are no registered springs within the Project area.

Recharge springs are quite common in the recharge areas on Cape York Peninsula, with numerous listed within the Cape Management Area. Recharge springs result from overflow or the rejection of recharge from the overfilling of aquifers. These springs provide an important source of water for maintaining surface water flow during the dry season. The Jardine, Wenlock, Archer, Coen, Holroyd and Dulhunty rivers all receive groundwater baseflow from the Gilbert River Formation aquifer (CSIRO 2009).

Watercourse springs are also found on Cape York Peninsula and are listed within the Cape Management Area. These are defined in the GAB-ROP as a part of a watercourse where water enters the watercourse through its bed or banks to become baseflow in the watercourse.

Discharge springs are not listed on The Springs Register as occurring within the Cape Management Area. These are defined as spring's supplied by underground water from a confined aquifer.

It should be noted, that an Environmental Protection and Biodiversity Conservation (EPBC) Act Protected Matters search was conducted of the pre-defined Cape York Natural Resource Management (NRM) region (accessed on 25/03/2011). The search identified the potential occurrence of discharge springs within the Cape York Management Area. The discharge springs are identified through association with the threatened ecological community '*The community of native species dependent on natural discharge of groundwater from the Great Artesian Basin'*. The listing advice for the community identifies that these springs are only associated with discharge springs and are an endangered ecological community.

It is likely that the Protected Matters database includes information from the Communities of National Environmental Significance database mapping (Environment Australia, 2003) which identifies one spring group in the Cape York Peninsula.

However, although the Protected Matters search identifies this community as potentially occurring in the Cape York NRM region, the GAB ROP does not identify any discharge springs within the Cape Management Area. Available evidence, detailed below also supports that GAB discharge springs do not occur within the Cape Management Area.

The *Great Artesian Basin Resource Study* (Cox and Barron 1998) separates this mapped Cape York spring group from the remainder of the known discharge spring groups at the time of publication, and associates these springs with recharge areas on the Cape York Peninsula. An update to this plan (GABCC 2010) provides a quantification of spring complexes within Queensland. Sixteen spring complexes are identified within the Cape Management Area, and all 16 are classified as active recharge springs. In addition, the *Recovery plan for the community of native species dependent on natural discharge of groundwater from the Great Artesian Basin* (Fensham *et al* 2010), also state that the "GAB discharge springs occur from the southern end of Cape York Peninsula to Lake Eyre in South Australia, spanning tropical semi-arid and temperate arid climates".

Discharge springs are therefore not associated with the Cape Management Area or the Project area. It is therefore unlikely that the threatened ecological community '*The community of native species dependent on natural discharge of groundwater from the Great Artesian Basin'* would occur in the Project area.

Existing Groundwater Use

The major water use from the Gilbert River Formation in the Project area and surrounds is for industrial and mining purposes associated with the RTA's existing operation north of the Embley River. Artesian groundwater is used to supplement process water supplies but would require significant treatment to make it suitable for sustained potable use.

RTA extracts artesian groundwater from borefields at both East Weipa and Andoom operations. Currently in use are three production bores at East Weipa and seven production bores at Andoom. The locations of existing production bores are shown on **Figure 5-30**. RTA takes water from these bores under an existing Water Licence, under the *Water Act 2000,* which allows abstraction of up to 9GL per annum. There are no other large users of artesian groundwater on Cape York.

RTA has installed monitoring bores within the artesian aquifer both on-site and off-site at various locations throughout the Cape York region. The Sudley Station and Batavia Downs monitoring bores are located off-site on cattle stations and are both used for stock watering.

The small number of stock and domestic bores that access GAB aquifers in the Western Cape region are restricted to areas of outcrop to the east, where only shallow bores are required (DNRM 2005a). Towards Aurukun, test bores have been drilled in the past and constructed and used in aquifer tests, but development of this aquifer for potable use has not proceeded owing to water quality constraints.

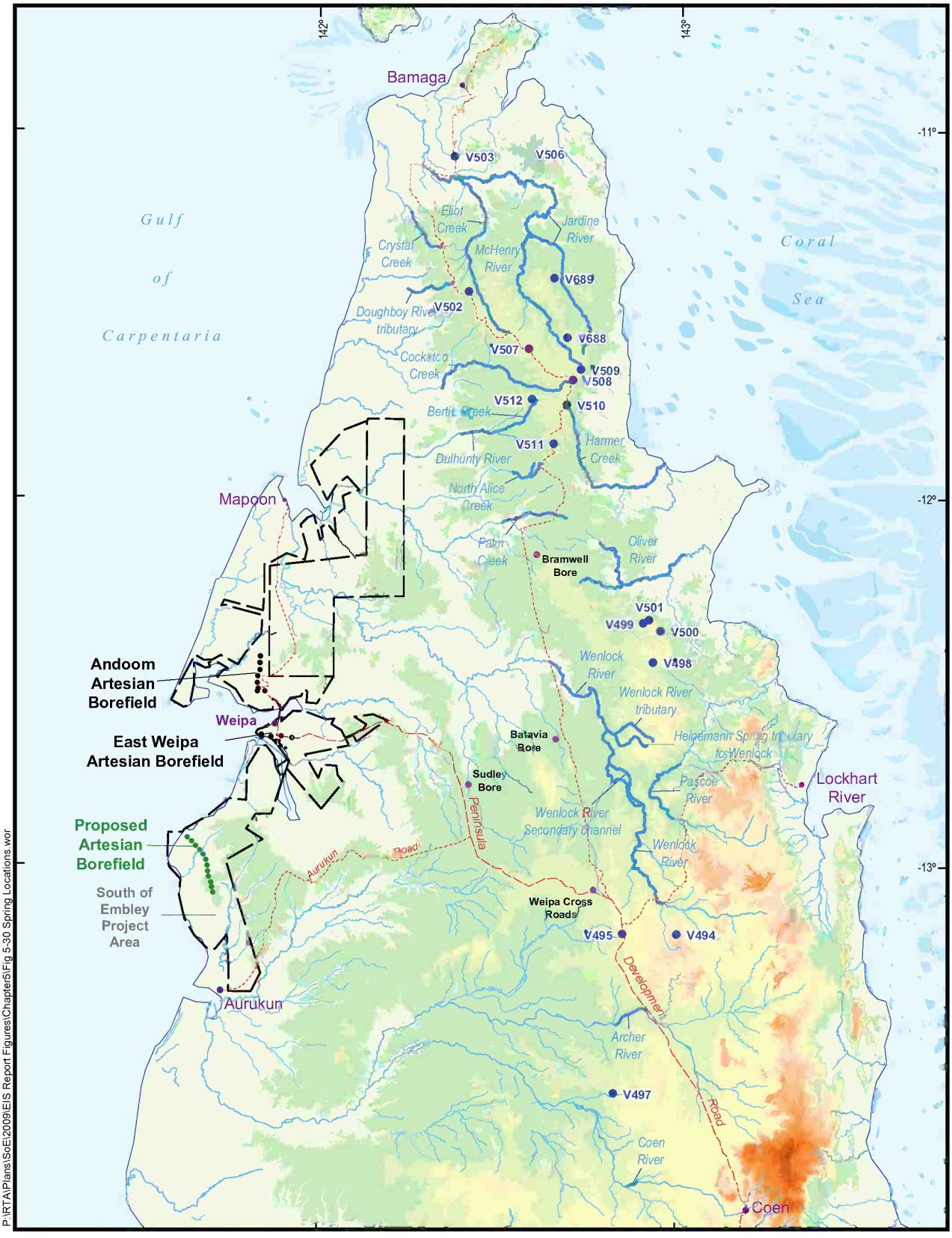
Existing Groundwater Monitoring Network

A Water Licence condition is that taking of water by RTA must not lower piezometric levels in monitoring bores located at Bramwell, Batavia Downs Homestead or Weipa Crossroads by more than five metres. To meet Water Licence conditions and internal RTA objectives, a borefield monitoring network has been installed at Andoom and at various locations throughout the Cape York region (refer **Figure 5-30**). The monitoring bores and their status are listed in **Table 5-25**.

Table 5-25 Artesian Aquifer Monitoring Bores

Bore ID	Status
ART 4 Bore	Former production bore at East Weipa, now monitoring bore
ART 5 Bore	Former production bore at Andoom, now monitoring bore
Sudley Station Bore	Artesian, east of Project area
Batavia Downs Bore	Sub-artesian, east of Project area
Weipa Crossroads Bore	Sub-artesian, east of Project area
Bramwell Station Bore	Sub-artesian, east of Project area

The majority of monitoring bores were pre-existing production bores which were retrofitted with either pressure gauges and dataloggers or downhole level sensors and dataloggers. The Weipa Crossroads bore and the Bramwell Station bore were constructed by RTA specifically as monitoring bores. Logging of production bore data is carried out through the telemetry system. Submersible data loggers with long-term storage capabilities have been installed at the non-production bores.



P:\RTA\Plans\SoE\2009\EIS Report Figures\Chapter5\Fig 5-30 Spring Locations.wor

Lease boundary
Township
River / Creek
Road / track
Recharge Spring
Watercourse springs
Monitoring Bore
Production Artesian Bore
Proposed Artesian Bore

South of Embley Project

Fig. 5-30: Spring Locations

N

0 50km

Datum/Projection: GDA94/MGA Zone 54 Date: 14/07/2010

5.3.5 Artesian Groundwater Quality

Five artesian monitoring bores were sampled in September 2006; results are detailed in **Table 5-26**, including one bore from the existing Andoom borefield (Art 7).

In general, artesian water quality is variable across the sampling sites and is summarised below.

- pH ranged from 4.7 to 8.3.
- Artesian water is generally brackish with EC ranging from 1,800µS/cm (Art 7) to 16,000µS/cm; however, 330µS/cm was recorded at Batavia Downs.
- The concentration of cations and anions are variable across locations as the concentration of calcium ranged from 7 to 1,060mg/L and magnesium ranged from 0.2 to 300mg/L.
- Artesian water sampled from Sudley, Batavia Downs and Andoom was of low hardness (<50mg/L$CaCO_3$); however, hardness was 460mg/L $CaCO_3$ and 1,060mg/L $CaCO_3$ in water from Weipa Cross Roads and Bramwell Station, respectively. Elevated hardness corresponds with chloride, sodium and total dissolved solids concentration in water. The use of artesian water must be monitored as high chloride has an undesirable impact on the bauxite refining process.
- The concentration of dissolved iron ranged from <100 to 2,000µg/L.
- The concentration of dissolved manganese ranged from 40 to 1,500µg/L.

Table 5-26 Artesian Water Quality

Parameter	Units	Sudley Station	Weipa Crossroads	Bramwell Station	Batavia Downs	Art 7 – Andoom
pH	pH	8.2	4.7	6.9	7.1	8.3
Electrical Conductance	µS/cm	2,800	8,000	16,000	330	1,800
Calcium	mg/L	16	460	1,060	8.6	7.2
Magnesium	mg/L	0.8	1.3	300	1.8	0.2
Carbonate Alkalinity	mg/L as CaCO3	<0.1	<0.1	<0.1	<0.1	<0.1
Hardness – Total	mg/L	43	1,000	4,000	29	19
Chloride	mg/L	620	2,200	5,100	36	310
Alkalinity – Total	mg/L CaCO3	490	<0.1	160	94	320
Fluoride	mg/L	1.4	NA	NA	0.2	2.3
Hydroxide Alkalinity	mg/L OH	<0.1	<0.1	<0.1	<0.1	<0.1
Potassium	mg/L	3.7	17	27	15	6.5
Sodium	mg/L	640	1,340	2,130	43	390
Solids – Total Dissolved	mg/L	1,500	5,100	11,000	190	980
Sulphate	mg/L	2.9	851	768	10	66
Iron – F (dissolved)	µg/L	400	2,000	<100	400	200
Iron – Total	µg/L	600	13,000	12,000	1,700	400
Manganese – F (dissolved)	µg/L	60	100	1,500	60	40
Manganese – Total	µg/L	60	140	2,100	70	40

5.4 Groundwater – Potential Impacts and Mitigation Measures

5.4.1 Shallow Aquifer

Mining may have the potential to affect the shallow aquifer in two ways:

- alterations to the surface drainage regime by the creation of internally draining post-mining landform may lead to changes in the shallow aquifer response; and
- removal of a portion of the lateritic bauxite strata that may host the aquifer.

The AWBM modelling of mining impacts has shown (refer **Section 5.2.4**) that mining has a temporary impact on the partitioning of surface runoff and baseflow and that, as rehabilitation matures, the overall hydrological regime at a catchment scale returns toward an "undisturbed" situation. The main reason change due to mining has a small impact is that direct surface runoff from the bauxite plateau is a very small proportion of incident rainfall (<1%); hence, redirection of surface flow does not greatly alter aquifer recharge characteristics.

The removal of bauxite would only have the potential to change discharge from the shallow aquifer in situations where the bauxite is an appreciable source of baseflow. Typically in the Project area, the water table is within the bauxite only at the height of the wet season, if at all. In the dry season the water table generally falls to 4 to 8m below the base of the bauxite. Streamflow during the dry season tends to be maintained by baseflow originating predominantly from kaolinitic strata. The overall effect of mining on the baseflow and deep baseflow component of the water balance is very small (**refer Section 5.2.4)**.

Monitoring and management commitments related to the shallow aquifers are described in Section 3.5 of the draft Environmental Management Plan (EM Plan) (**Section 21**).

5.4.2 Artesian Aquifer

RTA proposes to install an artesian borefield that accesses the Gilbert River Formation artesian aquifer, as part of the Project. The artesian water would form one component of the water supply for the Project (refer **Section 5.2.1**). RTA has an existing artesian Water Licence for 9GL per annum which allows abstraction from bores located on ML7024. RTA has applied to increase this artesian allocation to cover the increase in artesian demand arising from the Project. RTA proposes that the Water Licence be based on a five-year moving average of 12GL per annum, with a maximum of 15GL in any one year.

The general location of the proposed artesian borefield is shown in **Figure 5-30**. It is expected that no more than 12 artesian bores would be required to achieve the planned abstraction rates.

From experience of discharge rates at East Weipa and Andoom, it is expected the individual bores would be capable of delivering 80 to 100L/s with built-in standby redundancy. The exact locations of the bores would be determined at design stage to ensure the bores are sufficiently well spaced to prevent interference. The assumed design bore availability is 7,800 hours per year.

The potential drawdown impacts in the artesian aquifer at various stages over the life of the Project were assessed using the FEFLOW modelling package. The proposed abstraction scenarios, the model code, development and calibration and the potential drawdown impacts at existing production and monitoring bores are discussed below.

Groundwater Modelling

Assessment of two proposed abstraction scenarios was carried out using the FEFLOW modelling package, an industry-standard software for simulation of groundwater behaviour. All modelling was undertaken by Golder Associates Pty Ltd. The model was developed on behalf of RTA, and is in active use as part of the operational planning of Andoom and East Weipa. It is regularly updated in response to new field information from ongoing pumping tests and with data extension from updated monitoring records.

Abstraction Scenarios

The potential impacts of artesian groundwater abstraction were modelled under two different scenarios:

- a constant 12GL per annum over the 40-year mine life (the "12 GLpa scenario")
- 12GL per annum for the first 13 years and then 18GL per annum for the remainder of the 40-year mine life (the "18GLpa scenario").

The 12GL per annum scenario was used to determine the maximum potential impact under the proposed licensed abstraction regime. The 18GL per annum scenario was modelled to obtain an indication of the upper bounds of aquifer sustainability.

Table 5-27 lists the abstraction scenarios tested in the FEFLOW model. For each scenario, the same initial conditions apply. It was assumed that simulation Year One coincides with start of operations in 2013. The start of operations was nominally set at 2013 for the purposes of modelling. The initial conditions were simulated for 2012 based on historical data and from simulation of predicted usage between 2009 and 2012. That is, the model predicted the most likely and representative conditions expected to prevail by 2012 – these were then applied as the initial conditions for the tested scenarios. Mean recharge conditions were applied throughout each scenario simulation. The model was run in each trial for a further 70 years beyond the abstraction period to estimate the progress of the aquifer recovery following mine closure.

Table 5-27 Abstraction Scenarios

Scenario	Year 1 – Year 13		Year 14 – Year 40	
	Andoom/Weipa Borefield Abstraction (GLpa)	SoE Borefield Abstraction (GLpa)	Andoom/Weipa Borefield Abstraction (GLpa)	SoE Borefield Abstraction (GLpa)
12 GLpa	6	6	0	12
18 GLpa	6	6	0	18

Model Code

FEFLOW (version 5.3), is a finite element groundwater modelling package developed by WASY Institute for Water Resources Planning and Systems Research in Berlin, Germany. It has the following attributes:

- capability to simulate seepage flow in conditions dominated by irregular geological structure;
- ability to represent complex boundary conditions;
- capability to present distributions output in a range of different formats;
- ability to incorporate transient physical changes to the host aquifer, including excavation or the placing of tailings, for example; and
- an enhanced capability to represent 3D geometry accurately provides the following as primary computed results;
- hydraulic head distributions;
- pressure distributions; and
- flow distribution.

These can be reproduced for steady-state or transient conditions at any point within the simulated extent of the aquifers.

Model Mesh

The model mesh is shown in **Appendix 5B Figure 1**. It is bounded by the Great Dividing Range in the east. The north, south and west boundaries are set at a distance far enough away so as not to be affected by significant drawdown.

Recharge

It is believed the majority of the recharge occurs in the Great Dividing Range area via fractured sandstone in the Gilbert River Formation during rainfall events, particularly along watercourses. It is likely that higher recharge to the aquifer occurs in the Wenlock River area, and this is reflected in the model boundary conditions.

Recharge was based on data for the nearest rainfall gauge to the recharge area, which is located at Moreton Telegraph station. The average annual rainfall for this station is 1,390mm.

This record is conservative when compared to the continuous daily rainfall record derived from the Bureau of Meteorology SILO website's Data Drill database corresponding to a location in the Dividing Range recharge area. The Data Drill record at this location indicates an average annual rainfall value of 1,560mm. Data Drill accesses grids of data derived by interpolating the BoM's station records calculated by splining and kriging techniques.

Aquifer Properties

The initial aquifer hydraulic properties adopted in the model were based on values estimated from all available test pumping program results from production bores at East Weipa and Andoom. These parameters were then refined within acceptable bounds during the subsequent calibration process.

The model parameter distributions are generalised and extend over a wide area. Although they should not necessarily be expected to reflect the detailed conditions at single production bores or monitoring bores exactly, the storativities in the model were found after calibration to lie in the order of 10^{-6} to 10^{-4}, which is consistent with the pumping test results found using the Theis equation. Specific yield values are applied in the model to represent unconfined conditions where they occur during simulation.

The initial model parameter distributions were based on transmissivity values predicted from pumping tests. These distributions were then refined in a calibration exercise, and yielded results in the borefield area for transmissivities that lie in the range 180 to 300m^2/d. The pumping test results, when analysed using the Theis equation, tend to predict higher values (typically in the range 300 to 500m^2/d) for the individual production well sites because they are localised values estimated using analytical approaches to estimation. These analytical approaches are substantially different to the finite element modelling approach, which provides generalised values over a larger area. The outputs from the analysis of the individual tests are shown in **Appendix 5B Figures 2** to **9.**

Initial Conditions

Simulation starts from aquifer conditions based on the expected state of the aquifer at Year 1 (i.e. approximately 2013). To derive these conditions, the model is run from the time of the earliest aquifer development in the Weipa area, which took place around 1971. A steady-state model was developed in the first instance to simulate the original heads prevailing at 1971. It was then run for the period between 1971 and 2008 using the best estimates and known discharge details for the bores in both the Andoom and East Weipa borefields during this period. Finally it was run for predicted extraction rates for the period from 2008 to 2012. Hence the resulting simulation of aquifer conditions provides a representative starting point for the transient trials that investigate long-term borefield usage.

Boundary Conditions

The applied boundary conditions included recharge at the Great Dividing Range and a no flow boundary heads to the west. Geophysical information received recently indicates the Gilbert

River formation, which is host to the aquifer, pinches out in the Gulf of Carpentaria at a depth in excess of ~1,000m, about 150 to 180km to the west of Andoom.

No flow boundaries are applied at the northern and southern margins of the model domain, coinciding with groundwater flow lines which are assumed to be approximately aligned to an east-west direction.

Steady-State Calibration

The steady-state calibration carried out to simulate the natural conditions assumed prior to the East Weipa borefield development in 1971 considered recharge entering the aquifer in the Great Dividing Range area, and refinement of the aquifer parameters that have been collated from available pumping test information.

The aquifer parameters and the recharge applied over the exposed extent of the Gilbert River sandstone was varied in parameter estimation software (PEST).

The model boundary conditions include nodes corresponding to locations along the riverbed alignment, to represent the Wenlock River over the outcrop area. Potential river losses would recharge the artesian aquifer. These losses are predicted by the model on the basis of the relative groundwater head and river level, and the estimated river permeability.

Model calibration trials indicate the average direct rainfall recharge rates are approximately 1.1mm/year over the area.

Observed heads applied in the calibration were taken from representative estimates for East Weipa bores ART1 to ART4, based on bore construction completion records. The calibrated steady-state head distribution for the natural conditions prevailing prior to development in 1971 is shown in **Appendix 5B Figure 10.**

Transient Calibration

Transient calibration of the model was carried out using the steady-state initial conditions described previously based on relevant recorded data. Comparisons were made between available observed head data from monitoring and production bores for the wider area representative of transient conditions. Representative output for these calibrations are plotted as time series plots for the period subsequent to 1971, and are shown in **Appendix 5B Figures 11 to 18.**

As part of the calibration exercise to simulate the pumping test conditions, the model was used to estimate local and regional aquifer parameters being determined by the test.

Long-term time series plots, which show comparisons with field values monitored at different times over the 26-year period, indicate the model shows reasonable agreement with field conditions.

A summary of the parameter extents for hydraulic conductivity and storage used in modelling is provided in **Appendix 5B Figures 19 and 20** respectively.

The monitoring program, which is now well-established as part of the management of the Andoom borefield, is important for providing information on the resource with representative data on the state of both temporal and spatial conditions. This information is essential for calibration of the model and would provide a valuable check on model performance over time.

Modelling Simulation Results

The predicted relative drawdown for each scenario at the existing East Weipa and Andoom borefield and the monitoring bores is discussed below.

The existing Water Licence requires that drawdown does not exceed 5m at Bramwell Station, Batavia Downs and Weipa Crossroads monitoring bores. The FEFLOW model was used to predict relative drawdown for each abstraction scenario and determine whether current Water Licence conditions would be met.

The drawdown for each scenario described in **Table 5-27** is defined here as the difference in simulated aquifer head relative to simulated baseline conditions where no abstraction takes place; i.e., a baseline scenario is simulated in which there is no abstraction. The results of each scenario are then compared to this baseline, with the difference between the two data sets being the relative drawdown. The drawdown calculated in this way will then represent the direct influence of the proposed abstraction scenario only.

The predicted relative drawdown for each abstraction scenario at various time steps is shown in **Table 5-28**. Drawdown hydrographs for these locations over the full simulation period are provided in **Appendix 5B Figures 21 to 26**.

The drawdown contours for the 12GL per annum scenario at the end of mine life (Year 40) are shown in **Figure 5-31.** Predicted drawdown contour maps related to other years for 12GL per annum scenario are presented in **Appendix 5B Figures 27 to 31** and **Figures 32 to 36** for the 18GL per annum Scenario.

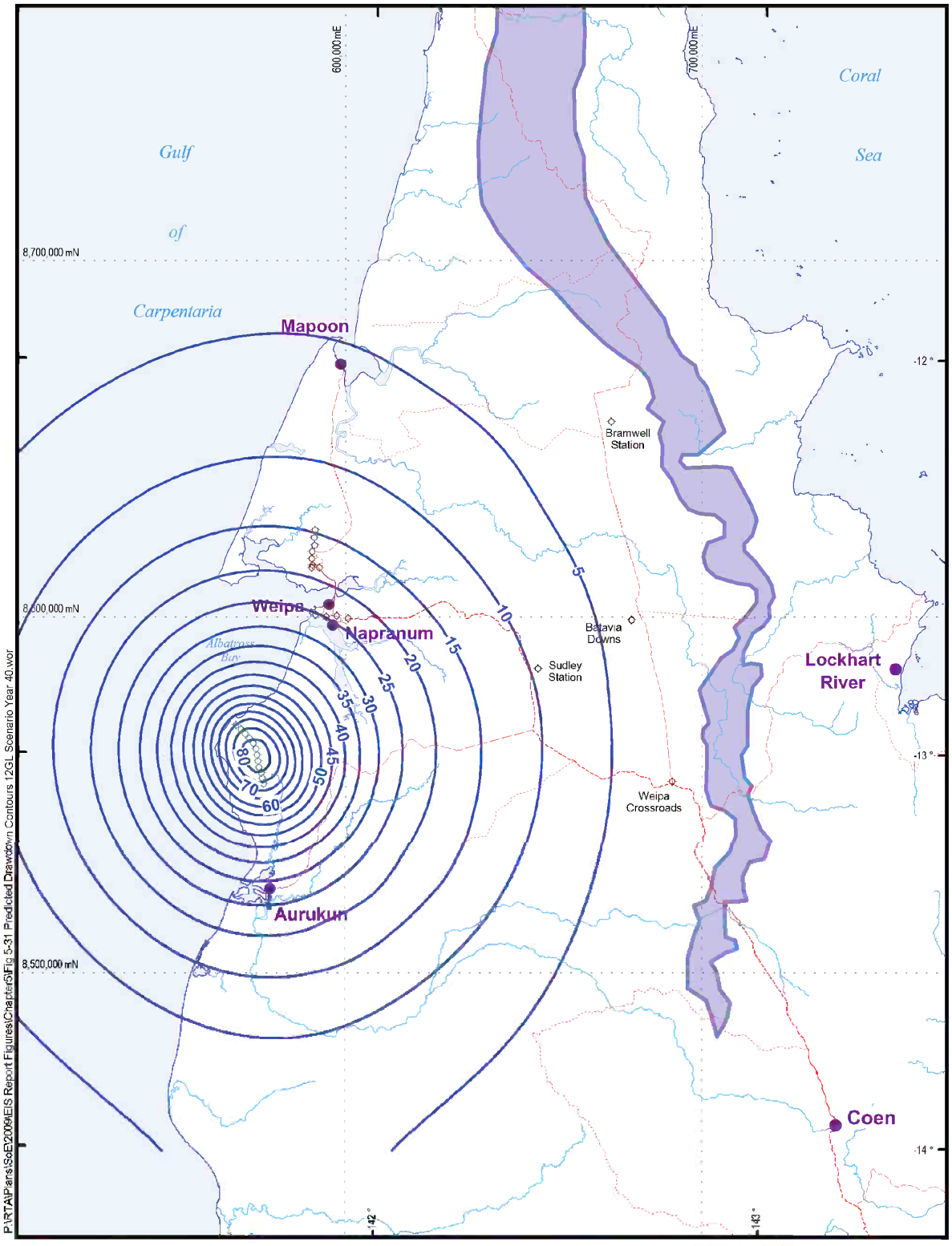
Table 5-28 Predicted Drawdown

12 GLpa Scenario		Drawdown Relative to Baseline Scenario (m)					
Year From Start of Simulation	Year	Andoom Borefield	SoE Borefield	Bramwell Station Bore*	Batavia Downs Bore*	Sudley Station Bore	Weipa Crossroads*
1	2013	78.6	22.9	0.0	0.0	0.0	0.0
13	2026	26.3	46.1	0.3	1.0	3.4	0.2
40	2053	18.4	71.0	1.0	3.2	9.4	1.5
90	2103	6.1	7.9	1.1	1.9	4.1	1.2
110	2123	4.5	6.0	0.9	1.4	2.9	1.0
18 GLpa Scenario		**Drawdown Relative to Baseline Scenario (m)**					
Year From Start of Simulation	Year	Andoom Borefield	SoE Borefield	Bramwell Station Bore*	Batavia Downs Bore*	Sudley Station Bore	Weipa Crossroads*
1	2013	78.6	22.9	0.0	0.0	0.0	0.0
13	2026	26.3	46.1	0.3	1.0	3.4	0.2
40	2053	25.1	120.0	1.1	4.1	12.5	2.0
90	2103	8.2	10.4	1.3	2.5	5.5	1.6
110	2123	6.0	7.8	1.1	2.9	3.9	1.3

* Water Licence compliance monitoring bore

The existing Water Licence requires that drawdown does not exceed 5m at Bramwell Station, Batavia Downs and Weipa Crossroads monitoring bores. The modelling results show that for both the 12 and 18GL per annum scenarios the maximum drawdown occurs in about Year 50 (2063). The predicted drawdown contours for the 12GL per annum scenario at Year 40 (refer **Figure 5-31**) shows that, at about the year of maximum drawdown, drawdown was less than 5m at the Water Licence compliance monitoring bores. The modelling results for those three monitoring bores show that, for the proposed licensed abstraction of 12GL per annum, the maximum drawdown occurs at Batavia Downs bore (3.75m at Year 50, refer **Appendix 5B Figure 24**). The maximum drawdown at the other two monitoring bores was less than 2m (refer **Appendix 5B Figure 23** and **Appendix 5B Figure 26**).

The modelling results indicate that under the proposed licensed abstraction regime the existing Water Licence condition relating to maximum relative drawdown would be met. The modelling also predicted that the existing Water Licence condition relating to maximum relative drawdown would also be met for a 18GL per annum scenario, with the maximum drawdown of 4.95m occurring in 2063 (year 50) at Batavia Downs. The results indicate that the aquifer could sustainably support abstraction rates greater than the proposed rate of 12GL per annum.



Recharge area
Township
River
Road/track
Existing Borehole
Proposed Borehole

South of Embley Project

Fig 5-31:
Predicted Drawdown Contours
12 GL per Annum Scenario Year 40

0 50km

Datum/Projection: GDA94/MGA Zone 54 Date: 14/07/2010

The Rolling Downs Group separates the shallow and artesian aquifers with a 500m thick confining layer of low hydraulic conductivity. Abstraction of artesian groundwater is not expected have any impact on the shallow aquifer.

Spring Factors

Section 39 of the GAB-ROP (DNRW 2007) prescribes conditions that must be met for the chief executive to make a decision about a Water Licence, if the decision is associated with a management unit connected to a spring, and the water is for purposes other than domestic and stock watering. A decision associated with abstraction from a management unit connected to a spring is subject to the cumulative spring factor not exceeding 400mm head of water. The GAB-ROP (DNRW 2007) prescribes how the spring factors are to be calculated.

The proposed artesian groundwater abstraction from existing and proposed new bores would take water from the Gilbert River Formation, which is connected to watercourse and recharge springs. The spring factors for the closest recharge and watercourse springs have been calculated to demonstrate that cumulative spring factor limit of 400mm is not exceeded for any of the existing or proposed new bores.

Table D-1 and Table D-2 of the GAB-ROP (DNRW 2007) must be used to determine the spring factor for each spring:

- Table D-1 is used to associate regions to transmissivity groups (TG); and
- Table D-2 provides multiplying factors according to the TG, distance and spring type to calculate cumulative spring factors.

Table D-2 is reproduced as **Table 5-29**.

Table 5-29 Spring Factor Multipliers from GAB-ROP

Table D-2. Spring factor multipliers

Column 1	Column 2			Column 3		
Distance (kilometre)	Spring factor multiplier for recharge and watercourse springs			Spring factor multiplier for discharge springs		
	TG- 50	TG-150	TG-250	TG-50	TG-150	TG-250
5	15.28508	6.67424	4.44776	25.25164	10.01124	6.45172
10	9.4634	4.68536	3.24852	19.23328	8.0002	5.24448
20	4.24556	2.76844	2.07556	13.28132	5.99656	4.03992
40	0.81688	1.1108	1.00128	7.5866	4.02228	2.846
60	0.11384	0.43412	0.49552	4.5996	2.9088	2.16276
80	0.0104	0.15416	0.2364	2.80004	2.1608	1.6936
100	0.0006	0.0484	0.1062	1.6776	1.6214	1.34532
120	0	0.01324	0.04436	0.97932	1.21904	1.07588
140	0	0.00312	0.01708	0.5536	0.91412	0.86252
160	0	0.00064	0.00604	0.30184	0.6816	0.69136
180	0	0.00012	0.00196	0.15824	0.50432	0.55304
200	0	0	0.00056	0.0796	0.36976	0.44092
220	0	0	0.00016	0.03832	0.26828	0.34996
240	0	0	0.00004	0.01764	0.19248	0.2764
260	0	0	0	0.00776	0.13644	0.217
280	0	0	0	0.00328	0.09552	0.16932
320	0	0	0	0.00048	0.04496	0.101
360	0	0	0	0	0.02004	0.05852
400	0	0	0	0	0.0084	0.03284
450	0	0	0	0	0.0026	0.01524
480	0	0	0	0	0.00124	0.00936
500	0	0	0	0	0.00072	0.00668
560	0	0	0	0	0.00016	0.00232
580	0	0	0	0	0	0.0016
600	0	0	0	0	0	0.00108
660	0	0	0	0	0	0.00032
700	0	0	0	0	0	0.00012
720	0	0	0	0	0	0.00008
780	0	0	0	0	0	0

Spring factors are calculated by multiplying the annual take of water in megalitres by the relevant spring factor multiplier determined from Table D-2. Where the actual distance between a spring and the bore is not shown in Table D-2, the spring factor multiplier can be determined on a pro-rata basis using the distances in Table D-2 that are the closest to the actual distance (DNRW 2007).

Spring Factor Calculation Results

Springs in the Cape 1 management unit are designated as either watercourse or recharge springs (not discharge springs) according to the definitions for spring types given in the GAB-ROP (DNRW 2007). Table D-1 of the GAB-ROP (DNRW 2007) indicates the relevant TG for the Cape 1 management unit is TG-50.

The watercourses and springs on the DERM spring register closest to the existing and proposed borefields are presented in **Table 5-30** with their respective calculated spring factors**.** The spring factors for the closest watercourse and recharge springs were calculated by multiplying the spring factor multiplier by the abstraction rate for the two abstraction rate scenarios (12,000ML and 18,000ML per annum).

Table 5-30 Spring Factors

Spring Type	Spring ID	Distance from Closest Borefield (km)	Closest Borefield	Spring Factor Multiplier (from Table D-2)	Spring Factor (mm Head of Water) (spring factor x abstraction rate)	
					12 GL/a	18 GL/a
Recharge	V512	110	Andoom	0.0003	3.6	5.4
Recharge	V511	107	Andoom	0.0004	4.8	7.2
Recharge	V499	113	Andoom	0.0002	2.4	3.6
Recharge	V498	112	East Weipa	0.0002	2.4	3.6
Recharge	V495	126	SoE	0	0	0
Recharge	V497	138	SoE	0	0	0
Watercourse	Palm Creek	84	Andoom	0.008	96	144
Watercourse	Oliver River	100	Andoom	0.0006	7.2	10.8
Watercourse	Wenlock River	87	Andoom	0.007	84	126
Watercourse	Wenlock River	94	East Weipa	0.004	48	72
Watercourse	Archer River	129	SoE	0	0	0
Watercourse	Coen River	154	SoE	0	0	0

The calculated spring factors represent the highest possible cumulative spring factor for each spring because the spring factors are calculated on the assumption that all the water is abstracted from the closest bore. The calculated spring factors are all well below the spring factor limit of 400mm head of water, demonstrating the spring factor requirement is met in all cases.

5.4.3 Regulatory Requirements

Water Licence Requirements

RTA has an existing artesian Water Licence under the *Water Act 2000* for 9GL per annum which allows abstraction from artesian bores located on ML7024, which access the Gilbert River Formation and Garraway Beds aquifers. RTA has applied to increase this artesian allocation to cover the increase in artesian demand arising from the Project. RTA proposes that the Water Licence be based on a five-year moving average of 12GL per annum, with a maximum of 15GL in any one year.

The decision to grant or amend a Water Licence is made by the chief executive administering the GAB-ROP (DNRW 2007), currently through the agency of DERM. The criteria used in deciding applications are outlined in Section 210 of the *Water Act 2000*.

Water Resource (Great Artesian Basin) Plan 2006

A primary purpose of the *Water Act 2000* is to advance sustainable management and efficient use of water and other resources by establishing a system for the planning, allocation and use of water. One of its main provisions is the development and implementation of Water Resource Plans for river basins in Queensland.

The Project area is located within the plan area of the *Water Resource (Great Artesian Basin) Plan 2006*, which will be referred to here as the GAB WRP. The GAB WRP applies to artesian water in the plan area and hence to the proposed increase in artesian allocation for the Project. The stated objectives for the GAB WRP are that water is to be allocated in a way that seeks to achieve a balance in the following outcomes:

- to protect the flow of water to springs and baseflow to watercourses that support significant cultural and environmental values;
- to provide for the continued use of all water entitlements and other authorizations to take or interfere with water;
- to reserve water in storage in aquifers for future generations;
- to ensure a reliable supply of water from the plan area; and
- to make water available for new users.

The GAB WRP deals with principles and objectives of the planning and management of water resources in the GAB. Details of how water management would be implemented to achieve those objectives are the subject of the GAB ROP (DNRW 2007).

Granting unallocated water from the State reserve

A new artesian allocation, or an increase in existing allocation, must be made from the State reserve. Section 25 of the GAB WRP states that unallocated water from the State reserve may only be granted for a project of State significance, a project of regional significance, or for town water supply purposes. The SoE Project was declared a project of State significance in November 2008 and is eligible for being considered for an allocation from the State reserve (which is limited to 10GL under Section 26 of the GAB WRP).

Section 18 of the GAB WRP states that in dealing with unallocated water the chief executive must consider, amongst other things, the impact the proposed taking of water may have on the flow of water to springs or baseflow to watercourses, artesian water pressure and subartesian water levels. The potential impact of the proposed taking of artesian water for this Project on groundwater levels is discussed in **Section 5.4.2**.

Protection of flow to springs and baseflow to watercourses

Section 12 of the GAB WRP states that Water Licences in the plan area must be consistent with the criteria for the protection of the flow of water to springs and baseflow to watercourses stated in the GAB ROP (DNRW 2007). Criteria to protect the flow of water to springs are detailed in Section 3 of the GAB ROP (DNRW 2007). The two relevant criteria for the SoE Project are:

- for a management unit connected to a spring, the chief executive must not make a decision about a Water Licence that would increase the amount of water that can be taken from within 5km of that spring; and
- for a decision about a Water Licence associated with a management unit connected to a spring, the chief executive may make a decision about a Water Licence if the decision does not result in the cumulative spring factor for the spring exceeding 400mm of water head.

The distances for those recharge springs and watercourse springs within the Great Dividing Range that have the closest location to the existing and proposed borefields all greatly exceed 5km. The calculated spring factors (refer **Table 5-30**) are all well below the spring factor limit of 400mm head of water, demonstrating that the spring factor criteria are met in all cases.

Installation of artesian borefield

Development of bores required to extract water from an aquifer is an assessable development under the *Sustainable Planning Act 2009* (Qld). The Comalco Agreement Act permits 12 artesian bores under section 32(b) (or more with Minister's consent). It is expected that no more than 12 artesian bores would be required to achieve the planned abstraction rates.

5.5 Monitoring

5.5.1 Surface Water

A surface water monitoring program is proposed to provide an early indicator of potential impacts identified in **Section 5.2.5** for parameters identified in **Section 8.15.1**. Locations and parameters were assigned based on catchment, location within the catchment and proposed activities up and down gradient. Locations, rationale and parameters are summarised in **Table 5-31**. Locations would be monitored monthly until a statistical baseline is established (consistent with ANZECC requirements) and then quarterly thereafter. Locations are shown on **Figure 5-32**.

In addition, quarterly vertical salinity profiling of Norman Creek and Ward River upper estuaries is proposed to evaluate if the Project has had any impact on the freshwater–saltwater interface.

Aluminium, iron and manganese concentrations may potentially be affected by geochemical changes arising from Project impacts (e.g. dam seepage) or natural causes. Turbidity may be affected by mining activities. It is proposed to set Project-specific trigger values for these parameters.

Project-specific trigger values were adopted in accordance with the decision tree processes defined in ANZECC (2000) guidelines. Trigger values can be set as tabulated default trigger values, provided in ANZECC (2000) or as site-specific trigger values obtained from baseline concentrations. Site-specific trigger values based on data from the Project area are preferred over default values (which are usually used when site data is lacking).

It is proposed to set Project trigger values for dissolved aluminium, iron, manganese and turbidity based on the 80th percentile of the baseline data set for freshwaters. If, during operations, the median concentration of aluminium, iron, manganese or turbidity exceeds the Project trigger value, an investigation would be carried out to determine the possible cause.

For estuarine waters, it is proposed to set Project trigger values for aluminium based on the 80th percentile of the baseline data set for estuarine waters. If, during operations, the median concentration of aluminium exceeds the Project trigger value, an investigation would be carried out to determine the possible cause.

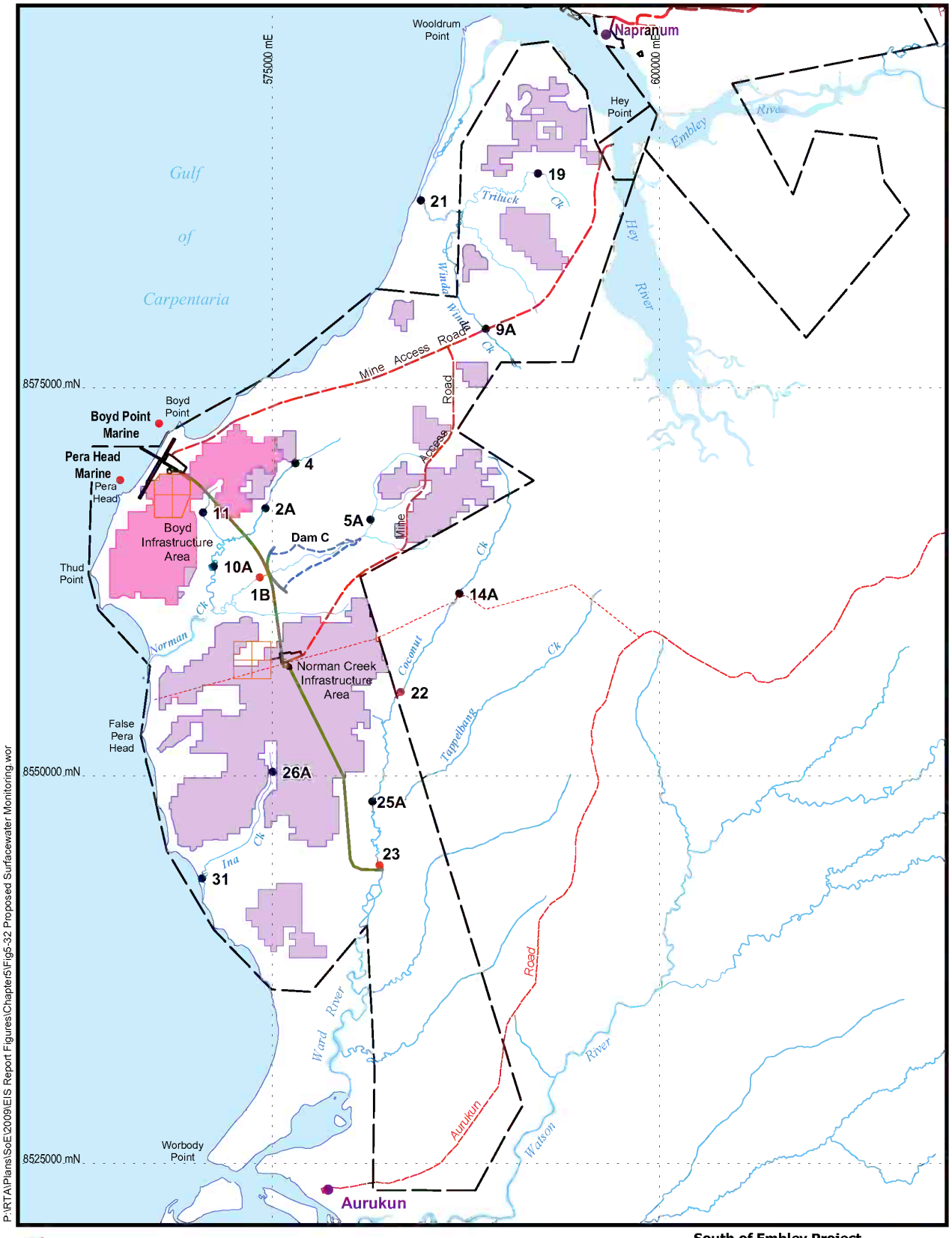
A trigger value is not proposed for pH as any fluctuations in pH would give rise to fluctuations in aluminium, iron and manganese and these are more appropriate environmental indicators. Dissolved oxygen would be monitored up and down gradient of the water supply dam to evaluate potential impacts. A trigger value is not proposed for electrical conductivity as bauxite mining would not contribute to any increase in salt levels in the environment. Lead, chromium, copper, nickel and zinc are not considered constituents of concern at the Project area (**Section 8.15.1**); however, concentrations may fluctuate with seasonal changes, particularly at the end of the dry season, and thus they would be monitored to confirm concentrations remain in normal ranges. All other metals are not considered constituents of concern at the Project area (**Section 8.15.1**). Concentrations of these metals were less than the laboratory reporting limit or very low, and the low concentrations do not fluctuate seasonally; therefore they would not be monitored.

Table 5-31 Proposed Surface Water Monitoring Program

Monitoring Location	Rationale	Type*	Parameters
Norman Creek estuary (10A)	Norman Creek Catchment. Upper Estuary. Down gradient of mining years 1–13.	E	EC, turbidity, Al, Cr, Cu, Fe, Pb, Mn, Ni, Zn.
Norman Creek (4)	Norman Creek Catchment. Freshwater. Up gradient of mining years 1–13.	F	EC, turbidity, Al, Cr, Cu, Fe, Pb, Mn, Ni, Zn.
Norman Creek (2A)	Norman Creek Catchment. Freshwater. Adjacent to area of mining years 1–13.	F	EC, turbidity, Al, Cr, Cu, Fe, Pb, Mn, Ni, Zn.
Norman Creek (11)	Norman Creek Catchment. Freshwater. Within mining years 1–13 and down gradient of tailings storage facility.	F	pH, EC, turbidity, Al, Cr, Cu, Fe, Pb, Mn, Ni, Zn.
Norman Creek upstream Dam C (5A)	Norman Creek Catchment. Freshwater. Up gradient of Dam C.	F	pH, EC, temperature, dissolved oxygen, turbidity, Al, Cr, Cu, Fe, Pb, Mn, Ni, Zn.
Norman Creek downstream Dam C (1B)	Norman Creek Catchment. Freshwater. Down gradient of Dam C.	F	pH, EC, temperature, dissolved oxygen, turbidity, Al, Cr, Cu, Fe, Pb, Mn, Ni, Zn.
Coconut Creek (14A)	Ward River Catchment. Freshwater. Up gradient, control location	F	EC, turbidity, Al, Cr, Cu, Fe, Pb, Mn, Ni, Zn.
Ward River upstream (22)	Ward River Catchment. Freshwater. New location on lease boundary	F	pH, EC, temperature, dissolved oxygen, turbidity, Al, Cr, Cu, Fe, Pb, Mn, Ni, Zn.
Ward River downstream (25A)	Ward River Catchment. Freshwater. Down gradient of mining.	F	pH, EC, temperature, dissolved oxygen, turbidity, Al, Cr, Cu, Fe, Pb, Mn, Ni, Zn.
Ward River at pump station (23)	Ward River Catchment. Freshwater. Down gradient of mining.	F	pH, EC, temperature, dissolved oxygen, turbidity, Al, Cr, Cu, Fe, Pb, Mn, Ni, Zn.
Winda Winda / Triluck Creek estuary (21)	Winda Winda / Triluck Creek Catchment. Lower estuary.	E	EC, turbidity, Al, Cr, Cu, Fe, Pb, Mn, Ni, Zn.
Triluck Creek (19)	Down gradient of future mining (years 14–40) Triluck Creek Catchment. Lower freshwater.	F	EC, turbidity, Al, Cr, Cu, Fe, Pb, Mn, Ni, Zn.
Winda Winda Creek (9a)	Winda Winda Catchment. Upper freshwater. Accessible and contains water during dry season.	F	EC, turbidity, Al, Cr, Cu, Fe, Pb, Mn, Ni, Zn.
Ina Creek (26A)	Ina Creek Catchment. Freshwater. Down gradient of future mining (years 14–40)	F	EC, turbidity, Al, Cr, Cu, Fe, Pb, Mn, Ni, Zn.
Ina Creek (31)	Ina Creek Catchment. Lower freshwater. Down gradient of mining area.	F	EC, turbidity, Al, Cr, Cu, Fe, Pb, Mn, Ni, Zn.
Boyd Point (Marine)	Marine. North of port. Adjacent to reef habitat.	M	Hydrocarbons, turbidity.
Pera Head (Marine)	Marine. South of port. Adjacent to sensitive habitat.	M	Hydrocarbons, turbidity.

F = freshwater streams, E = estuarine, M = marine, S = swamp

Streamflow gauging stations would be installed upstream and downstream of Dam C, as well as in two Norman Creek sub-catchments (one to be mined and one non-mined "control"). When the Ward River pump station is installed, a stream gauging station would be installed on the river in the vicinity of the pump.



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RTA Mining Lease boundary
Road/track
Town
Surface water quality sampling site
New surface water quality sampling site
Mining Years 1 -13
Mining Years 14 - 40

South of Embley Project

Fig. 5-32: Proposed Surface Water Monitoring Locations

N

0 10km

Datum/Projection: GDA94/MGA Zone 54 Date: 15/07/2010

5.5.2 Shallow Aquifer

A network of shallow groundwater bores would be maintained. Some of the existing bores are likely to be discontinued and replaced by new bores more closely aligned with the mine plan and positioned up-gradient and down-gradient of mining pits. Exact locations would be determined once the detailed mine plan is developed. Water levels would be measured manually on a monthly basis (subject to access).

5.5.3 Artesian Aquifer

RTA proposes to continue the current monitoring and reporting requirements under the existing Water Licence:

- quantity of water abstracted from production bores;
- artesian groundwater quality and changes in water quality;
- artesian groundwater levels and changes in groundwater levels; and
- drawdown levels in the recharge area (through monitoring bores at Bramwell Station, Batavia Downs and Weipa Crossroads).

As part of the original Water Licence application, RTA submitted to DNRM predictions of the impact of artesian groundwater abstraction on the artesian groundwater levels in the region. These predictions were derived from a numerical model. The current Water Licence requires RTA to regularly undertake the following:

- comparison of actual impacts on artesian groundwater levels to impacts predicted from modelling; and
- assessment of the need to update the model used to predict impacts on artesian groundwater levels and description of any updates made.

The current and proposed monitoring requirements in relation to abstraction quantities and groundwater levels are presented in **Table 5-32.**

Table 5-32 Monitoring Regime

Bore Type	Parameter	Frequency
Production	Instantaneous discharge rate	Continuous
Production	Accumulated usage	Continuous
Production	Discharge pressure	Continuous
Production	Groundwater head	Weekly
Monitoring	Groundwater head	Weekly

Logging of production bore data is carried out through the telemetry system and data from monitoring bores east of the Project area is captured in installed data loggers. The current bore monitoring regime would continue.

The FEFLOW model developed for the Project would continue to be regularly updated in response to new field information from ongoing pumping tests and with data from updated monitoring records.

Groundwater quality analyses of artesian water are required to be undertaken at least annually. This monitoring regime would continue. It is expected the groundwater quality analyses would include the following parameters: pH, electrical conductivity, colour, turbidity, total dissolved solids, total suspended solids, magnesium, manganese, calcium, sodium, potassium, fluoride, chloride, sulphide, iron, sulphate, carbonates, alkalinity and hardness.

Monitoring data and reporting would continue to be provided to the regulatory authorities that administer the *Water Act 2000* on a regular basis.

The monitoring program would be reviewed regularly and updated as required.

Environmental Impact Statement

for South of Embley Project

Section 6
Marine

6 MARINE

This section describes the existing physical and biological marine environment including water quality and sediment properties in the vicinity of the SoE Project area, the associated environmental values, and any potential impacts associated with the Project.

The general study area, used to describe the existing marine environment and predict the environmental impacts from the Project, includes:

- Albatross Bay (including rivers and creeks) bound by Jantz Point in the north and Pera Head in the south, and extending further south to Thud Point (refer **Figure 1-1**);
- Embley and Hey River estuaries; and
- an area extending 17km westward, offshore from Boyd Point.

This area includes all marine components of the Project including the proposed port site, the proposed spoil ground offshore of Boyd Point, the existing Albatross Bay spoil ground, the location for barge and ferry facilities at Hornibrook Point and Humbug Wharf in the Embley River, and the location for the proposed barge/ferry terminal in the Hey River.

The State Coastal Plan describes how the coastal zone is to be managed as required by the *Coastal Protection and Management Act 1995* (Qld). Within the State Coastal Plan, Regional Coastal Management Plans specify the policy framework at the regional level and identify key coastal sites requiring special management within the region. Of the 11 coastal regions identified for Queensland, four Regional Coastal Management Plans have been finalised and three are under development. Development of Gulf of Carpentaria and Cape York Peninsula Coast regional plans has not yet commenced.

Following public consultation and review of the 2002 State Coastal Management Plan, the draft Queensland Coastal Plan was released for public comment on 25 August 2009 and closed on 30 November 2009. Submissions made during this period are currently being considered. The Queensland Coastal Plan will replace the State Coastal Plan once finalised.

6.1 Physical Environment and Coastal Processes

6.1.1 Bathymetry

The bathymetry (seabed topography) from Boyd Point to Thud Point was surveyed by 3-D Marine Mapping Pty Ltd during August 2006. In the vicinity of the proposed port development between Boyd Point and Pera Head, the mapping identified an upper-beach perched below high cliffs. The existing beach profile and proposed wharf jetty structure are presented in **Figure 6-1**. The nearshore bathymetry contours indicate that depth increases rapidly offshore. The seabed falls from –3m to –12m at Lowest Astronomical Tide (LAT) over the first 500m, levelling to –16m approximately 2km from shore. Detailed bathymetry beyond 2km from shore, for the extent of the departure channel, has not been completed and is not proposed. Navigation charts indicate a uniform grade. Description of the seabed and bathymetry in the vicinity of key offshore areas, including the new spoil ground, entrance channel and Nine Mile Reef, is based predominantly on drop-camera video inspection.

The nearest substantial sensitive seabed features include reefs and outcrops at Boyd Point 2.8km north-east of the proposed port area and Pera Head 2km south-west. Isolated reefs also occur south of Pera Head to Thud Point (refer **Figure 6-18**). Satellite imagery indicates there may be numerous small reef outcrops between Thud Point and Aurukun; however their presence have not been verified via bathymetric survey due to their distance from the proposed Port site and very low likelihood of impact from turbid plumes generated by dredging.

Seabed features in the departure channel area have been investigated using drop camera video and essentially comprise open seabed with infrequent low density aggregations of soft corals or sponges.

The proposed new spoil ground located 17km (central point) offshore from Boyd Point is located in approximately 23m water depth to LAT and is locally characterised by a flat, unvegetated, soft sediment seabed. The spoil ground is proposed to have a radius of 0.5 nautical mile (nm). Drop camera video survey within and adjacent to the spoil ground did not identify any small scale features, such as patch reefs. The nearest substantial seabed feature to the proposed spoil ground is Nine Mile Reef which is located approximately 6km to the south-south-west.

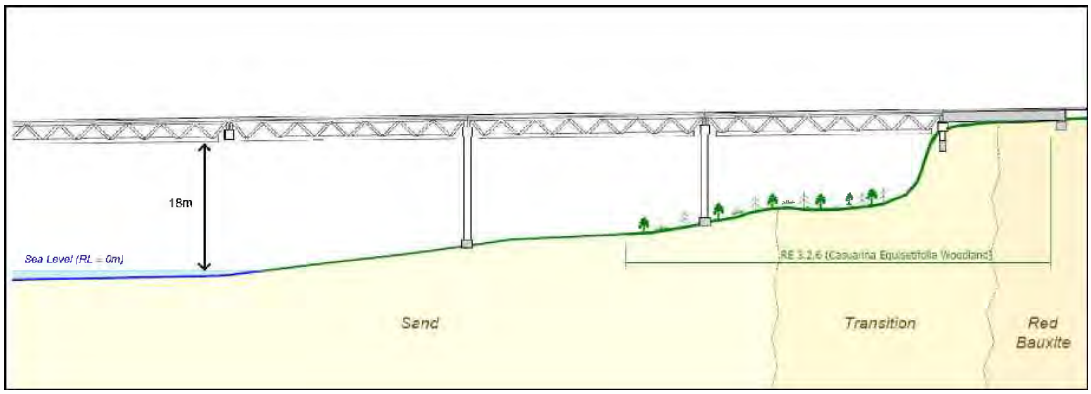


Figure 6-1 Beach Marine Profile and Proposed Jetty Structure.

6.1.2 Existing Coastal Processes and Hydrodynamics

Coastal processes and the hydrodynamics around the proposed port development area were assessed in the study using numerical models and analysis of collected field data. Currents, water levels, wave heights, plumes, and sediment transport were predicted with numerical models and compared against recorded data where practical. The predicted results were also used to ascertain the level of impact on the marine environment from proposed development in the coastal zone.

Full hydrodynamic modelling was undertaken using MIKE21 software (Danish Hydraulic Institute (DHI), a two-dimensional depth-integrated hydrodynamic modelling program. This software is an industry standard for modelling marine environments.

A large-scale hydrodynamic model of the Gulf of Carpentaria (referred to as the Outer model) and a fine-scale model around the proposed port development site (referred to as the Inner model) were developed (refer **Figure 6-2** and **Figure 6-3**). Bathymetry data from the following sources was used to assess coastal processes and hydrodynamics, sediment movement and turbidity effects from dredging at the proposed port and placement at the proposed new spoil ground:

- Australian Bathymetry and Topography Grid June 2005, Geoscience Australia;
- Australian Hydrographic Chart 410, Booby Island to Cape Wessel including the Gulf of Carpentaria. Scale 1:1,000,000 at Latitude 27°15';
- Australian Hydrographic Chart 376, Australia to Papua New Guinea. Scale 1:300,000 at Latitude 27°15'; and
- Hydrographic survey of the study site between Boyd Point and Pera Head to produce bed contours between –3 and –15m at one-metre intervals to LAT datum (3D Marine Mapping Pty Ltd).

Hydrodynamic modelling of dredging at Hornibrook ferry terminal, Humbug barge terminal and Hey River barge/ferry terminal and disposal at the Albatross Bay spoil ground was not undertaken given the relatively minor volumes to be dredged (i.e. approximately 19,000m^3, 10,700m^3 and 17,300m^3 respectively).

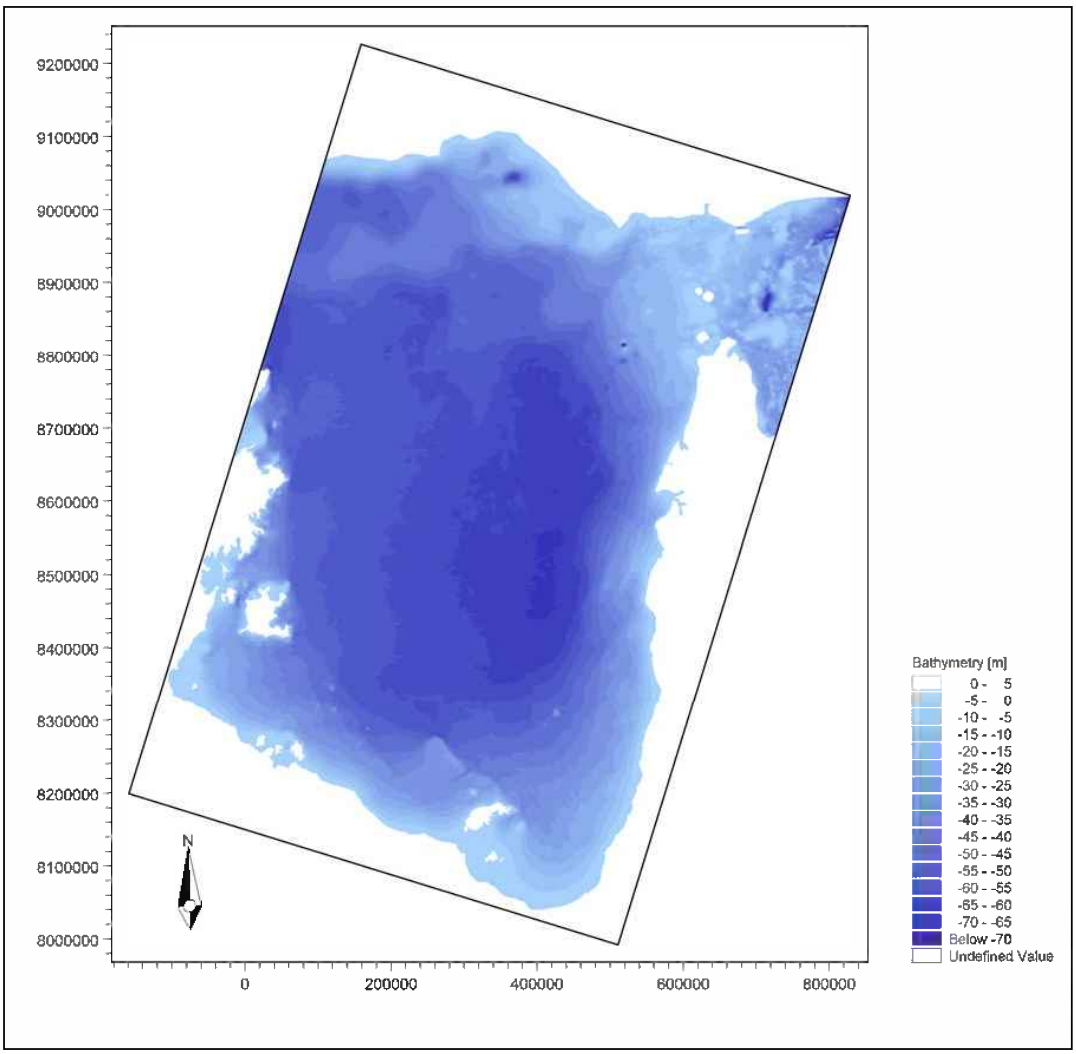


Figure 6-2 Gulf of Carpentaria Bathymetry and Model Boundaries

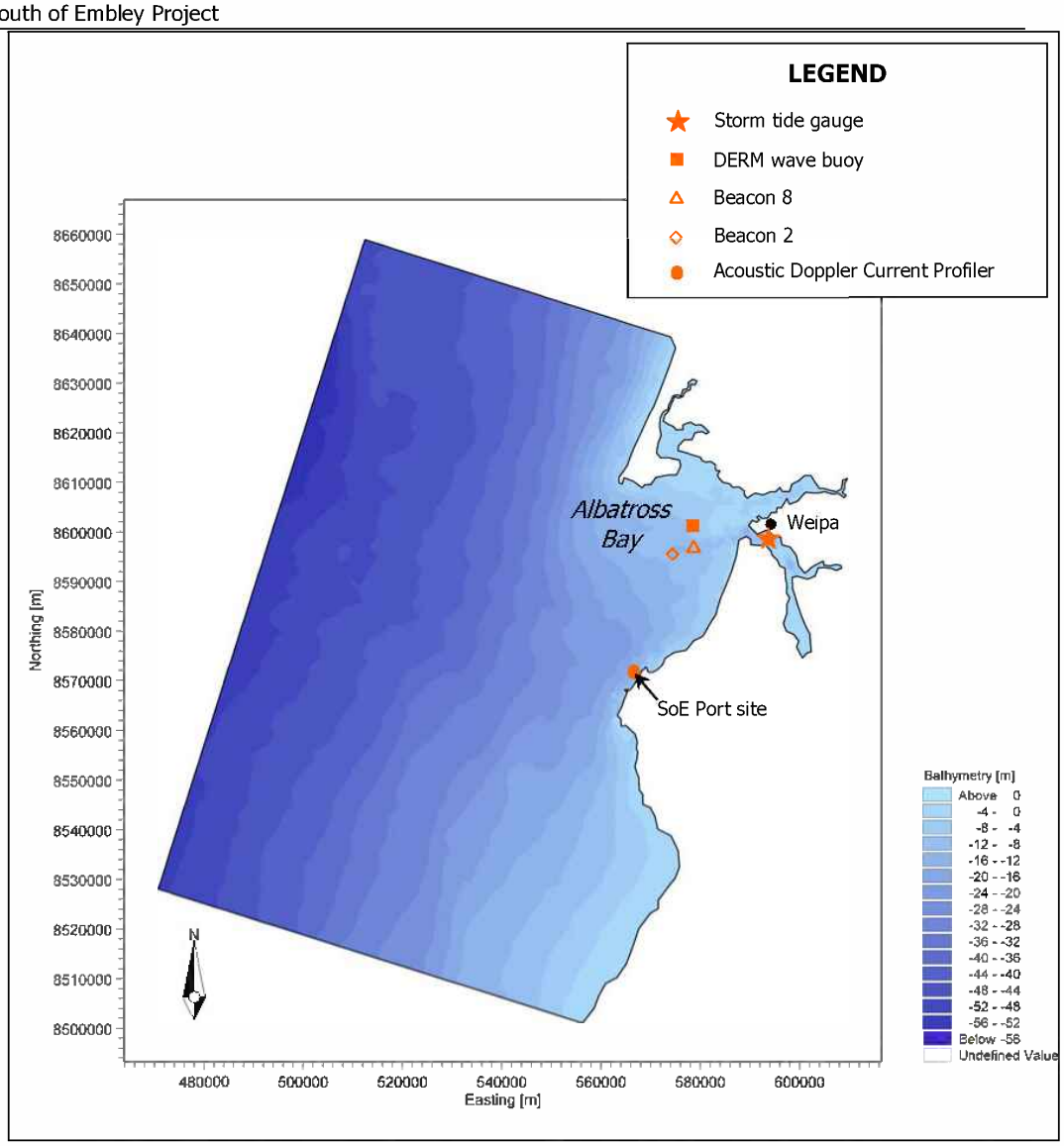


Figure 6-3 Inner Model Flexible Mesh Bathymetry and Model Boundaries with Observational Data Locations.

The Outer (Gulf) model has two open boundaries (refer **Figure 6-2**):

- the western boundary, which extends from Cape Wessel to the south-western tip of Dolak Island; and
- the eastern boundary, which extends from Shelbourne Bay to Bramble Cay.

Global tide model predictions, incorporating the major tidal constituents, were obtained at the outer model open boundary extents and are presented in **Figure 6-4**. The timing and magnitude of the tidal water level over the length of each open boundary was expected to show variation. This was represented in the model by applying a linear variation in predicted tide level between:

- Cape Wessel and Dolak Island for the western boundary; and
- Shelbourne Bay and Bramble Cay for the eastern boundary.

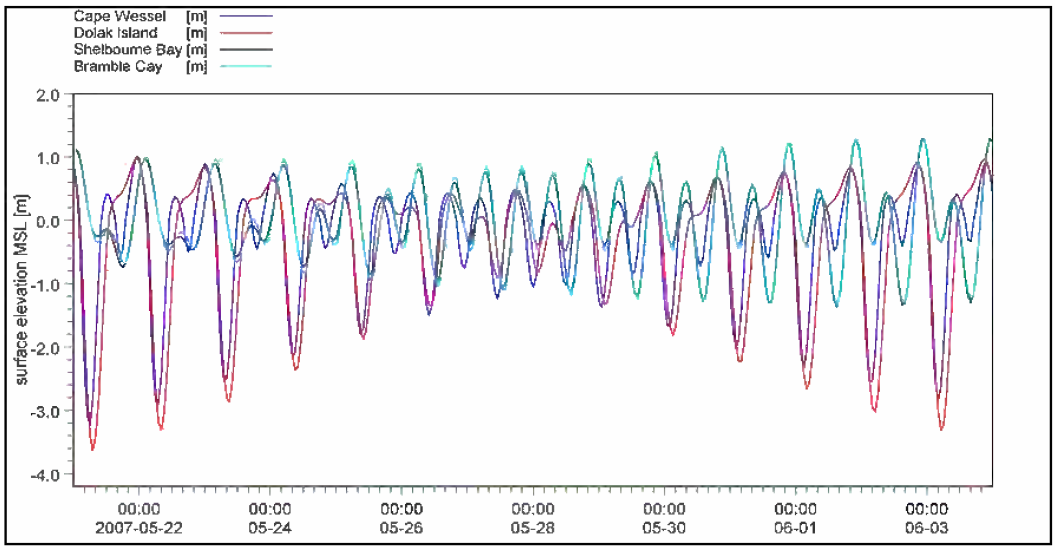


Figure 6-4 Global Tide Model Prediction at Outer Model Open Boundary Extents

Acoustic Doppler Current Profiler (ADCP) instrument deployment at the proposed port site (location indicated in **Figure 6-3**) provided measurements of current speed, current direction, and water level useful for hydrodynamic model verification. Additional water level data for the Weipa region collected by the Queensland Department of Environment and Resource Management (DERM, formerly the Queensland Environmental Protection Agency, EPA) was provided by Maritime Safety Queensland (MSQ). The data included both the Weipa storm tide gauge predictions and observations (May–June 2007) and a time-series (July–August 2003) of observational data from "Beacon 2", located toward the western extent of the existing Weipa shipping channel (refer **Figure 6-3**).

Three model simulations were performed, with each simulation covering a different observational data period. Outer model verification plots of MSQ observed/predicted versus simulated water levels are presented in **Figure 6-5** and **Figure 6-6**. Model verification at the Weipa storm tide gauge (May–June 2007) and at Beacon 2 (July–August 2003) was generally good in terms of the magnitude and timing of flood and ebb tide peaks, noting some over-prediction of peak water levels during neap tides. Small discrepancies between the observed and predicted water levels may be attributed to meteorological effects (e.g. atmospheric pressure or local wind effects) which are not typically included in the simulations during model development and/or the Outer model boundary conditions not incorporating the minor tidal constituents.

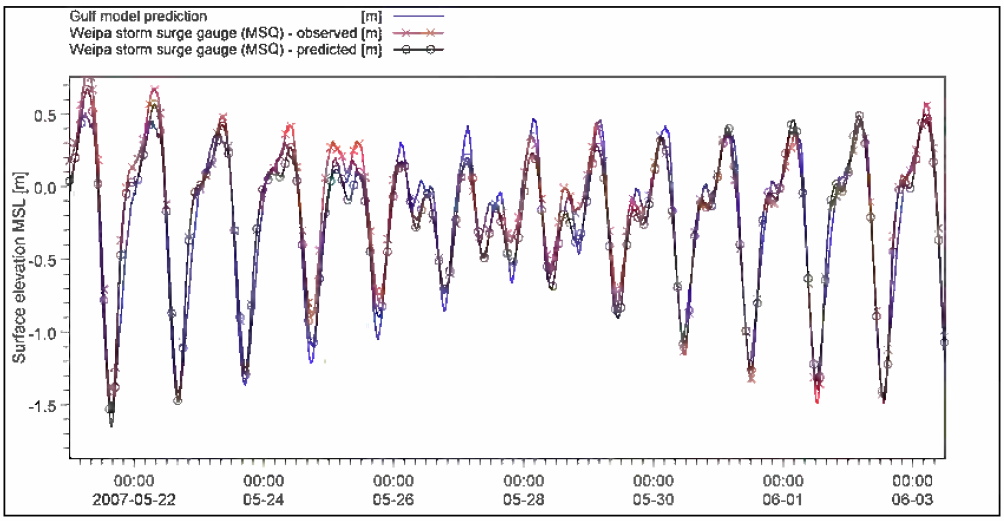


Figure 6-5 Outer Model Water Level Prediction Compared with Weipa Storm Tide Gauge

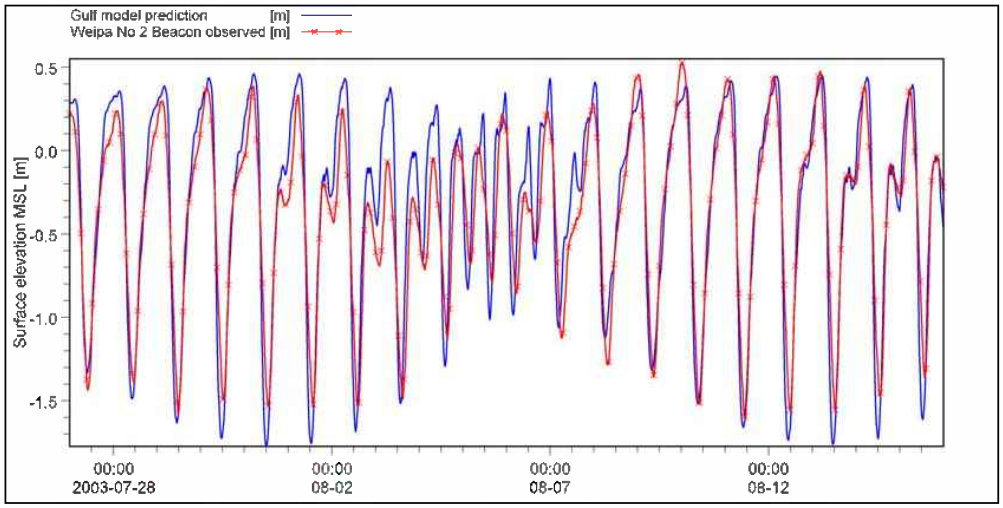


Figure 6-6 Observed Water Levels at Beacon 2 Compared with Gulf Model Prediction

Verification of the Inner model was achieved by comparing water level, and current speed and direction against measurements from the ADCP deployed at the Boyd Point site. Good agreement between measured and modelled hydrodynamics in the study area was found (refer **Figure 6-7**).

The Inner hydrodynamic finite-volume model (flexible mesh) was used in plume modelling and to quantify current speed and direction information to assess the potential impacts of turbidity, siltation, and sediment mobilisation as a result of dredging and disposal.

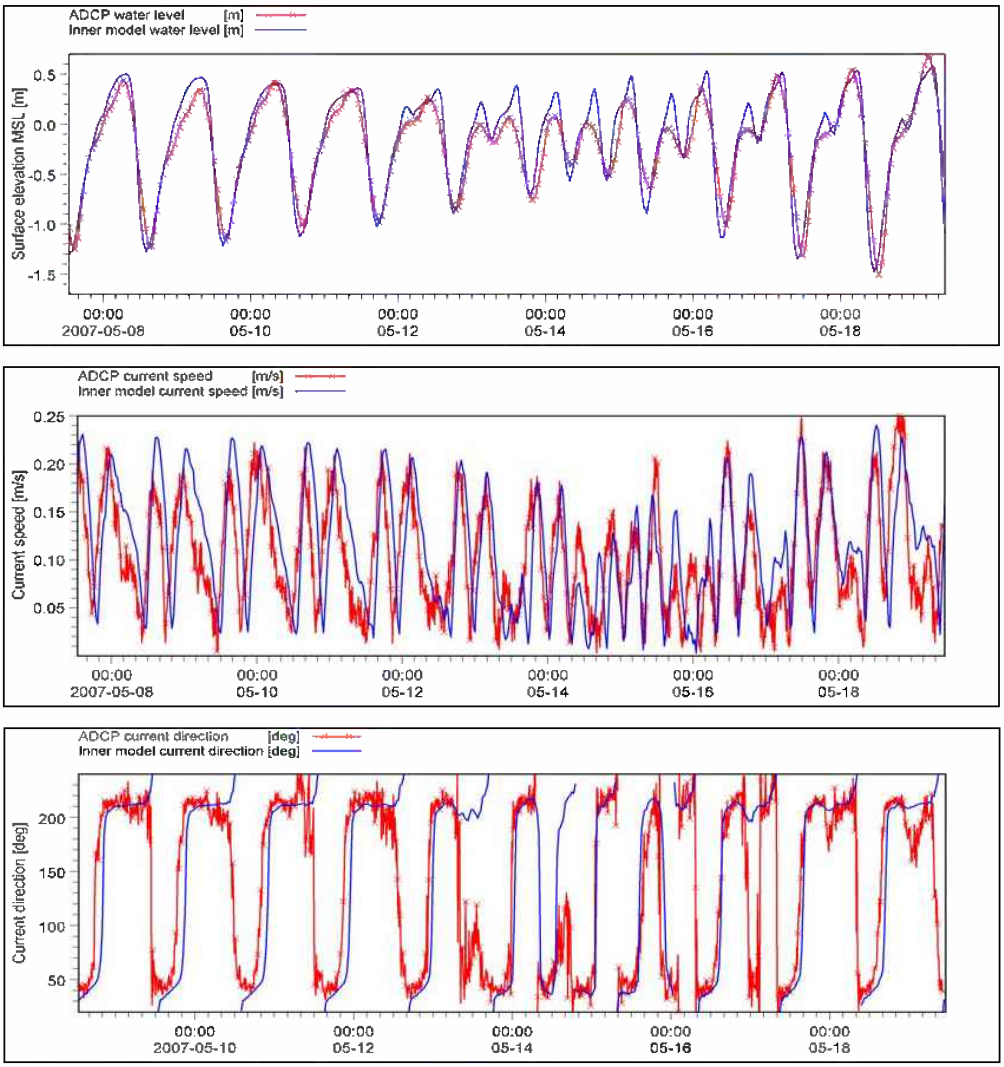


Figure 6-7 Measured (ADCP) Data Compared with Inner Model Prediction

Predicted peak flood (incoming) and ebb (outgoing) tide current vectors at the proposed port site are presented in **Figure 6-8** and **Figure 6-9**. Current vectors over the tide cycle indicate flow from the north-east or south-west depending on the tidal phase. Peak model currents are approximately 0.3m/s. ADCP measurements demonstrate the current speed is relatively uniform over depth.

The existing wave climate within the area is described in **Section 6.1.4** and the estimate of annual longshore sediment transport is reported on in **Section 6.1.5**.

The coastline between Boyd Point and Pera Head is relatively straight and has a bearing of 210º with respect to true north (i.e. 210°N). Above the water line the beach is relatively wide and contains a substantial volume of sand material. Nearshore beach slope immediately above and below the water line is steep inferring a reflective beach type (i.e. convex profile that reflects low wave energy).

Under existing coastal conditions, the shoreline either side of the proposed port development area appears to be uniform, inferring a balance of sediment supply in and out of the compartment.

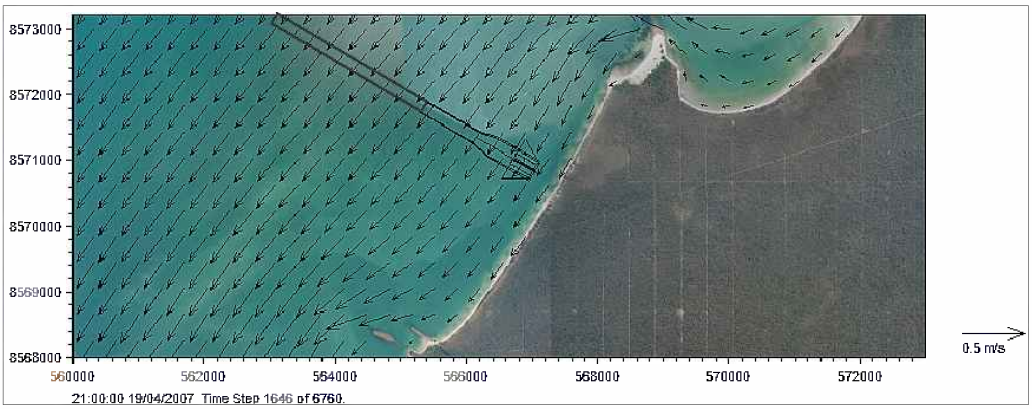


Figure 6-8 Predicted Peak Flood Tidal Currents at Proposed Port Dredging Area

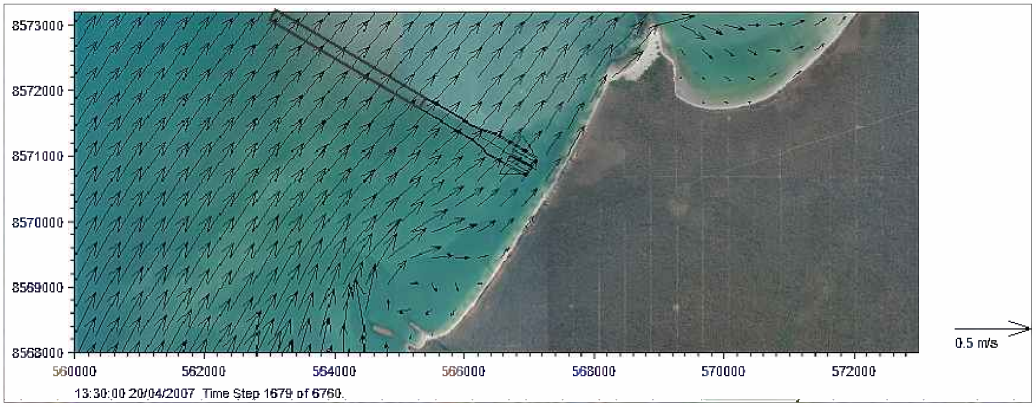


Figure 6-9 Predicted Peak Ebb Tidal Currents at Proposed Port Dredging Area

The supply of sediment to this part of the coast appears to originate from:

- nearby river systems such as the Embley and Archer River catchments;
- dunes and indurated sand and clay cliffs; and
- offshore marine sediments.

During severe storms, scarping or lowering of the existing beach profile is expected. The type of response will depend on the presence and depth of firmer underlying strata. During severe storms, when surge is combined with high tide, wave run-up will also erode the cliff at the back of the beach, transporting sediment into the littoral system.

Coastal process modelling was undertaken to assess the potential for shoreline change due to the construction of the proposed wharf and dredging. In particular, two aspects were analysed in detail to determine the influence on coastal processes:

- potential long-term changes to the alongshore profile and back-beach brought about by the required deepening of the inshore area through dredging and a qualitative description of the potential influence of the wharf trestle structure; and

- potential for upper beach profile sediments reaching the berths due to cross-shore transport during storm events.

A discussion of these potential impacts is provided in **Section 6.9.1**.

6.1.3 Currents and Tides

Weipa is the closest standard port to the Project area with sufficient tidal data for analysis. The tidal signal at Weipa is predominantly diurnal (daily cycles) with short periods of semi-diurnal tides at times of neap tides.

The tidal planes at the Weipa tide gauge located at Humbug Point (1.752m above LAT) are shown in **Table 6-1**. Heights are also shown in Australian Height Datum (AHD).

Table 6-1 Weipa Tidal Planes

Tidal Plane	Metres above LAT	Metres above AHD
HAT (Highest Astronomical Tide)	3.38	1.63
MHHW (Mean High High-Water)	3.0	1.2
MLHW (Mean Low High-Water)	2.2	0.4
MSL (Mean Sea Level)	1.85	0.10
MHLW (Mean High Low-Water)	1.5	–0.3
MLLW (Mean Low Low-Water)	0.7	–1.1

LAT = Lowest Astronomical Tide

AHD = Australian Height Datum

The tide prediction does not always fully explain the tidal observations at Weipa. Meteorological conditions acting over time can transfer additional energy to tidal signals, resulting in higher or lower water levels than the predicted values.

The tidal signal in the Project area is almost identical to Weipa, with a slight phase shift resulting in the high tide being slightly later than at Humbug Point.

Current data at the proposed port site was collected over the 2006–07 and 2007–08 periods. Measurements were taken with an ADCP located in 10 to 14m of water at Boyd Point. The ADCP recorded data at six-minute intervals and currents were measured at every half-metre depth over the water column. Little variation of current was observed with depth. Average peak spring tide currents were approximately 0.25 meters per second (m/s). Average peak neap tide currents were 0.15m/s. Currents are predominantly aligned with the coast, typically between 210 and 220°N during flood tides and between 30 and 40°N during ebb tides. The depth-averaged measured current speed and direction over a four-week period during April–May 2007 is presented in **Figure 6-10**.

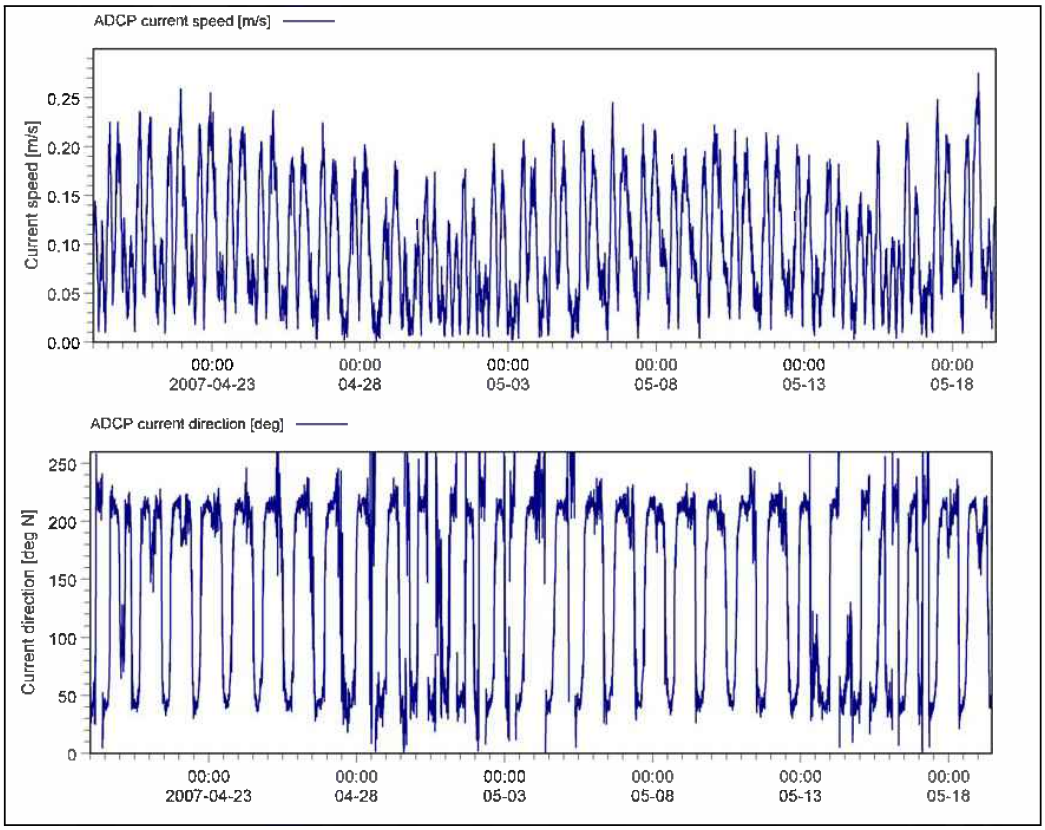


Figure 6-10 Depth-averaged Measured Current Speed and Direction at Study Site

6.1.4 Waves

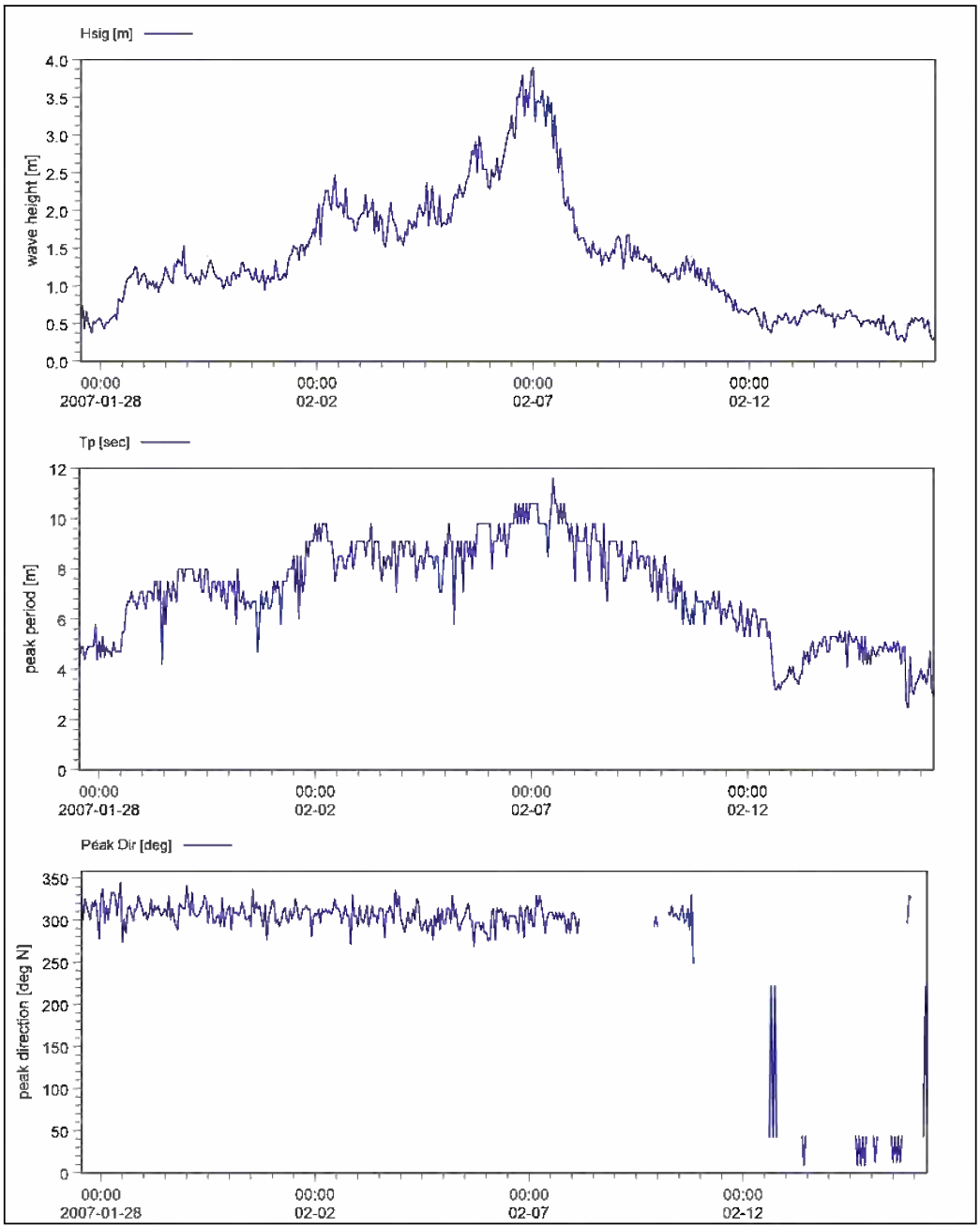
Smooth seas are frequently present at the Project site in the dry season (May to November). The westerly afternoon summer sea breezes are the only conditions favourable for generation of local seas.

Other than local seas, wave events are generated by the following during the wet season:

- tropical cyclones, tracking some distance away, that propagate waves towards Boyd Point;
- tropical cyclones that track over the proposed SoE Port site. The largest waves are produced if conditions are conducive to onshore winds; and
- monsoon winds that occasionally blow over long fetches that may commence in the Arafura Sea. Although these winds are not the same strength as cyclonic winds they still generate very active sea conditions in the Weipa area.

DERM has operated a long-term wave buoy site in Albatross Bay since 1978. Recorded summer data from this site indicates that significant wave heights (H_{sig}) are below 1m for more than 95% of the time. Hourly wave data statistics were also collected at the study site from August 2006 to March 2008. During this time two notable wave events occurred, one associated with Tropical Cyclone *Nelson* on 6 February 2007 and the other with ex-Tropical Cyclone *Helen* on 7 January 2008. The highest significant wave heights at the site during Tropical Cyclone *Nelson* were 3.5m from the north-west, characterised by peak energy wave periods (T_p) of ten seconds.

The wave measurements shown in **Figure 6-11** are associated with strong winds from the north-west that were generated by Tropical Cyclone *Nelson*'s low pressure system in the southern half of the Gulf of Carpentaria, as shown in **Figure 6-12**.



Note: Reliable directional data was not available after February 8, 2007

Figure 6-11 Boyd Point Wave Data Statistics during Tropical Cyclone Nelson

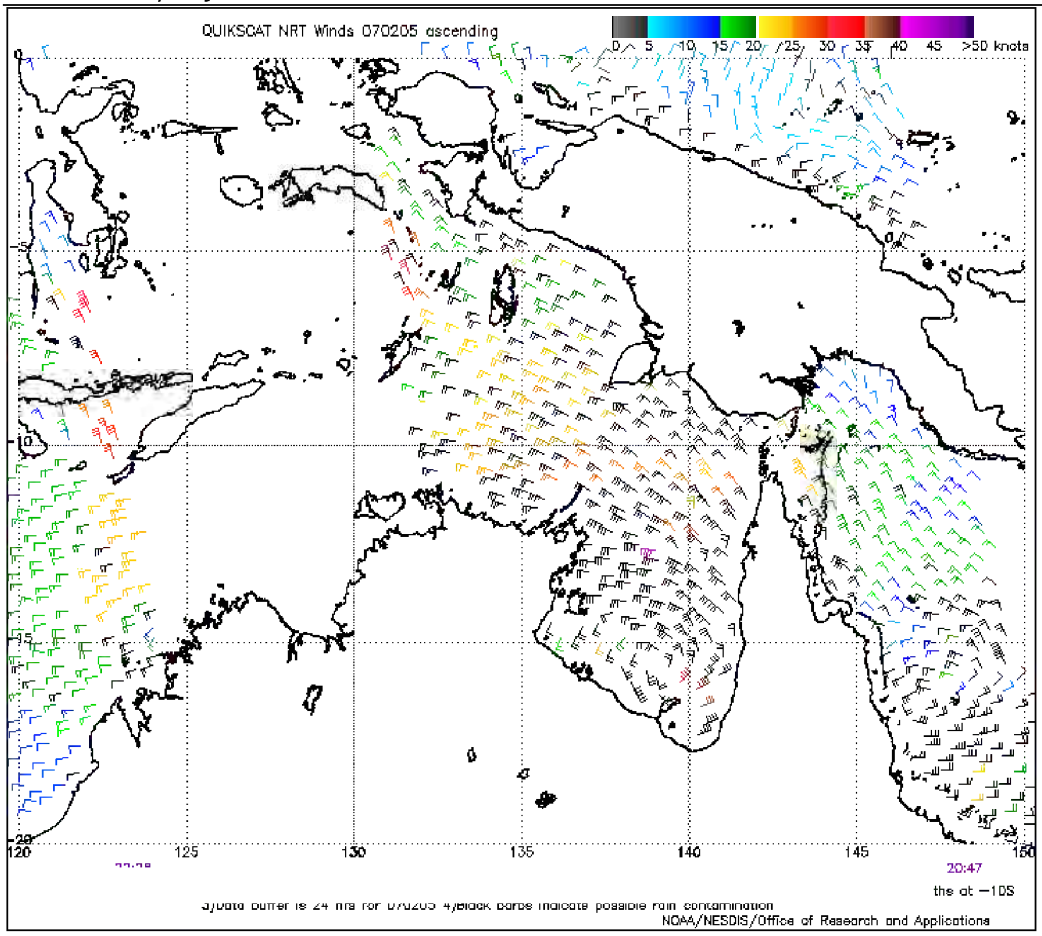


Figure 6-12 Tropical Cyclone Nelson Wind Field 5 February 2007

A Holland wind model and a SWAN (Simulating Waves Nearshore) wave model were used to simulate 15 historical events and to obtain a time series of wave parameters at the study site for inclusion into the coastal process models used to assess shoreline changes. A regular grid was developed, with a mesh resolution of 2km to suitably resolve the wind field. Wind fields used to generate waves acting on the study site can be of a regional scale and, to represent these, the model extents included the whole of the Gulf of Carpentaria, as shown in **Figure 6-13**.

Coastal processes were modelled by using wave height, period and direction information extracted from the wave model results at the proposed port site.

Modelled wave heights were compared with the actual DERM wave buoy measurements (non-directional) located in Albatross Bay. As shown in **Figure 6-14**, the relationship is reasonably linear. However, wave heights at the buoy site are limited by depth.

The relationship between modelled mean wave direction at the proposed port site and at the DERM wave buoy site is shown in **Figure 6-15**. Wave refraction in the shallower water of Albatross Bay accounts for differences in mean direction.

Figure 6-16 indicates that for the wave events modelled, directions were predominantly from the north-west, west, and south-west sectors. More of the large waves occur in the south-west and west sectors shown in **Figure 6-16**, resulting in higher sediment transport up the coast towards Boyd Point. As the alignment of the shoreline between Pera Head and Boyd Point is approximately 210°N, waves from the north-western sector tend to arrive at the shoreline square-on, resulting in minimal longshore movement.

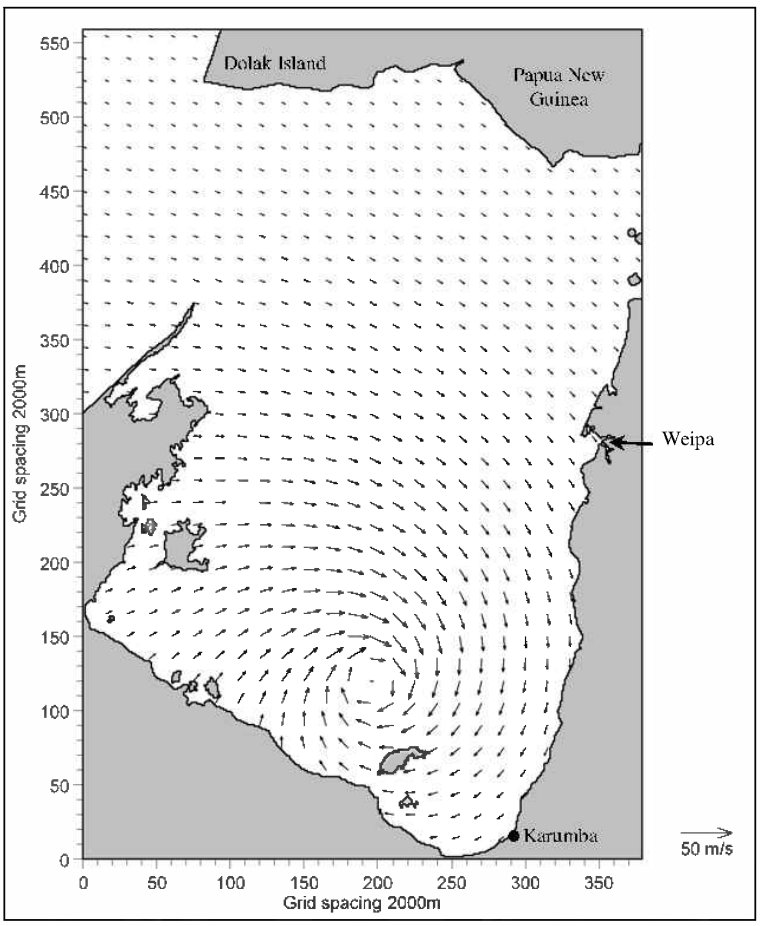


Figure 6-13 SWAN Wave Model Boundaries with an Example of Tropical Cyclone Wind Field

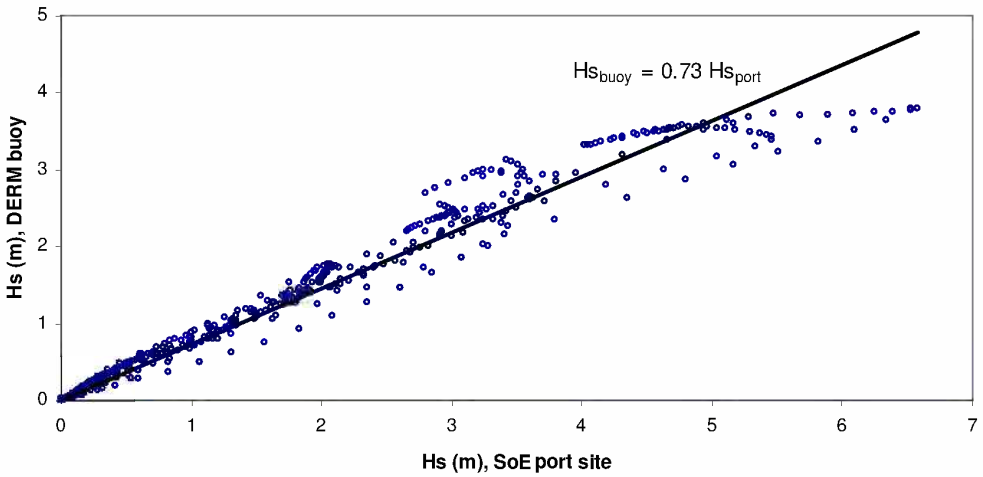


Figure 6-14 Modelled Highest Significant Wave Height at Proposed Port vs Measured at Buoy

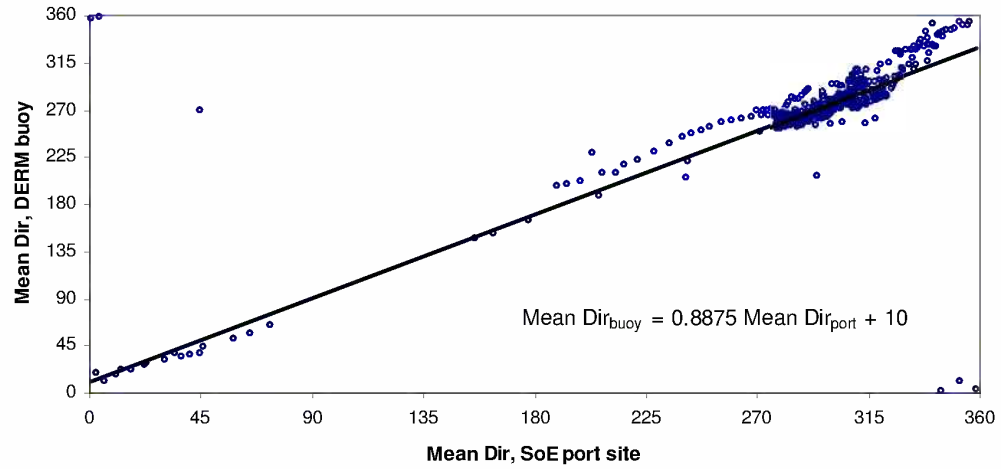


Figure 6-15 Modelled Mean Wave Direction at Proposed Port vs Measured at Buoy

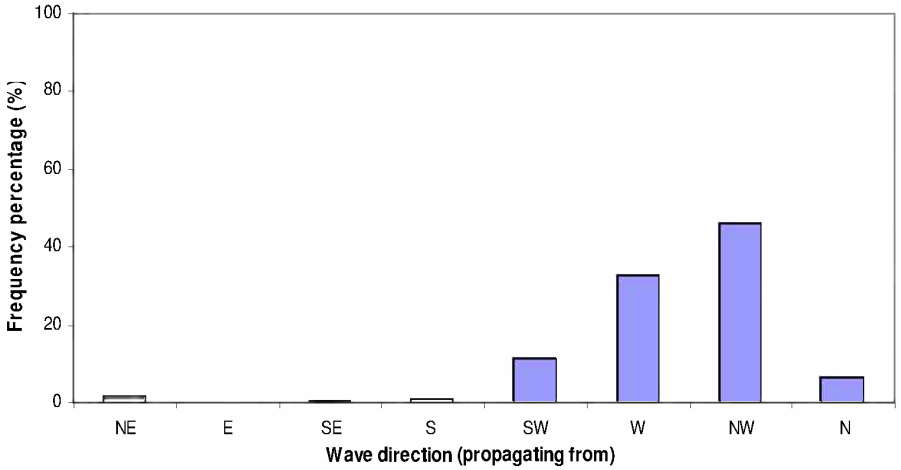


Figure 6-16 Modelled Wave Direction Frequency of Occurrence at Proposed Port Site

6.1.5 Sediment Movement

The beach either side of the proposed port site is relatively straight as shown in **Plate 6-1**. Longshore transport of beach sand occurs during storm events and the extent depends on wave height, direction, and storm duration. Calculations, using modelled wave data, show that over time there has been a net movement of approximately 12,000m^3 of beach sand per cyclone season transported towards Boyd Point. The largest single sand movement event of 86,000m^3 towards Boyd Point occurred during Tropical Cyclone *Dominic* in April 1982.

Mobilisation of fine sediments surrounding the dredge area is a function of the cohesive or non-cohesive nature of the material and the bed stresses that are able to be developed under prevailing current and wave conditions. The material within the dredge area mainly consists of cohesive sediments at least out to about 4km from shore where sediments increase significantly in sand content (refer **Section 6.5.4.2**). Once the current and wave conditions overcome the critical bed-shear stress, sediments will begin to move.

Normally the critical bed-shear stress is not greater than 0.3N/m^2 for a weakly consolidated mud and 1.2N/m^2 or greater for a moderately consolidated mud (mud is the combined silt and clay fractions).

Calculations show that the critical bed-shear stresses are exceeded when significant wave heights are larger than 1m during a neap tide, assuming the bed is weakly consolidated. During spring tides, the peak flood and ebb current forces alone are almost enough to initiate sediment motion and any additional wave action exceeds the critical bed-shear stress associated with fresh deposits of fine sediments. Larger waves will result in high concentrations of the fine bed material in suspension and higher turbidity of the waters around Weipa and the Project area. Changes in sediment movement as a result of the wharf trestle structure and berth dredging area are discussed in **Section 6.9.1**.

Plate 6-1 View at Beach Level Looking South (towards proposed port site)

6.2 Marine Protected Areas, Conservation Areas and Biodiversity Areas

Section 7.2 discusses protected areas, conservation areas and biodiversity areas from Cape York to the Project area. These relate largely to terrestrial habitats and wilderness areas which may include riverine and estuarine habitats including the Embley and Hey Rivers.

There are currently no similar protected, conservation or biodiversity areas specific to the marine environment. However, there is a current proposal by the Queensland Government to declare a fish habitat area (FHA) under the *Fisheries Act 1994* over the northern portion of Albatross Bay. Public consultation on the matter is currently being conducted. The area of Albatross Bay concerned is that north of 12° 36′ 00″ south. The existing Albatross Bay spoil ground and Port of Weipa entrance channel are south of the boundary of the proposed FHA.

The Australian Government is currently completing the marine bioregional planning process for the North Marine Region which covers more than 715,000 square kilometres of ocean covering the Gulf of Carpentaria, Arafura Sea and the Timor Sea as far west as the Northern Territory – Western Australian border. Within the region, five "Areas for Further Assessment" have been defined. "Areas for Further Assessment" are not the proposed boundaries for new marine reserves. Instead, they are intended to aid further analysis of information at a more detailed scale and assist in the design of new marine reserves. Based on ecological information and information obtained from key stakeholders on human activities within the "Areas for Further Assessment", the location and zoning arrangements of a new network of marine reserves will be developed. The Project area is not included within any of the five areas being further assessed.

6.3 Marine Habitats

Albatross Bay is recognised as containing environmentally important marine habitats (Baker and Sheppard, 2006). Key benthic marine habitat components and their associated environmental values in the vicinity of the Project marine infrastructure are discussed below and include:

- inshore and offshore reefs;
- mangroves;
- seagrass; and
- soft sediments.

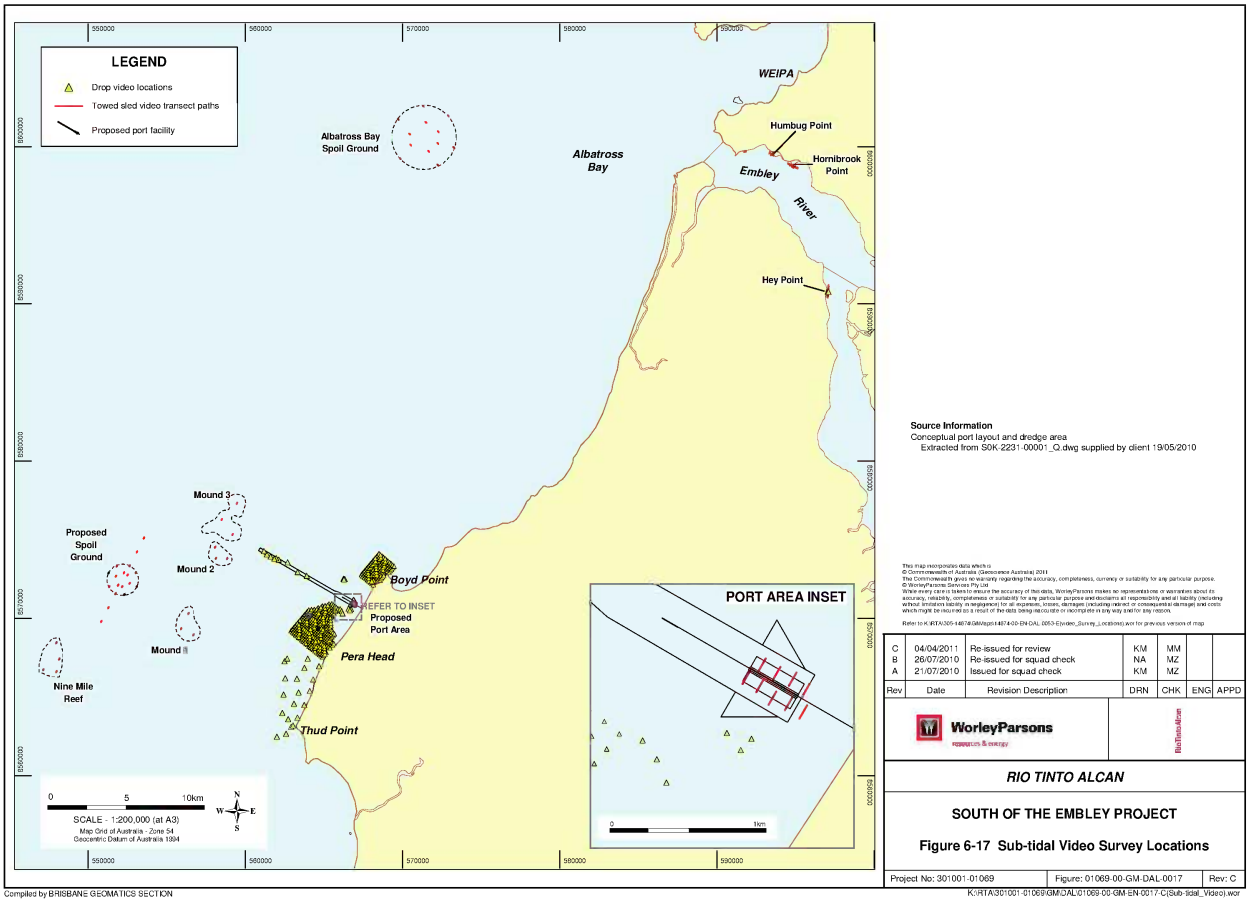
6.3.1 Benthic Habitat Survey Methods

Benthic (sea floor) habitat surveys were completed within the Project area during October 2007, June 2008, November 2008, June 2009 and June 2010. A combination of towed video sled and drop camera video techniques were adopted for this study, allowing the survey of multiple sites in a short period, providing key information to describe the distribution and structure of benthic habitats. Towed video sled was used over low profile soft sediment habitats. Towed video transects covered a distance of 100m and had a field of view of approximately 0.5m width. Drop camera video was used over patchy reef habitat, seagrass areas and the proposed port entrance channel. The field of view was approximately 0.5m width. Vision was captured as the boat drifted, ranging from about 20m to 50m transect lengths. Detailed reef habitat surveys also utilised drop camera video methods at grid point (refer **Section 6.3.1.1**) and captured an area of 0.5m x 0.5m using a frame. In-water surveys were not undertaken due to potential safety risks posed by salt water crocodiles in the area. Refer to **Figure 6-17** and **Table 6-2** for survey locations and techniques.

6.3.1.1 Detailed Reef Habitat Surveys

Detailed drop camera video and towed video sled techniques were used between Pera Head and Boyd Point (inclusive) to systematically survey sponge, soft coral and fringing hard coral reef habitats in the immediate vicinity of the proposed port development during October 2007 and June 2008. These techniques assess the percentage of live benthic cover, provide diversity estimates via still imagery analysis and allow mapping of habitat distribution. Detailed sampling grids incorporating 125m spacing were applied over Pera Head and Boyd Point, facilitating the inspection of approximately 415 benthic survey sites. The *Coral Point Count with Excel Extensions* software (CPCe – Version 3.4) was used to analyse still images obtained from the video footage. Benthic community cover and diversity was assessed by randomly locating 20 points over each image. The underlying benthic biota from these 20 points was classified as follows:

- coral – massive coral, branching coral, tabulate coral, encrusting coral, foliose coral;
- gorgonian coral;
- hydroids;
- sponges;
- soft coral;
- algae – brown macroalgae, green macroalgae, red macroalgae, coralline algae, seagrass; and
- other biota – anemone, ascidians, holuthurians, sipunculid, bivalve, gastropod, zoanthid, nudibranch, bryozoan, crustacean, sea pen.



Source Information
Conceptual port layout and dredge area
Extracted from S0K-2231-00001_Q.dwg supplied by client 19/05/2010

This map incorporates data which is
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Rev	Date	Revision Description	DRN	CHK	ENG	APPD
C	04/04/2011	Re-issued for review	KM	MM		
B	26/07/2010	Re-issued for squad check	NA	MZ		
A	21/07/2010	Issued for squad check	KM	MZ		

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Figure 6-17 Sub-tidal Video Survey Locations

Project No: 301001-01069	Figure: 01069-00-GM-DAL-0017	Rev: C

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Table 6-2 Benthic Habitat Surveys

Location	Number of Towed Transects or Drop Video Drift Sites	Method	Survey date
Proposed disposal ground	18	Towed sled	Oct 07
Mounds areas (10km WNW from the port)	9	Towed sled	Oct 07
Proposed port area	9	Towed sled	Oct 07
Sub-tidal soft reef area (150m south of the port)	9	Drop video	Oct 07
Hey River Terminal	Preliminary inspection	Drop video	Oct 07
Hey River Terminal	10	Drop video	Nov 08
Hey River Terminal	12	Drop video	June 09
Hornibrook Terminal	Preliminary inspection	Drop video	June 08
Hornibrook Terminal	11	Drop video	June 09
Humbug Terminal	Preliminary inspection	Drop video	June 08
Humbug Terminal	7	Drop video	June 08
Pera Head**	Preliminary inspection	Drop video	Oct 07
Pera Head	299 (points on grid)	Drop video	June 08
Boyd Point**	Preliminary inspection	Drop video	Oct 07
Boyd Point	114 (points on grid)	Drop video	June 08
Pera Head to Thud Point	19	Drop video	June 10
Port area departure channel	20	Drop video	June 10
Nine Mile Reef	4	Drop video	June 10

** Preliminary inspection following identification of hard coral reefs

6.3.1.2 Dominant Reef Habitat Surveys

The distribution of dominant reef habitat types (hard coral or soft-coral – sponge) between Boyd Point and Thud Point were determined through site inspection following inference from available bathymetric charts, bathymetric survey commissioned by RTA and interpreted aerial photography. Slope analysis overlain with detailed contour information was also applied to assist in the delineation of reef patches. Drop camera video inspection was undertaken at Pera Head and Thud Point to assist in confirming the inferred presence of these reef areas. Detailed drop camera video surveys (described below) in 2007 and 2008 had already confirmed the extent of reef habitats at Pera Head and Boyd Point.

Drop camera video inspection was also undertaken from Nine Mile Reef approximately 6km south-south-west of the proposed disposal ground. This is the nearest substantial seabed feature to the proposed spoil ground.

Inspection of potential reef habitat south of Thud point was not undertaken due to the very low likelihood of turbid plumes extending inshore beyond Thud Point. This was confirmed through turbid plume modelling (refer to **Section 6.9.2.2**).

6.3.2 Inshore and Offshore Reef Habitats

While the vast majority of the Gulf of Carpentaria consists of open sandy and muddy habitats, some reef habitat occurs. Fringing and nearshore reefs occur on many parts of western Cape York and are recorded in parts of Albatross Bay, including much of the southern foreshore and Jantz/Duyfken Point (Baker and Sheppard 2006), but are generally poorly mapped.

The iron stone formations present along the western Cape York shoreline support the development of shallow fringing hard coral and soft benthos reef communities. Reef habitat similar to what is present within the Project area is located approximately 75km to the north of Albatross Bay, in the vicinity of the mouth of Port Musgrave (refer **Figure 1-1** for regional map). Dog Reef extends approximately 7km to the south of the mouth of Port Musgrave and

averages about 800m in width. It is a rocky algal reef system with patchy live hard and soft coral cover along its deepest fringe. Kerr Reef is situated approximately 16 km north-north west of the mouth of Port Musgrave, and supports a high live hard coral cover compared with inshore reef areas (Pers. obs. T. Koskela 2009).

There are also recently discovered deeper sub-tidal reefs in the Gulf of Carpentaria that are well below the surface and consist of a thin and patchy veneer of live corals (Harris *et al.* 2004). None of these deeper reefs are known to occur in the vicinity of the study area.

6.3.2.1 Proposed Port Area

Near shore fringing reef communities in the vicinity of the proposed port area occur at Boyd Point, Pera Head and between Pera Head and Thud Point. These comprise both reefs containing hard corals and low profile reefs containing soft coral – sponge assemblages. The reef habitats have established primarily over ironstone formations. Overall, reef systems between Boyd Point and Thud Point covered approximately 418ha (refer **Figure 6-18**), comprising 144ha of validated reef extent and 274ha of inferred reef. A breakdown of reef habitats is included in **Table 6-3**.

Three abiotic habitats – silty sand, coarse sand and rock – were identified around Boyd Point and Pera Head. Video results confirm the presence of fringing and submerged reefs located at Boyd Point, approximately 2.0km north of the proposed port, and Pera Head approximately 2.8km south of the proposed port. These reefs cover an area of approximately 49ha and 72ha, respectively. Results of percentage cover for sponges, soft corals and hard corals are presented in **Figure 6-19**. Percentage cover of reefs between Pera Head and Thud Point was inferred from the detailed Boyd Point and Pera Head survey on the basis that the reefs occupied similar inshore environments and appeared similar during drop camera video inspections.

Hard corals over the reef areas include species from the following genera: *Porites*, branching *Acropora*, *Turbinaria*, *Monitipora*, *Lobophyllia*, *Platygyra*, *Pavona* and *Favia*. Identification of corals to species level was not possible as this would have required scientific divers entering waters where saltwater crocodiles pose a safety threat. While hard corals are present, there is also abundant sponge and soft-coral fauna and marine algae.

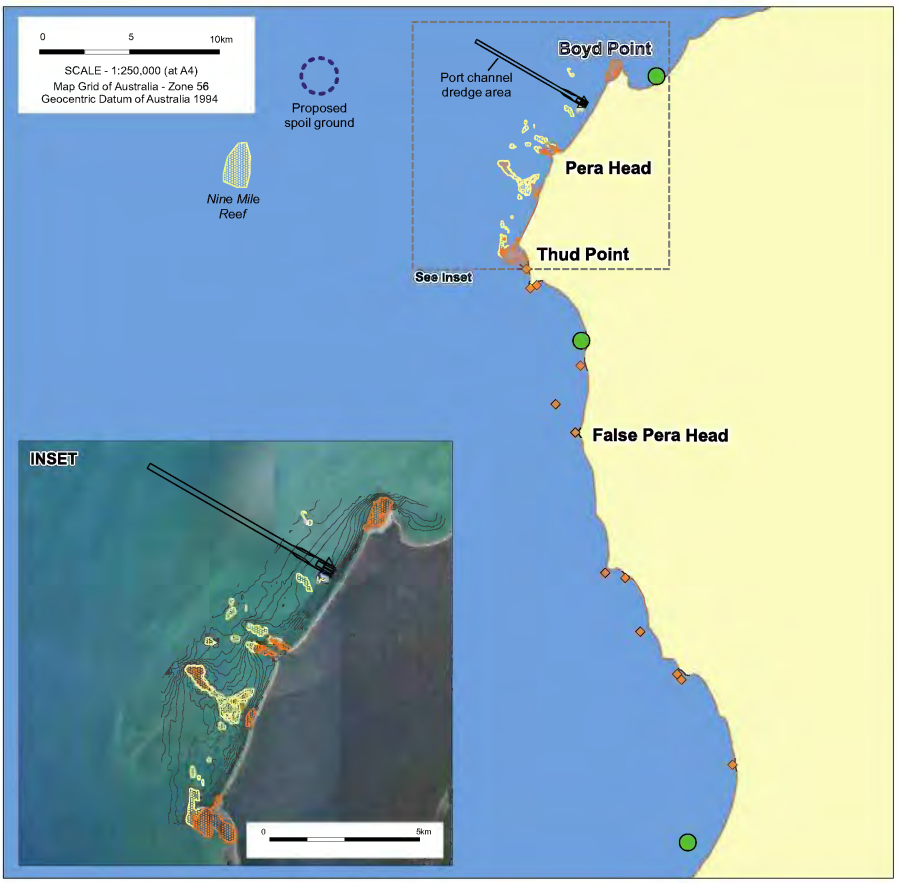
Two small patches of submerged sponge and soft coral reef occur 150m south of the proposed port, and another two approximately 1km north-east of the proposed access channel. Together, these habitats total approximately 23ha. Sponge and soft coral assemblages adjacent to Pera Head are estimated at 48ha (refer **Figure 6-19**). Inferred extent of sponge – soft coral habitat between Pera Head and Thud Point is estimated to be approximately 117ha.

A summary of reef areas and extent of their dominant benthic assemblage (hard coral or sponge – soft coral) is provided in **Table 6-3**.

Table 6-3 Inshore Reef Areas and Extent of Dominant Benthic Assemblages

Location	Total area (ha)	Hard Coral (ha)	Sponge – Soft Coral (ha)
Boyd Point	49	49	0
Port area (between Boyd Point to Pera Head)	23	0	23
Pera Head	72	24	48
South from Pera Head to Thud Point (inferred)	274	157	117

Images of benthic habitats from Boyd Point reef, Pera Head reef, the port area, Thud Point reef and open benthic habitat within the departure channel area are provided within **Plate 6-2**.



LEGEND

- Seagrass locations
- Unconfirmed reef locations

Indicative Reef Classes

- Hard coral
- Soft coral
- Extent of dredge area

2006 Aerial Photography
Supplied by client December 2006
Bathymetry
Extracted from bathy.dwg supplied by client December 2006
Conceptual Port Layout and Dredge Area
Extracted from SOK-2231-00001_Q.dwg supplied by client 19/05/2010
Indicative Seagrass Locations
Queensland Seagrass Meadows 1984-1988
Department of Primary Industries and Fisheries 2002
Coastal Habitat Resources Information System
http://chrisweb.dpi.qld.gov.au/CHRIS/
Pers. Comm. Michael Rasheed, 2010

This map incorporates data which is
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Rev	Date	Revision Description	ORIG	CHK	ENG	APPD
D	9/11/2010	Re-issued for review	MM	KM		
C	5/11/2010	Re-issued for squad check	JMM	---		
B	26/07/2010	Re-issued for squad check	NA	MZ		
A	20/07/2010	Issued for squad check	KM	MZ		

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Figure 6-18 Reef Habitat Distribution and Classification

Project No: 301001-01069	Figure: 01069-00-GM-DAL-0013	Rev: D

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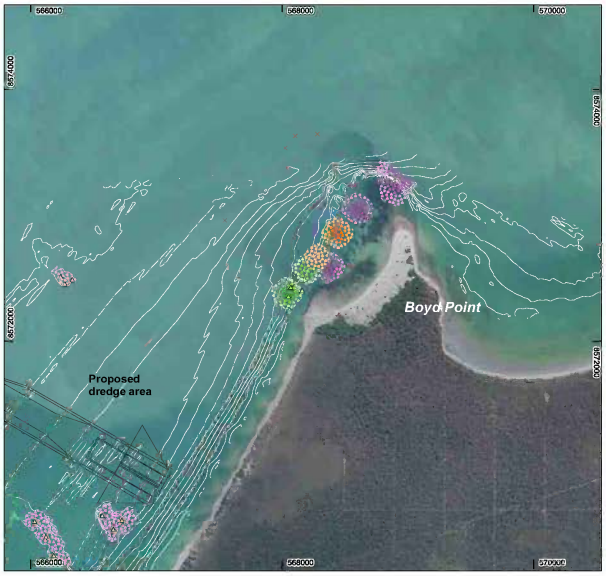

BOYD POINT

PERA HEAD

LEGEND

Proposed dredge area

Survey location

Drop video location

Sponges (% coverage)	*Soft Coral (% coverage)*	*Coral (% coverage)*
1 - 10%	1 - 10%	1 - 10%
10 - 30%	10 - 30%	10 - 30%
30 - 50%	30 - 50%	30 - 50%
>50%	>50%	>50%

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Benthic assemblages interpolated from WorleyParsons marine survey data (June 2008) using MapInfo Vertical Mapper software.

Aerial photography, bathymetry and other vector data supplied by Matrix Consulting.

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0 0.5 1km

SCALE - 1:25,000 (at A3)

Map Grid of Australia - Zone 54
Geocentric Datum of Australia 1994

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Rev	Date	Revision Description	DRN	CHK	ENG	APPD
A	20/07/2010	Issued for squad check	KM	MZ		

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Figure 6-19 Sponge, soft coral and hard coral cover between Pera Head and Boyd Point

Project No: 301001-01069	Figure: 01069-00-GM-DAL-0018	Rev: A

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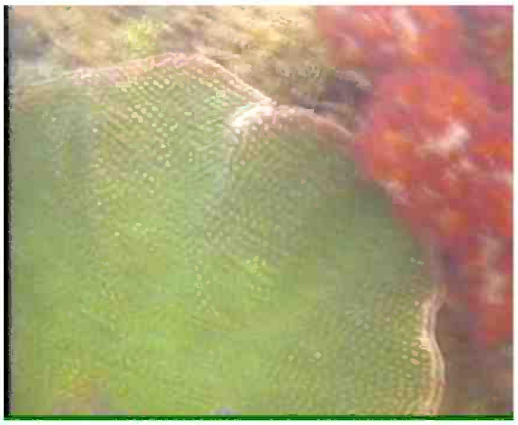
Plate 6-2 Images of Typical Benthic Assemblages

Boyd Point – Mixed branching soft corals, hard corals, rocks, sand and Sarcophyton (soft coral)

Boyd Point Reef Spur – Seawhips, soft corals, entrusting algae and zoanthids

Pera Head – Turbinaria hard coral, seawhips, rocks and entrusting algae



Pera Head – Turbinaria hard coral and soft coral

Pera Head – Branching soft corals, polyps out

Pera Head – Soft corals, rock and coarse sand substrate at base of reef slope

Shallow reef spur south of Pera Head – Montipora and Turbinaria hard corals.

Inner channel alignment – Sponges, bryazoans and encrusting algae

Port berth area – Open silty sand with sponge

Port berth area – Open silty sand

Sponge reef adjacent to Port development

Sponge reef adjacent to port development

There is a paucity of published information on lifecycles of nearshore corals in the Gulf of Carpentaria. Gilmour et al (2006) described a similar paucity of information regarding reef areas of the Pilbara in Western Australia, especially for mid and inshore reef corals. Gilmour et al (2006) note that, in contrast to mid to offshore reef corals, which commonly are broadcast spawners having gametogenic cycle a year, many of the species of inshore and coastal reefs do not mass-spawn or have variable modes of reproduction that are poorly described. This includes some of the most abundant coral species. Inshore corals of the genera *Porites, Pavona* and *Turbinaria* were identified to generally have colonies that are separate sexes and spawn heir gametes over protracted periods of several months, possibly at times other than the major spawning period. In addition, brooding corals, including corals from the families Dendrophyliidae, Faviidae, Acroporidae and Pocilloporidae, are also identified as common in inshore areas and characteristically have several gamete producing cycles over the warmer months. Gilmour et al (2006) concluded that there is a tendency for some of the most abundant species of corals not to spawn synchronously over a few nights each year, particularly on inshore reefs. This means that their patterns of reproduction are unpredictable and largely unknown. The situation discussed by Gilmore et al (2006) may reflect the situation of inshore reef areas of the Gulf of Carpentaria and therefore specific times of the year that corals within the Project area may reproduce are difficult to predict, although it may be concluded from the above research that mass spawning events do not take place within the Project area.

The importance of these reef systems (Boyd Point to Thud Point) in a regional context is considered to be high, as they support resources that are of conservation, cultural, commercial and recreational importance. In particular, near shore sponge and soft coral habitat provides a food resource for a range of turtle species in the area. The importance of inshore reef areas to marine fauna and fisheries is presented in **Sections 6.6** and **6.7** respectively.

6.3.2.2 Proposed Spoil Ground

Drop camera video survey within and adjacent to the proposed spoil ground did not identify any seabed features such as patch reefs. The proposed spoil ground location was selected primarily due to the absence of such features. The area is characterised by flat, unvegetated, soft sediment (refer **Sections 6.1.1** and **6.3.5**) that is considered to be of lower habitat value than reef or vegetated benthic habitats.

Nine Mile Reef is located approximately 6km south-south-west of the proposed spoil ground (refer to **Figure 6-18**) and is estimated to cover an area of approximately 287ha, based on available bathymetry information and video inspection. Its structure contains mixed sponge and soft coral assemblages developing a low profile reef system in depths approximately –22 to –25mLAT, arising from a silty sand substrate and occasional rock outcrops. Zoanthid colonies were observed at some locations clearly attached to the rock structure, their large polyps keeping fine silt deposition clear of their tissues.

Nine Mile Reef is accessed frequently by recreational fishers targeting species such as mackerel, cobia, tuna, finger mark and trevally.

6.3.3 Mangrove Habitat

Mangroves provide nursery habitat for species of fisheries significance including barramundi (*Lates calcarifer*), banana prawns (*Peneaus merguiensis*) and mud crabs (*Scylla serrata*). Mangroves provide a structurally complex habitat that can provide food and protection directly for juveniles and are a source of carbon that is exported by prevailing hydrodynamic processes to other areas, contributing widely to foodwebs elsewhere in the region.

The Albatross Bay mangrove assemblage is extremely diverse and is the most extensive system of mangroves on the eastern Gulf of Carpentaria. Thirty-six species of mangrove have been recorded on western Cape York and 30 of these are found in Albatross Bay (Duke, 2006). The mangrove assemblage of the Albatross Bay area is dominated by closed *Rhizopora*, *Avicennia* and *Ceriops* forests.

Mangroves are absent from the foreshores at and adjacent to the proposed port area (refer **Plate 6-3**), Hornibrook ferry terminal location (refer **Plate 6-3**) and Humbug barge terminal location.

Plate 6-3 Proposed Port Location (left) and Proposed Hornibrook Ferry Terminal Location (right)

The foreshore at the location of the proposed Hey River barge/ferry terminal has a thin mangrove fringe (1–2 trees wide), established over a mud and gravel shore at the base of a low pisolite plateau.

A maximum of 400m^2 of mangroves would be required to be removed to construct the Hey River barge/ferry terminal**.** At this location there is a narrow band of low-growing mangroves fringing the high tide zone. The mangrove species in the Hey River estuary include:

- *Rhizophora stylosa* (red mangrove);
- *Bruguiera gymnorhiza* (large-fruited orange mangrove);
- *Avicennia marina* (grey mangrove); and
- *Aegiceras corniculatum* (river mangrove).

The extent of mangrove clearing represents approximately 0.008% of RE 3.1.1a and 0.003% of the mangrove communities within the Project area (refer **Table 7.10**). The potential impacts on marine fauna associated with the removal of 400m^2 of mangrove habitat are discussed in **Section 6.9.3**.

6.3.4 Seagrass Habitat

Seagrass habitats in the Albatross Bay area provide nursery habitat for fish and macroinvertebrates such as tiger prawns (*Peneaus semisulcatus* and *Peneaus esculentus*). Seagrass beds also provide habitat for species of conservation significance such as Dugongs (*Dugong dugon*), Green Turtles (*Chelonia mydas*) and various species of pipefish (Order Sygnathiformes). Six species of seagrass have been recorded in Albatross Bay (Roelofs *et al.* 2003):

- *Halodule uninervis;*
- *Syringodium isoetifolium;*
- *Enhalus acoroides;*
- *Halophila decipiens;*
- *Halophila ovalis;* and
- *Thalassia hemprichii.*

Seagrass beds are typically present in the more sheltered areas of Albatross Bay, including the lower reaches of the Embley and Mission Rivers and Pine River Bay and are largely restricted to

shallow sand and mud banks of less than 4m below mean sea level (MSL) (Roelofs *et al.* 2003) or –2.2mLAT.

The Department of Employment, Economic Development and Innovation (DEEDI) (formerly the Department of Primary Industries and Fisheries) has been undertaking annual seagrass monitoring within the Port of Weipa since 2000. This monitoring is undertaken at three scales, with more intensive monitoring occurring near port and shipping infrastructure:

- mapping of seagrass distribution and community type within the entire Port of Weipa limits, including Albatross Bay and the Embley, Hey, and Mission Rivers and Pine River Bay. This survey is helicopter-based and occurs approximately every three years with surveys so far undertaken in 2000–2002, 2005 and 2008;
- annual mapping of seagrass distribution and confirmation of species composition in a defined Intensive Monitoring Area (IMA; refer **Figure 6-20**) which focuses on meadows in the vicinity of the port and shipping infrastructure in the Embley and Hey Rivers; and
- annual assessment of seagrass distribution, species composition and abundance in five core monitoring meadows (A2, A3, A5, A6, A7; refer **Figure 6-20** meadow for locations) primarily in the Embley River.

The most recent (2008) survey of the entire Port of Weipa (Chartrand and Rasheed 2009) identified approximately 3200ha of seagrass present primarily in aggregated patches, with continuous cover representing only about 10% of seagrass area. The mapped area was the lowest recorded over the five surveys completed since 2000.

6.3.4.1 Port Development Area Seagrass Distribution

The regular monitoring of seagrasses within the Port of Weipa does not extend to the southern areas of Albatross Bay in the vicinity of the proposed port development.

Extensive towed video and drop camera video surveys undertaken for the Project between Boyd Point and Thud Point and at the proposed spoil ground location confirmed that seagrass is absent from both these areas.

To the north of Boyd Point, a survey undertaken by Marine Ecology Consulting (cited in McKenzie and Yoshida 2009) identified relatively continuous sub-tidal meadows adjacent to Boyd Bay beach containing *Halophila dicepiens* and *Halodule uninervis*, about 4km north-east of the proposed port. Physical conditions, sediments and prevailing bathymetry were unlikely to support the occurrence of seagrass within the footprint of the proposed port development (Rasheed, Pers Comm. 2010). These assumptions support findings from several site-based surveys within the study area which did not find seagrass.

Other surveys undertaken between 1984 and 1988, and identified from the DEEDI Coastal Habitat Resources Information System (CHRIS) database, reported seagrass meadows south of Thud Point at Norman Creek and the Gulf beaches of Aurukun. These meadows are summarised as:

- sparse (1%) cover of *Halophila ovalis* adjacent to the mouth of Norman Creek, about 15km south of the proposed port; and
- 5% cover of *Halophila decipiens* located approximately 45km south of the proposed port area near Aurukun.

The location of the three identified patches of seagrass in Boyd Bay and south to Aurukun is indicated on **Figure 6-18**. The seagrass species identified are considered pioneering species and highly variable in their distribution over time.

6.3.4.2 Embley and Hey River Seagrass Distribution

In September 2009, it was estimated there were approximately 980 hectares of seagrass in 13 meadows within the bounds of the IMA within the Embley and Hey Rivers (McKenna and Rasheed 2010). This area was consistent with that of the previous four survey years where meadow coverage was the lowest recorded since monitoring began in 2000. Seagrass meadows

The extent and cover of the seagrass beds in Albatross Bay and estuaries can vary significantly on an annual basis with climatic conditions being the main driver of this variation. A review by Chartrand and Rasheed (2009) of seagrass density in the long-term monitoring meadows between 2000 and 2008 indicated declines in density for a number of meadows. These were particularly notable for intertidal *E. acoroides* meadows, with the largest of these meadows (A2) on the intertidal bank opposite Lorim Point reported to have been declining since 2000. The changes in biomass were largely a response to regional and local climate conditions, driven particularly by tidal exposure, temperature and solar irradiance, leading to "burning" – browning of the leaves and subsequent death. The most recent study in September 2009 identified an improvement in meadow A2 biomass over the 2008 record low but was still substantially below levels observed from 2000–2002. DEEDI considers *Enhalus* meadows in Weipa likely to be vulnerable to further cumulative impacts. While DEEDI considers the driver for *Enhalus* biomass change is tidal exposure, it does not discount that other natural and anthropogenic factors may contribute (McKenna and Rasheed 2010).

Additional detailed inspection for seagrass at the Hornibrook ferry terminal, Humbug barge terminal and Hey River barge/ferry terminal locations was undertaken during July 2009, as described below.

Hornibrook Terminal

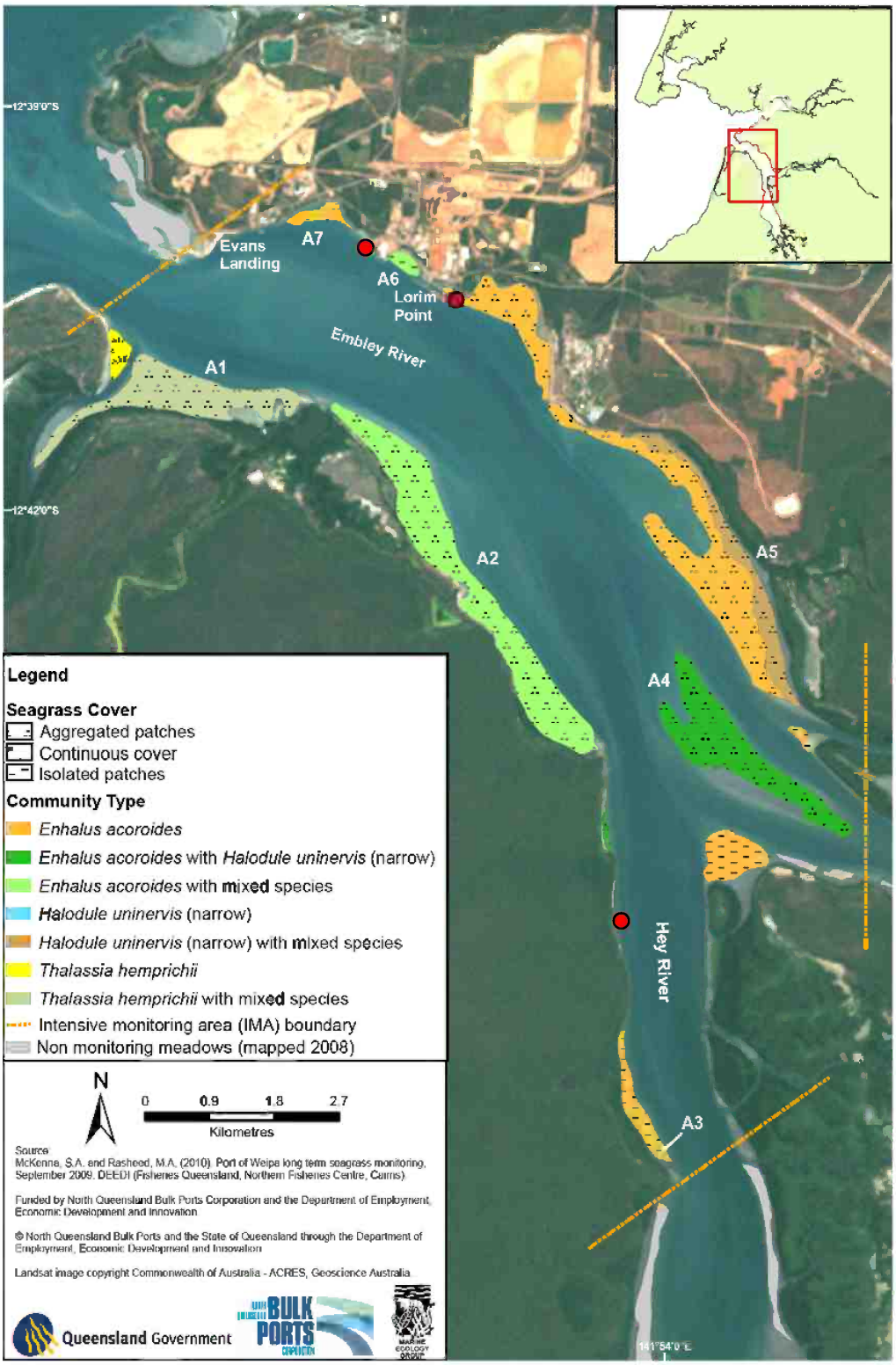
Surveys undertaken by DEEDI (e.g. Chartrand and Rasheed 2009, McKenna and Rasheed 2010) have mapped aggregated patches of *E. acoroides* at Hornibrook Point and landward of the Lorim Point Ship Loaders (refer **Figure 6-20**).

Drop camera video survey of the sub-tidal banks at Hornibrook Point was undertaken in July 2009 as part of the present study to identify the presence of seagrass within or immediately adjacent to the proposed Hornibrook ferry terminal dredging footprint. The survey did not identify seagrass within the dredging footprint or in areas landward of the Lorim Point Ship Loaders, however *E. acoroides* was identified approximately 50m east of the proposed terminal to a maximum depth of approximately 0.3mLAT (–2.1mMSL). The substrate within the dredge footprint area comprised bare, soft silts (refer **Plate 6-4**).

The absence of seagrass during the present survey is unlikely to be due to seasonal absence during the winter survey period since *E. acoroides* is not a highly seasonal or pioneering seagrass species. Further, no seagrass rhizome material was observed during sediment collection studies for contaminant assessment. The absence of seagrass is plausible given the most recent mapping prepared by DEEDI (McKenna and Rasheed 2010) indicated only aggregated patches of *E. acoroides* were present in the vicinity of Hornibrook Point and within the adjacent embayment to the east (refer **Figure 6-20**).

Humbug Terminal

Surveys of the proposed Humbug Terminal area and surrounds in July 2009 did not identify seagrass within or immediately adjacent to the proposed dredging footprint. However, visual inspection during early May 2010, coinciding with peak spring tides, did reveal isolated patches of *E. acoroides* in good condition within and adjacent to the proposed dredge footprint at low tide. The presence of isolated patches of *E. acoroides* is consistent with recent survey data reported by McKenna and Rasheed (2010) (refer **Figure 6-20**). While isolated seagrass was present, substrates at these locations were mixed, combining bare soft silts with patches of shell, sand and rubble. A range of other benthic biota was observed, including sponges, soft coral – seawhips, turfing algae, *Sargassum sp.*, and hydroids (refer **Plate 6-5**). A large patch



Note: Red dots indicate proposed barge/ferry terminal locations.

Figure 6-20 Seagrass Meadow Type and Cover – Embley and Hey River Estuaries, 2009

Plate 6-4 Bare Soft Silts within the Dredge Footprint

Plate 6-5 Coarse Sand and Shell Layer Winnowed from the Prevailing Current with Sea Whip (left) Hydroids Colonising Rubble Field Near the Intertidal Zone (right)

of exposed rubble was observed within the intertidal zone between Humbug Wharf and the Weipa sewage outfall, a distance of approximately 300m. A range of encrusting biota was associated with this rubble field.

Hey River Terminal

At the Hey River Terminal location, steep cliff lines, rocky beach and a thin mangrove fringe border a 20–30m wide intertidal habitat comprised of mixed mud, rock and rubble. Subtidally, shell, mud and sand substrates continue into deeper waters of the adjacent Hey River channel (refer **Plate 6-6**).

Seagrass monitoring between 2000 and 2009 (Chartrand and Rasheed 2009; McKenna and Rasheed 2010) in the vicinity of the Hey River Terminal location occasionally reports a very thin patch of isolated seagrass (refer **Figure 6-20**). The species composition of this seagrass appears to vary over the years, being recorded as absent in 2000, 2003, 2006–2007 and 2009, as *Halodule uninervis* with *Halophila ovalis* in 2001, as *E. acroides* with mixed species in 2002, and as *E. acroides* in 2004–2005 and 2008.

Preliminary drop camera surveys undertaken over the Hey River Terminal dredge footprint in October 2007 and November 2008 as part of the present study did not record any seagrass.

Additional detailed survey was undertaken in June 2009 (refer **Figure 6-45**) to confirm the absence of seagrass within the dredge footprint and adjacent areas. Based on the prevailing tidal conditions, drifting drop camera video inspection was undertaken along 12 transects encompassing the proposed footprint and adjacent areas to the north and south to a distance of approximately 300m at a spacing of approximately 50m. Depths of survey varied from approximately +0.3mLAT to –1.8mLAT, which is well within the primary depth range of seagrass reported for the Embley River estuary by Roelofs *et al* (2003) of shallower than –2.2mLAT (–4mMSL). No seagrass was recorded from the drift video transects undertaken at the proposed Hey River Terminal. Further, no rhizome material was observed in sediments collected when testing for contaminant assessment. Due to the timing of the study in winter months, it is possible that seasonally variable seagrasses were absent (e.g. *Halophila ovalis*). Overall though, it is considered that if any seagrasses do occur at the proposed terminal site from time to time, they are likely to contribute minimally to primary productivity in the area.

Inspection of the small cove and associated intertidal zone to the north of the proposed Hey River Terminal also failed to locate aggregated seagrass patches (*E. acoroides* and *Halodule uninervis*) as mapped in 2008 (Chartrand and Rasheed 2009) (refer **Figure 6-20**). Rather, this intertidal area was dominated by a dark rock and rubble substrate.

Isolated seagrass patches have been mapped approximately 1km to the east on intertidal banks at the junction of the Embley and Hey Rivers, and about 2km to the south along the shoreline (Chartrand and Rasheed 2009) (refer **Figure 6-20**). Confirmation inspection of these isolated seagrasses was not undertaken as it was considered unlikely that any impacts from the Hey River Terminal construction or operation would extend such distances.

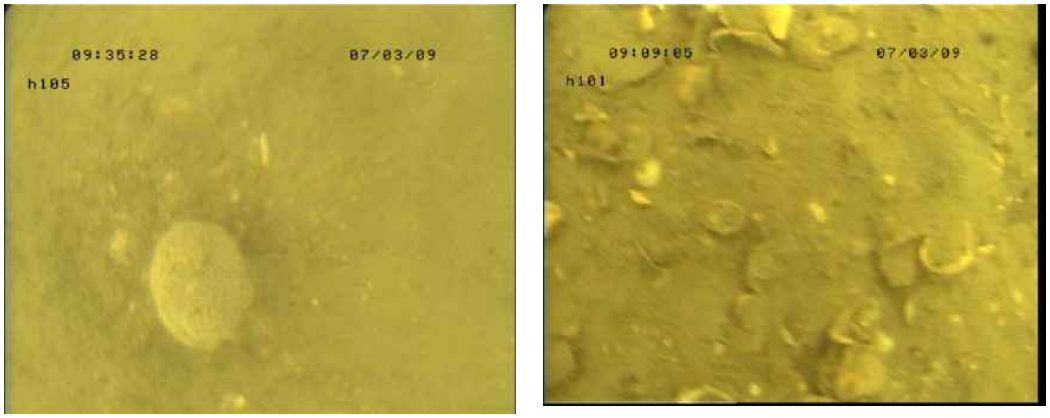


Plate 6-6 Hey River Terminal Area: Soft Coral (left). Mud and Shells Give Way to Gravel and Rocky Rubble Nearer the Intertidal Zone (right).

6.3.5 Soft Sediment Habitats

The study area contains extensive intertidal and sub-tidal soft sediment habitats. The development footprints for all marine infrastructure components of the Project (port area, proposed spoil ground, Albatross Bay spoil ground, Hornibrook ferry terminal, Humbug barge terminal and Hey River barge/ferry terminal) have been confirmed by field inspection as consisting primarily of soft sediment habitats that contain sparse epifauna typical of soft sediments, such as seapens and tube dwelling anemones, soft corals or sponges. **Figure 6-21** shows the types of unvegetated seabed at the proposed new spoil ground.

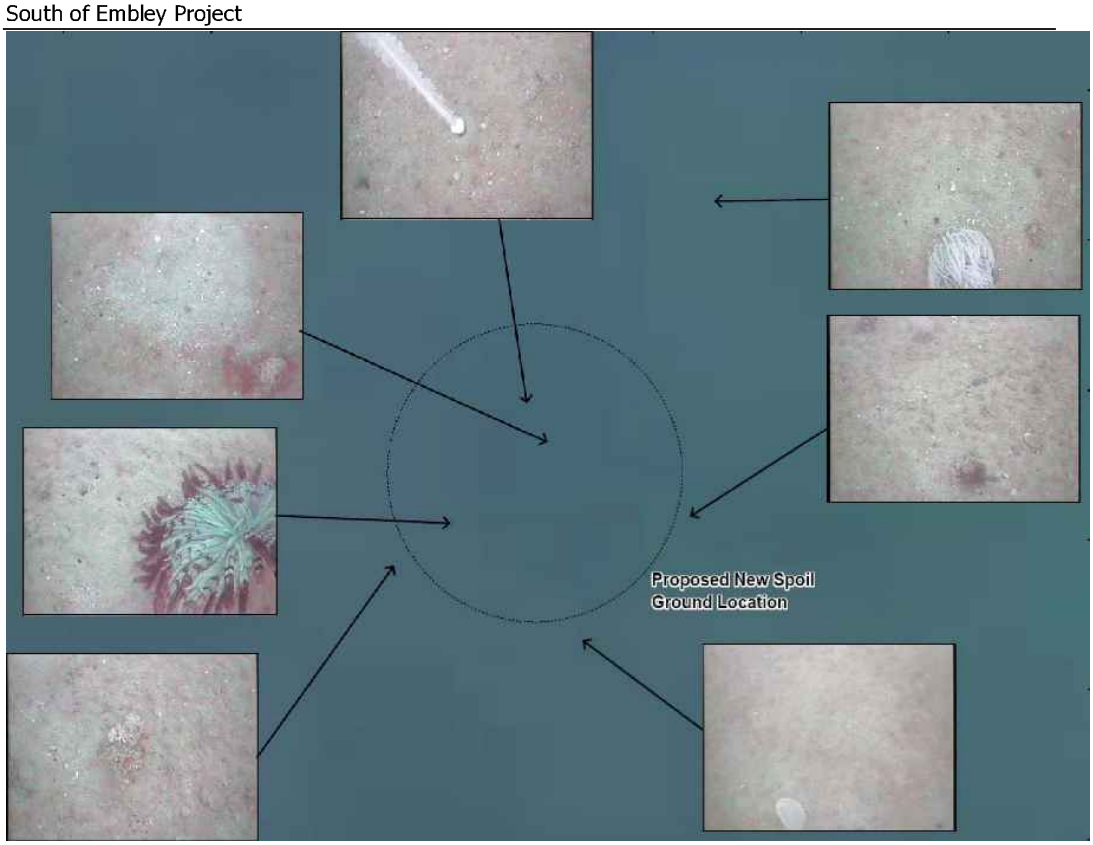


Figure 6-21 Seabed at the Proposed New Spoil Ground

While the environmental value of these habitats is generally considered less than that of vegetated habitats, primary production in these habitats can still be quite high through microscopic benthic algae, particularly in shallow water. These areas can also contain diverse and abundant assemblages of macrobenthic infauna. Soft sediments also provide habitat for a number of fish species that prefer shallow unvegetated habitats such as golden trevally (*Gnathanodon speciosus*), black spotted dart (*Trachinotus baillonii*) and whiting (*Sillago* spp.).

6.4 Water Quality

This section describes existing marine water quality conditions in the areas where the Project marine infrastructure would be located. The objectives of this section are to:

- identify background physicochemical and chemical water quality conditions at the proposed port area, barge/ferry terminals (Embley and Hey Rivers), existing Albatross Bay disposal ground and proposed new spoil ground offshore from Boyd Point;
- compare background water quality to applicable guideline criteria for the protection of aquatic ecosystems; and
- define key natural processes that act to drive water quality conditions within the study area, in particular the fate of suspended sediments.

6.4.1 Environmental Values and Water Quality Objectives

The *Environmental Protection (Water) Policy 1997* (EPP Water) is the principal legislative basis for water quality management in Queensland, and embodies the principles of the National Water Quality Management Strategy. The EPP Water includes a process for determining environmental values (EVs) (or uses) of waterways and corresponding water quality objectives

(WQOs) for different indicators of water quality. Protecting or achieving the identified WQOs for a waterway means the corresponding EVs and uses of that waterway will be protected. EVs and WQOs can be included in Schedule 1 of the EPP Water, and have been for the following areas:

- Moreton Bay/south-east Queensland;
- Mary River Basin/Great Sandy Region;
- Douglas Shire waters; and
- Trinity Inlet.

No EVs or WQOs have been determined for the Western Cape York area. The marine ecosystem in the Project area is effectively unmodified and, under the EPP (Water), is considered of high ecological value. The EV to be protected is the biological integrity of the aquatic ecosystem. In the absence of specified WQOs, the *Queensland Water Quality Guidelines* (DERM 2009a) recommends a range of other state or national guidelines. For aquatic ecosystem protection, the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC/ARMCANZ 2000) is recommended. Relevant ANZECC/ARMCANZ (2000) guideline values have been used for comparison with background water quality in the Project area.

6.4.2 Marine Water Quality Assessment Methods

Assessment of marine and estuarine water quality for the Project was informed primarily from the results of the following surveys:

- short-term field investigations for the Project (October 2007);
- long-term in-situ logger data collection for the Project (November 2007 to March 2008); and
- long-term Boyd Point in-situ data logger information from December 2006 to July 2007 and December 2007 to March 2008, sourced from Chalco.

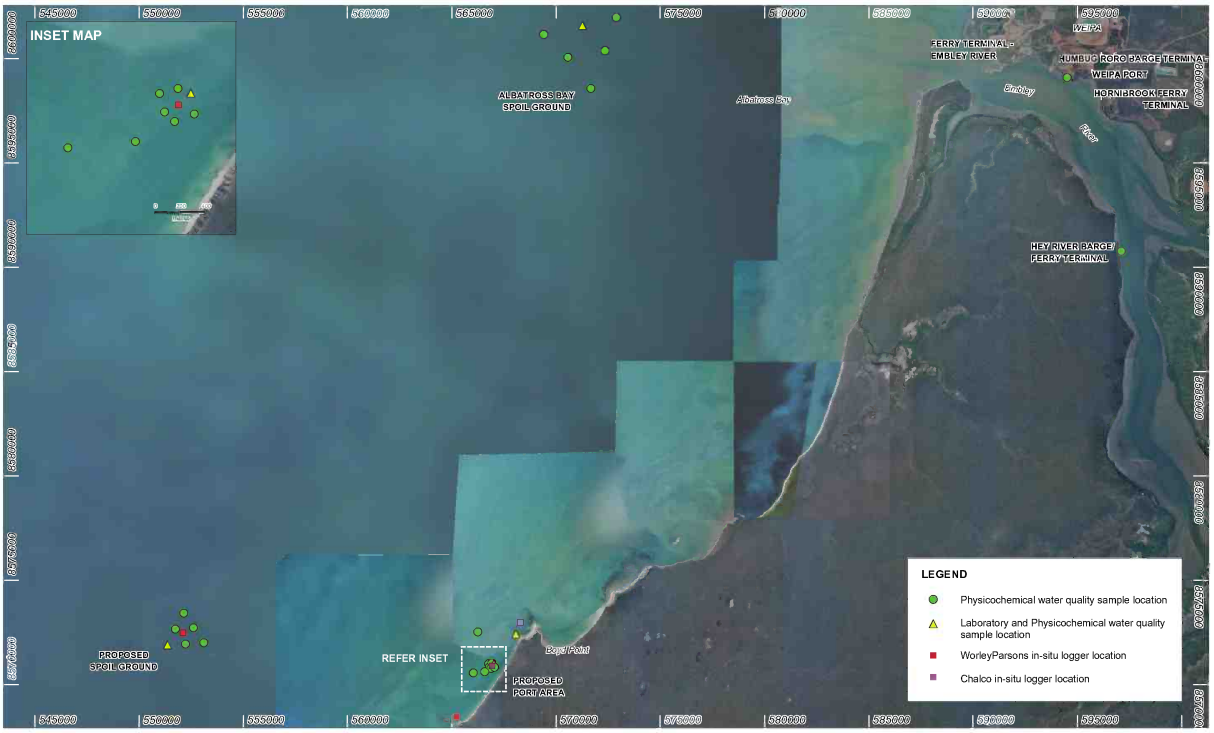
6.4.2.1 Short-term Field Investigation

In October 2007, 24 water quality monitoring sites were sampled over the Project development area. Locations included the Embley and Hey Rivers, the Port of Weipa spoil ground in Albatross Bay, the proposed port area, the proposed new spoil ground and near shore reef and soft sediment habitats adjacent to the proposed port. A map showing water quality sampling sites monitored during the October 2007 survey is presented in **Figure 6-22**.

At each site, physicochemical conditions were measured using a multi-parameter water quality meter which recorded salinity, oxidation-reduction potential, pH, temperature and turbidity. Dissolved oxygen was not recorded due to probe failure.

In addition, water samples were collected at approximately 0.5m below the surface from each site for laboratory analysis. Sampling was completed in accordance with DERM's *Water Quality Sampling Manual* (EPA 1999) and analysed for nutrients, dissolved metals and chlorophyll-a.

Results of the sort-term field investigations are discussed in **Section 6.4.3**.



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Aerial photography, bathymetry and other vector data supplied by Matrix Consulting.

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Map Grid of Australia - Zone 54
Geocentric Datum of Australia 1994

Rev	Date	Revision Description	ORIG	CHK	ENG	APPD
D	30/10/2009	Re-issued for client review	MM	KM		
C	15/10/2009	Re-issued for client review	KM	WT		
B	16/06/2009	Issued for client review	KM	DH		
A	19/09/2008	Issued for review	KM	DH		

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RIO TINTO ALCAN

SOUTH OF THE EMBLEY PROJECT

FIGURE 6-22

Location of Water Quality Survey Locations

Project No: 301001-00063 | Figure: 14674-00-EN-DAL-0050 | Rev: D

Compiled by BRISBANE INFRASTRUCTURE GIS SECTION

K:\RTA\305-14674\GIS\Maps\14674-00-EN-DAL-0050-D(WQ_Survey_Locations).wor

6.4.2.2 Long-Term Data Collection

Three in-situ water quality data loggers were installed to characterise ambient water quality at the proposed port area, proposed new spoil ground and at the nearest sensitive receiving habitat at Pera Head. These sites represent the primary area of port dredging, spoil disposal and a sensitive receptor close to the dredging works, respectively. In-situ logger equipment was supplied, maintained and calibrated by James Cook University (JCU). A summary of data recording and logger deployment is provided in **Table 6-4.** Long-term water quality data logging was not undertaken in areas of minor dredging proposed for the barge/ferry terminals or at the existing Albatross Bay spoil ground which would receive the dredge spoil.

The loggers recorded turbidity and light (photo-synthetically active radiation, PAR) approximately 0.5m above the seabed at 10-minute intervals from November 2007 to March 2008. The JCU turbidity instrument uses an optical backscatter sensor to measure concentration of particles in the water. The output from this instrument is within +/–2% that of a standard nephelometer for silt and clay size particles and is expressed as Nephelometric Turbidity Units-equivalent (NTU-e).

Table 6-4 Summary of Project Long-Term Data Collection Program

Logger location	Date	Event	Comments
Port area	12/11/2007	Installation	Completed
	10/12/2007	Download 1	Logger was not found. Data lost
	19/12/2007	Installation of replacement logger	Completed
	25/01/2008	Download 2	Completed
	5/03/2008	Download 3 and retrieval	Completed
	17/06/2010	Installation	Completed
New spoil ground	12/11/2007	Installation	Completed
	10/12/2007	Download 1	Completed
	25/01/2008	Download 2	Data downloaded to 23/01/08 (battery failure)
	18/03/2008	Download 3 and retrieval	Data downloaded to 3/03/08 (battery failure)
	17/06/2010	Installation	Completed
Pera Head	19/12/2007	Installation	Completed
	25/01/2008	Download 1	Data downloaded to 6/01/08 (battery failure)
	18/03/2008	Download 2 and retrieval	Completed except deposition data was not downloaded due to malfunction of logger
	17/06/2010	Installation	Completed
Boyd Point	12/2006	Installation	Data provided by Chalco
	7/2007	Monthly downloads	Data provided by Chalco

Additional data from two in-situ loggers previously installed by JCU at Boyd Point to the north of the proposed port area was also considered. Reports of this data (GHD 2007c-2007h) were provided to RTA by Chalco and encompassed the period December 2006 to July 2007. The location of all data loggers is shown in **Figure 6-22**.

Results of the long-term data collection are discussed in **Section 6.4.4**.

6.4.3 Short-Term Physical and Chemical Water Quality Assessment

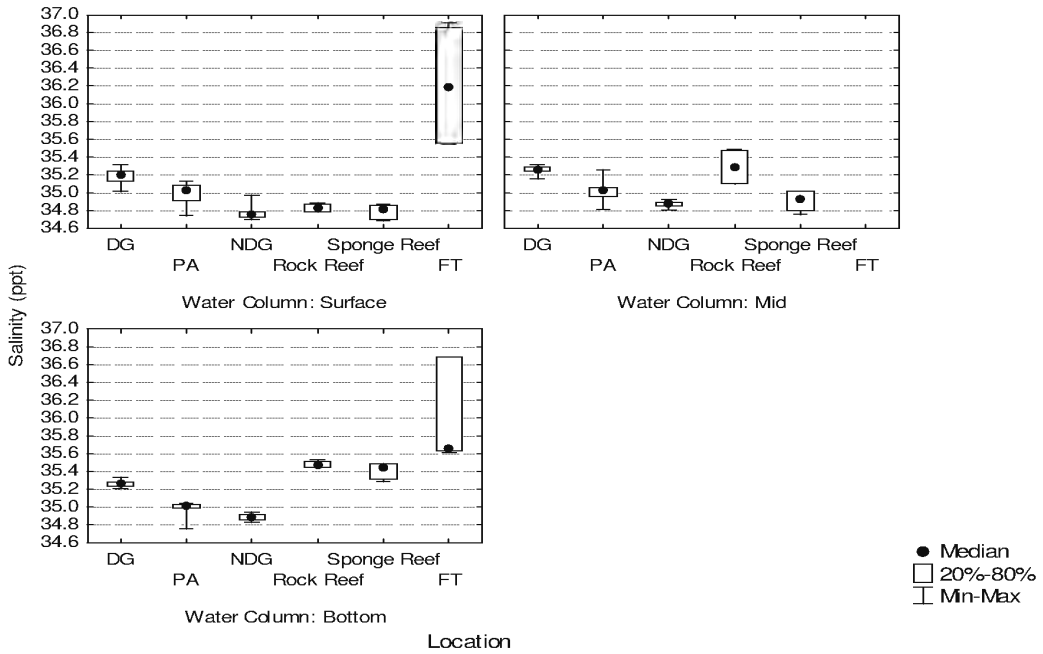
This section summarises the physical and chemical results from water sampling completed during the short-term field investigations in October 2007.

6.4.3.1 Salinity

The concentration of salinity in marine waters sampled ranged from 34.7 parts per thousand (ppt) adjacent to the proposed port development and spoil ground area to 36.9ppt at the proposed Hey River Terminal location. Apart from the barge/ferry terminal areas, salinity

concentrations in the Embley and Hey Rivers were generally consistent between all sites. Salinity concentrations within the barge/ferry terminal areas were marginally higher and more variable (35.6ppt to 36.9ppt) (refer **Figure 6-23**). In terms of vertical profiling, salinity was similar between surface, mid and bottom depths at each location, except for the rock reef and sponge habitats between Boyd Point and Pera Head, which exhibited a minor increase in salinity at increasing depths.

Salinity typically increases in estuary systems over the flooding tide due to "fresh" seawater intrusion. Interestingly, at the time of sampling, salinity at Hey River was elevated compared with all other sampling locations. It would normally be expected that due to daily freshwater input from the catchment, salinity and conductivity would be lower than those displayed at offshore marine locations. However, it has been previously identified that tropical estuary systems can develop elevated salinities towards the end of the dry season as a result of increased evaporation rates in their upper reaches.

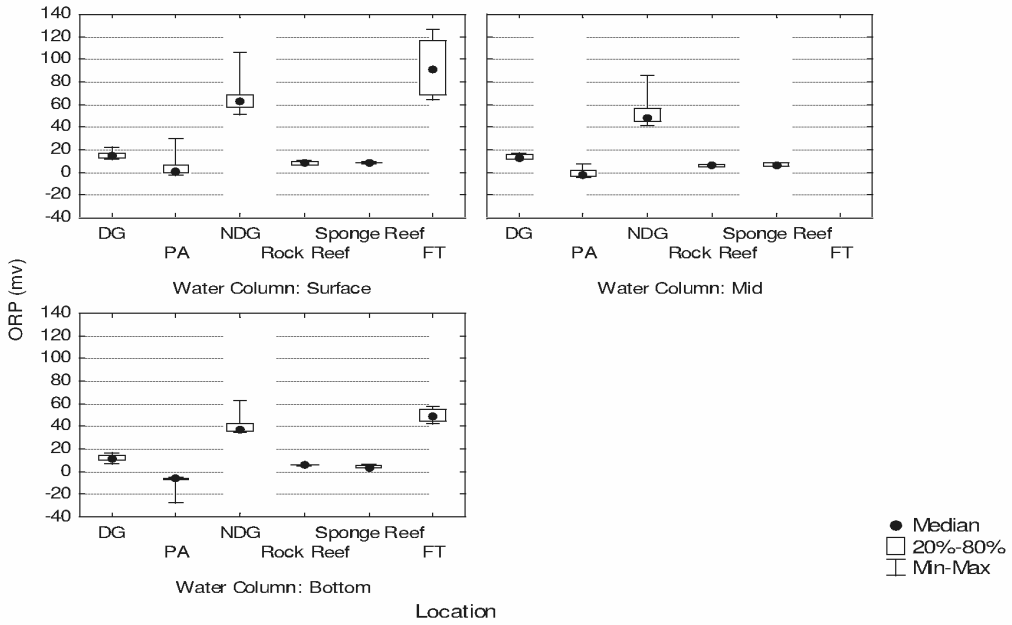


Legend: DG = Disposal Ground – Albatross Bay; PA = Port Area – Boyd Bay; NDG = New Disposal Ground – offshore from Boyd Point; FT = Ferry Terminals.
Note: Mid depths were not recorded at the ferry terminal due to the shallow depth.

Figure 6-23 Salinity Measured (October 2007) at Surface, Mid and Bottom Depths

6.4.3.2 Oxidation Reduction Potential (ORP)

Oxidation reduction potential (ORP) ranged from –27 millivolts (mv) in the port area to 126mv at the Hey River terminal area. The Albatross Bay spoil ground, port area, sponge reef and rock reef areas displayed similar median ORP values of between 0mv and 20mV while the new spoil ground and ferry terminal areas displayed higher ORP values compared with all other locations (median range was between 40mv and 90mv). Generally there was no variation in ORP between surface, mid and bottom depths within each location (refer **Figure 6-24**).

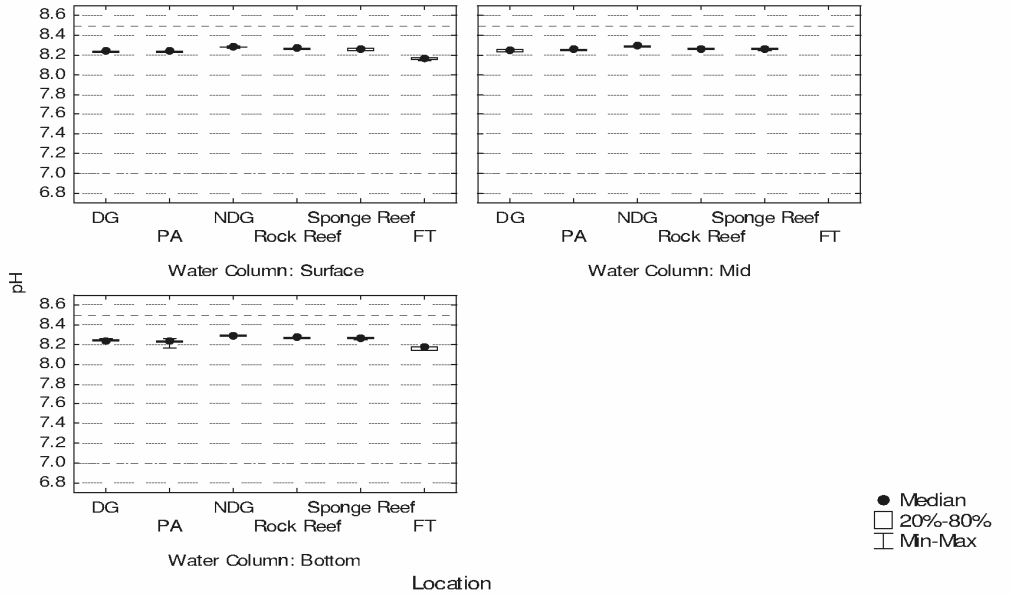


Legend: DG = Disposal Ground – Albatross Bay; PA = Port Area – Boyd Bay; NDG = New Disposal Ground – offshore from Boyd Point; FT = Ferry Terminals.
Note: Mid depths were not recorded at the ferry terminal due to the shallow depth.

Figure 6-24 ORP Measured (October 2007) at Surface, Mid and Bottom Depths

6.4.3.3 pH

pH ranged between 8.14 at the barge/ferry terminal locations in the Embley and Hey Rivers and 8.29 at the proposed new spoil ground. There was no variation in pH within and between locations across all sample depths. All locations were consistent with the ANZECC/ARMCANZ (2000) guideline range of between 7 and 8.5 (refer **Figure 6-25**).

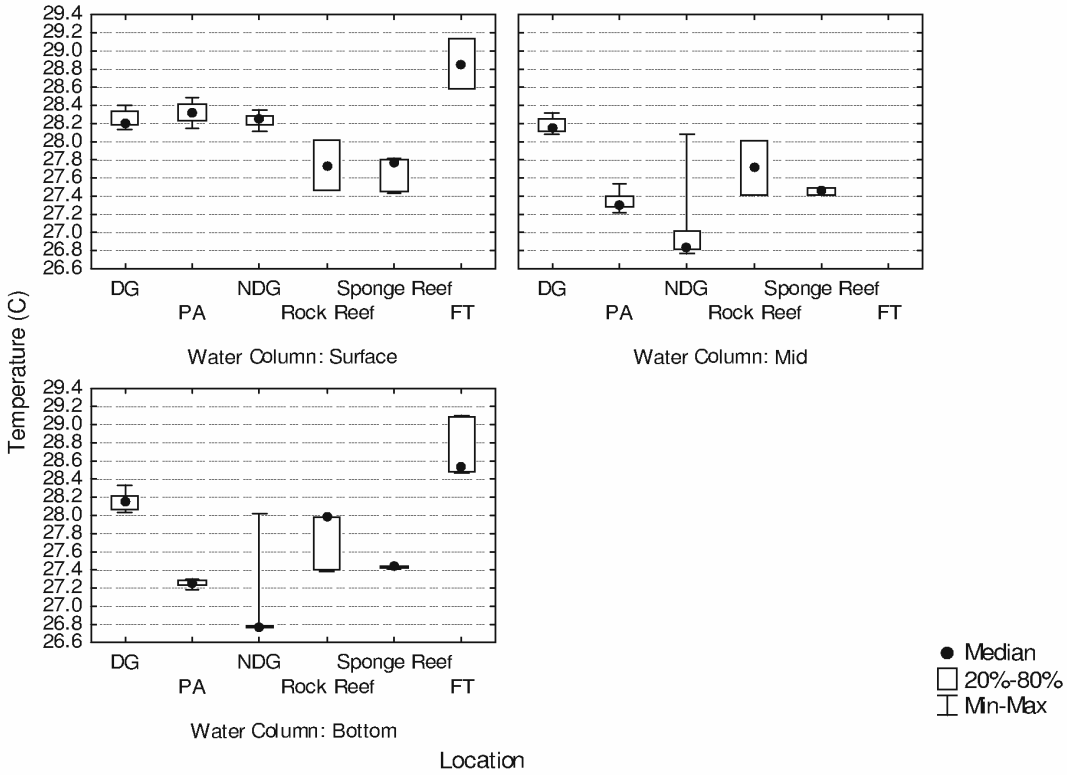


Legend: DG = Disposal Ground – Albatross Bay; PA = Port Area – Boyd Bay; NDG = New Disposal Ground – offshore from Boyd Point; FT = Ferry Terminals.
Red line = ANZECC/ARMCANZ (2000) guideline range.
Note: Mid depths were not recorded at the ferry terminal due to the shallow depth.

Figure 6-25 pH Measured (October 2007) at Surface, Mid and Bottom Depths

6.4.3.4 Temperature

Temperature ranged from 26.8°C at the new spoil ground to 29.1°C at the Hey River terminal area. While surface temperatures remained relatively constant between locations, mid and bottom depth temperatures were more variable (refer **Figure 6-26**).



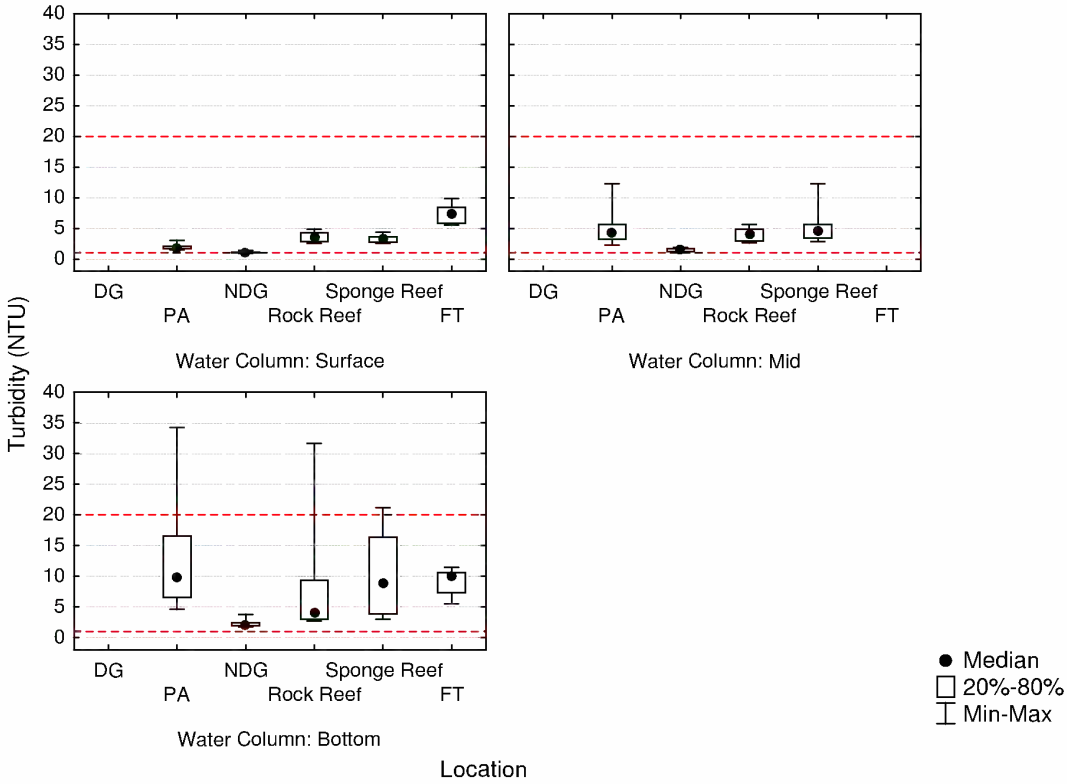
Legend: DG = Disposal Ground – Albatross Bay; PA = Port Area – Boyd Bay; NDG = New Disposal Ground – offshore from Boyd Point; FT = Ferry Terminals.
Note: Mid depths were not recorded at the ferry terminal due to the shallow depth.

Figure 6-26 Temperature Measured (October 2007) at Surface, Mid and Bottom Depths

6.4.3.5 Turbidity

Turbidity was measured with a Troll 9000 side scatter instrument. Values ranged from 0.86NTU at the proposed spoil ground to 34.25NTU at the proposed port area. Generally, median turbidity values were from 0–10NTU at all locations. Both surface and mid column depths tended to be lower and showed less variation in turbidity compared with bottom depths. The deeper waters of the proposed spoil ground did not follow this trend, recording similar turbidity ranges throughout the water column (refer **Figure 6-27**). Median turbidity values from each location complied with the adopted ANZECC/ARMCANZ (2000) guideline range of 1–20NTU (refer **Figure 6-27**). Turbidity concentrations were not recorded within the Albatross Bay spoil ground due to a malfunction of the sampling probe in the field.

Turbidity at estuarine sites recorded the highest median value compared with other locations. High turbidity regimes are typical in estuarine systems, with the effects of catchment runoff, shallow bathymetry and high current velocities mobilising fine sediments into the water column. The functioning of estuary dynamics acts to trap fine sediments, leading to a naturally turbid environment.



Legend: DG = Disposal Ground – Albatross Bay; PA = Port Area – Boyd Bay; NDG = New Disposal Ground – offshore from Boyd Point; FT = Ferry Terminals.
Red line = ANZECC/ARMCANZ (2000) water quality guideline range.
Note: Mid depths were not recorded at the ferry terminal due to the shallow depth.

Figure 6-27 Turbidity Measured (October 2007) at Surface, Mid and Bottom Depths

6.4.3.6 Dissolved Metals

Dissolved metal concentrations in water samples collected from the proposed port area and adjacent soft sediments habitat, Pera Head reef, proposed new spoil ground and the existing Albatross Bay spoil ground are summarised in **Table 6-5**. Summary findings of the metal analyses are:

- cadmium, chromium, copper, manganese, mercury, nickel and lead concentrations were at or below the laboratory limit of reporting (LOR) from all sites;
- aluminium concentrations were consistent across all sample sites, ranging between 34 micrograms per litre (µg/L) and 36µg/L;
- arsenic concentrations were consistent between sites, ranging between 1.7µg/L and 1.9µg/L;
- the concentration of iron in samples from all locations was 70µg/L; and
- with the exception of zinc, all sites displayed metal concentrations consistent with ANZECC/ ARMCANZ (2000) water quality guideline levels. Zinc concentrations ranged between 30µg/L and 120µg/L across all sites, which is above the guideline of 15µg/L.

Table 6-5 Dissolved Metal Concentrations in Water Samples, October 2007

Location	Site Name	Date Sampled	Aluminium	Arsenic	Cadmium	Chromium	Copper	Iron	Manganese	Mercury	Nickel	Lead	Zinc
Unit			µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
LOR			**<30**	**<1**	**<0.1**	**<1**	**<1**	**<20**	**<2**	**<0.1**	**<1**	**<1**	**<3**
Guideline					**5.5**	**4.4**	**1.3**			**0.4**	**70**	**4.4**	**15**
Port area	PA5	22/10/2007	36	1.9	<0.1	<1	<1	70	3	<0.1	<1	<1	**41**
Soft sediment habitat adjacent to Port Area	Port Soft	22/10/2007	35	1.9	<0.1	<1	<1	70	<2	<0.1	<1	<1	**49**
Rock reef (Pera Head)	PAR2A	22/10/2007	34	1.8	<0.1	<1	<1	70	<2	<0.1	<1	<1	**30**
New disposal ground	NDG3	22/10/2007	35	1.7	<0.1	<1	<1	70	<2	<0.1	<1	<1	**41**
Disposal ground (Albatross Bay)	DG1	22/10/2007	35	1.8	0.1	<1	<1	70	<2	<0.1	<1	<1	**120**

µg/L = micrograms per litre; LOR = limit of reporting by the laboratory
Note: Bold values indicate an exceedance of ANZECC/ARMCANZ (2000) water quality guideline for respective metals

6.4.3.7 Nutrients

Nutrient concentrations reported from the proposed port area and adjacent soft sediments habitat, Pera Head reef, proposed new spoil ground and the existing Albatross Bay spoil ground are provided in **Table 6-6**. Summary findings of the nutrient analyses are:

- Total nitrogen (TN) concentrations ranged between 0.7 milligrams per litre (mg/L) and 1.3mg/L, and mimic Total Kjeldahl Nitrogen (TKN) concentrations. The concentration of TN in samples from all locations was above the ANZECC/ARMCANZ (2000) water quality guideline of 0.1mg/L;
- Ammonia concentrations ranged between 0.01 and 0.04mg/L. Ammonia concentrations in samples from sites located within the existing spoil ground, new spoil ground and rock reef area exceeded the ANZECC/ARMCANZ (2000) guideline of 0.01mg/L;
- Nitrate, nitrite and reactive phosphorous concentrations were at, or below, the LOR in samples analysed from all locations. Compliance assessment was not possible as the LOR provided by the laboratory was above the guideline level for each of these parameters; and
- Total phosphorus (TP) concentrations ranged between 0.03mg/L and 0.06mg/L. All sites exceeded the ANZECC/ARMCANZ (2000) guideline of 0.015mg/L and 0.01mg/L for inshore and offshore environments respectively.

6.4.3.8 Biological

Chlorophyll-a concentrations measured at each location are provided in **Table 6-6.** Chlorophyll-a concentrations ranged between 0.09µg/L and 0.35µg/L. In all samples, the concentration of chlorophyll-a was less than the ANZECC/ARMCANZ (2000) water quality guidelines of 1.4µg/L and 0.9µg/L for inshore and offshore waters respectively.

Marine nutrient and chlorophyll-a concentrations generally demonstrated little or no variation between sites but were elevated against ANZECC/ARMCANZ (2000) guidelines. Nitrate and phosphorous concentrations were found to be similar to previous studies undertaken in Albatross Bay (Burford and Rothlisberg 1999) while chlorophyll-a concentrations were slightly lower.

Table 6-6 Nutrient and Chlorophyll-a Concentrations in Water Samples, October 2007

Location	Site Name	Date Sampled	Ammonia as N	Nitrate as N	Nitrite as N	Total Kjeldahl Nitrogen	Total Nitrogen	Reactive Phosphorus	Phosphorus - Total	Chlorophyll -a
Unit			**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**µg/L**
LOR			**<0.01**	**<0.01**	**<0.01**	**<0.1**	**<0.1**	**<0.01**	**<0.02**	**<0.02**
Guideline										
Inshore			**0.01**	**0.008**	**0.008**		**0.1**	**0.005**	**0.015**	**1.4**
Offshore			**0.006**	**0.004**	**0.004**		**0.1**	**0.005**	**0.01**	**0.9**
Port area	PA5	10/22/2007	0.01	**0.01**	<0.01	1.3	**1.3**	**<0.01**	**0.06**	0.35
Soft sediment habitat adjacent to port area	Port Soft	10/22/2007	0.01	**<0.01**	<0.01	0.7	**0.7**	**<0.01**	**0.05**	0.35
Rock reef (Pera Head)	PAR2A	10/22/2007	**0.02**	**<0.01**	<0.01	0.7	**0.7**	**<0.01**	**0.05**	0.57
New disposal ground	NDG3	10/22/2007	**0.03**	**<0.01**	<0.01	0.7	**0.7**	**<0.01**	**0.03**	0.09
Disposal ground (Albatross Bay)	DG1	10/22/2007	**0.04**	**<0.01**	<0.01	0.8	**0.8**	**<0.01**	**0.06**	0.10

mg/L = milligrams per litre; LOR = limit of reporting by the laboratory
Note: Bold values indicate an exceedance of ANZECC/ARMCANZ (2000) water quality guideline for respective nutrients of chlorophyll-a

6.4.4 Long-Term Water Quality Assessment: Turbidity, TSS and PAR

This section summarises the long-term data collected for turbidity, total suspended solids (TSS) and photosynthetically active radiation (PAR) between November 2007 and March 2008 from in-situ data loggers as summarised in **Table 6-4**.

6.4.4.1 Turbidity and TSS

The turbidity recorded at each long-term monitoring location is summarised in **Table 6-7**and presented graphically as a line plot of NTU-e in **Figure 6-28**. Maximum turbidity data was recorded at the three in-situ logger locations during two periods in January and February 2008 (refer **Figure 6-28**). During these two periods turbidity reached levels of 503NTU-e, 339NTU-e and 149NTU-e at the proposed port area, Pera Head and proposed new spoil ground respectively. Median turbidity ranged from 2NTU-e at Pera Head to 13NTU-e at the proposed port area. Mean turbidity values recorded at the proposed port area were significantly higher than mean turbidity values at the proposed new spoil ground and Pera Head locations (ANOVA; $p<0.05$).

Table 6-7 Summary of Background Turbidity Data

Location	No. of samples	Units	Mean	Median	Minimum	Maximum	Standard Deviation
Port area	5341	NTU-e	25.2	15.0	<0.1	503	37.0
		TSS mg/L*	179	106	<1	3566	262
New disposal ground (offshore)	7994	NTU-e	19.0	4.6	<0.1	149	32.1
		TSS mg/L*	135	33	<1	1056	228
Pera Head (inshore reef)	5110	NTU-e	15.4	2.2	<0.1	339	30.2
		TSS mg/L*	109	16	<1	2405	214

*converted using factor of 7.09 (refer **Section 6.4.4.3**)

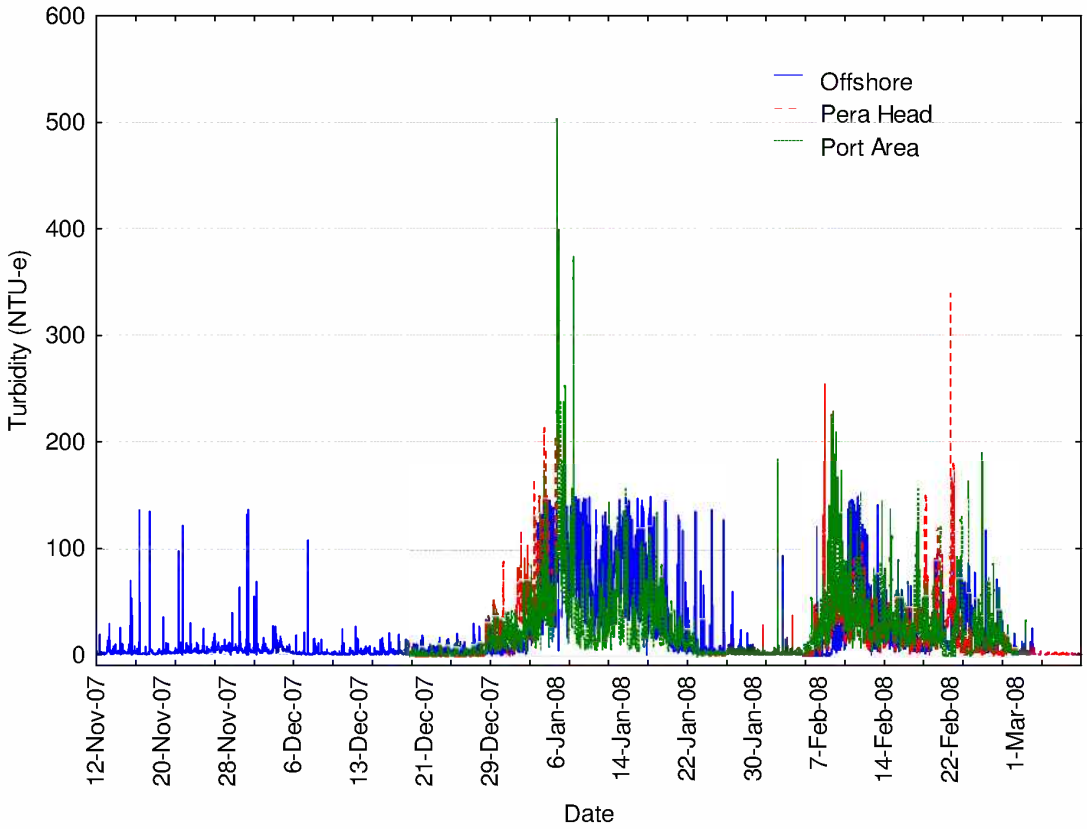


Figure 6-28 Turbidity as NTU-e Measured at Project Locations

6.4.4.2 Photosynthetically Active Radiation (PAR)

PAR measures the spectral range of solar light from 400–700 nanometers (nm), which is the range that organisms are able to use in the process of photosynthesis. The level of PAR penetrating the water column can be greatly affected by turbidity and water depth.

As to be expected, PAR was negatively correlated to turbidity levels at each logger location (refer **Figure 6-29** to **Figure 6-31**). The intensity of light reaching the seabed decreases markedly when suspended materials enter the water column following physical disturbance. Low PAR levels were observed at each logger location with increasing turbidity. Median PAR levels were less than 0.6 micro-Einsteins per square centimetre (µE/cm^2) at both inshore logger locations while the proposed new spoil ground recorded a median of 2.4µE/cm^2. Maximum light levels ranged from 89µE/cm^2 within the port area (refer **Table 6-8**) to 266µE/cm^2 at the proposed spoil ground (refer **Table 6-8**). Pera Head displayed significantly higher ambient PAR levels (mean 13µE/cm^2) compared with all other locations, while the proposed port area displayed considerably lower light levels compared with all other locations ($p<0.05$) (refer **Table 6-8**).

PAR levels were reduced to levels below 2.5µE/cm^2 at median turbidity values greater than 11NTU-e for all locations. Generally, PAR levels within both Pera Head and port site inshore locations were reduced to approximately 0µE/cm^2 PAR between 12 and 18NTU-e. PAR at the proposed new spoil ground was extinguished at median turbidity levels of 8NTU-e.

This relationship includes a function of depth, with significantly more light being stripped by the water column at the proposed disposal site (–23mLAT) as compared to both the proposed port location (–12mLAT) and the Pera Head site (–8mLAT).

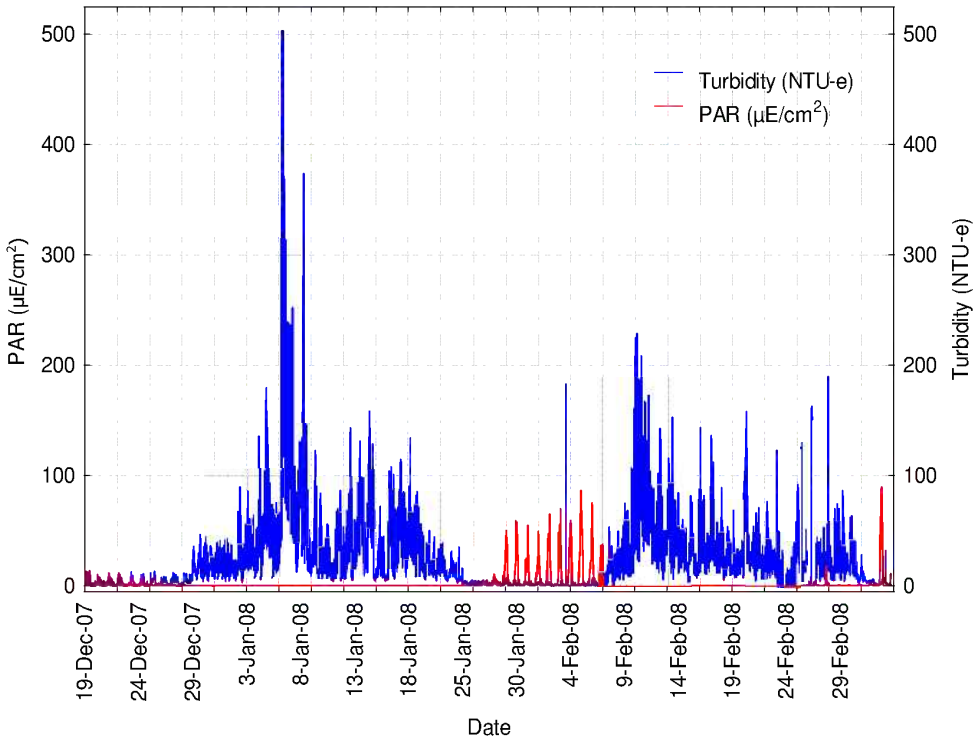


Figure 6-29 Turbidity and PAR Results for the Proposed Port Area

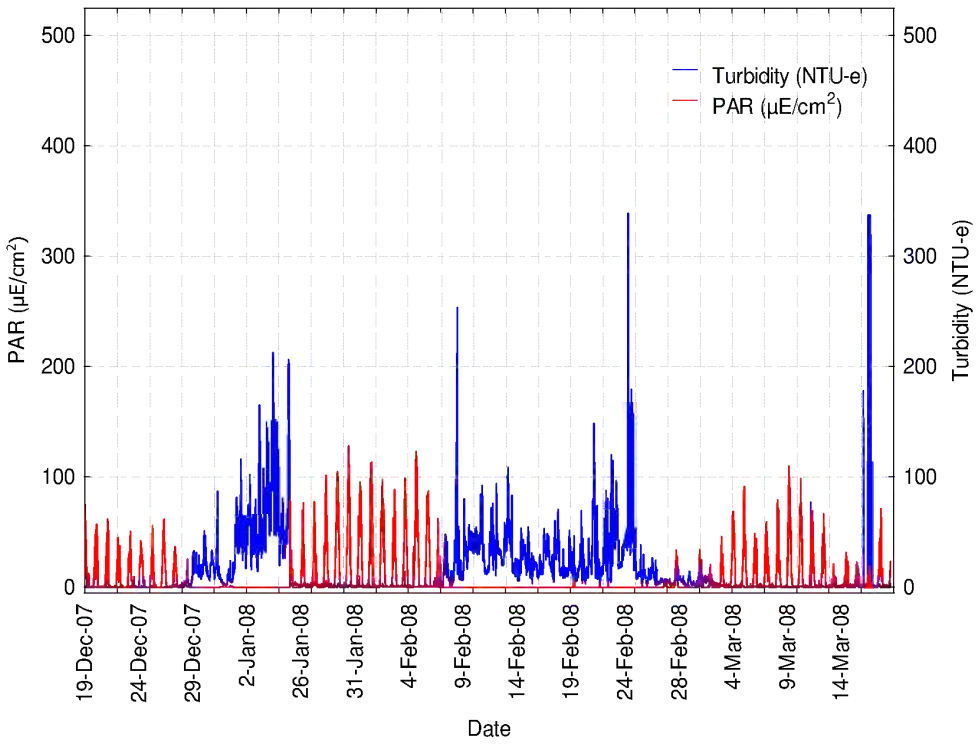


Figure 6-30 Turbidity and PAR Results for Pera Head

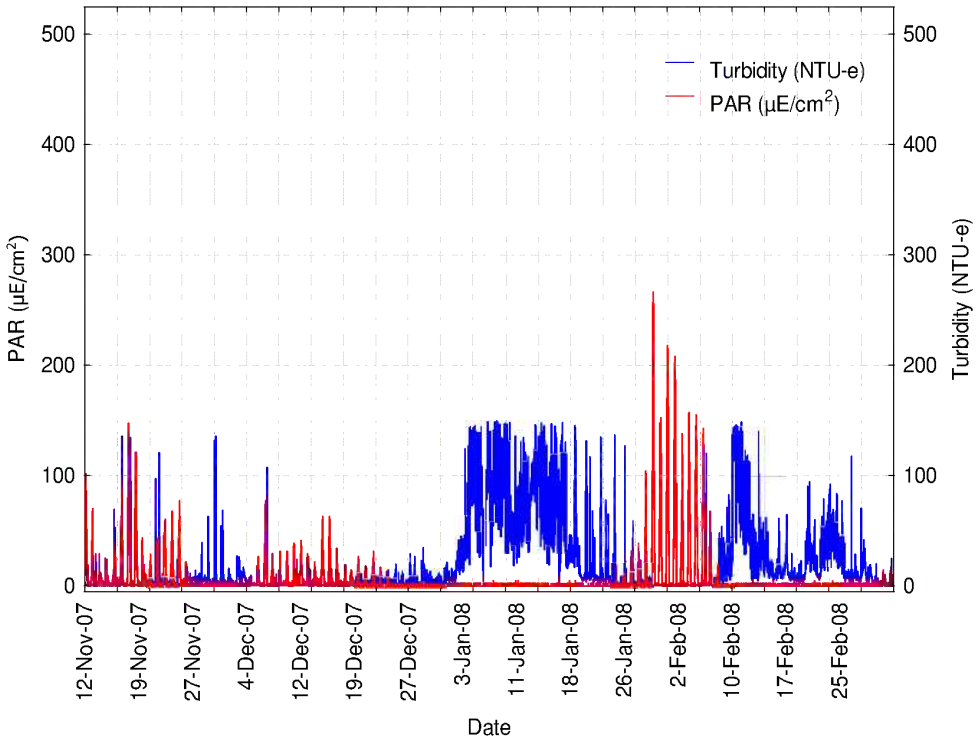


Figure 6-31 Turbidity and PAR Results for the Proposed New Spoil Ground Location

Table 6-8 Statistical Summary of PAR at Project Logger Locations

Location	Parameter	No. of samples	Mean	Median	Minimum	Maximum	Standard Deviation
Port area	PAR (uE/cm^2)	2701	4.2	0.55	0	89.8	11.5
Proposed spoil ground (offshore)	PAR (uE/cm^2)	4052	10.9	2.43	0	266.3	27.8
Pera Head	PAR (uE/cm^2)	2574	13.5	0.36	0	128.1	23.5

6.4.4.3 Turbidity – Total Suspended Solids Relationship

As part of the long-term water quality logger program, James Cook University established a relationship between turbidity (NTU-e) and TSS expressed in mg/L. Establishment of this relationship extended the turbidity/PAR relationship described above to include TSS, which is the primary predictive output of turbidity plume modelling undertaken for dredging projects.

To establish this relationship, the turbidity logging instrument was placed in a large container (50L or greater) with black sides and filled with seawater. The basic approach is to measure turbidity (NTU-e) after a known mass of marine sediment from the study site has been added to the container and stirred with a paddle connected to a slowly rotating electric drill. After a turbidity reading has been taken, a water sample is drawn off from the container and analysed for TSS using standard laboratory techniques. TSS analysis was undertaken by the JCU Australian Centre for Tropical and Freshwater Research which is accredited for these analytical techniques. Additional sediment is then added to increase the recorded TSS concentration and the sampling process repeated to achieve a strong calibration with turbidity (NTU-e).

The turbidity instrument was calibrated using surface sediments obtained at the proposed port location to derive a TSS-NTU-e relationship for existing background conditions. The following relationship was obtained:

TSS (mg/L) = 7.09 x turbidity (NTU-e).

Calibration was also undertaken using a combination of surface sediments and deeper clay sediments from the proposed port location to derive a TSS-NTU-e relationship for suspended sediment likely to be generated by dredging. Due to the nature of this material a different relationship was observed:

TSS (mg/L) = 5.4 x turbidity (NTU-e).

Application of the surface sediment calibration (i.e. 7.09) is appropriate in describing ambient TSS regimes. These have been used in the transformation of logger turbidity data to TSS, the correlation of TSS and light conditions (PAR), and predictions regarding light climate of the reef habitats. The application of the 5.4 calibration factor is appropriate when considering future logger based monitoring results during the dredging program. The variation between the two calibration factors originates from differing particle sizes and optical properties of the sediment, and is important to understand when utilising infield loggers for impact monitoring purposes.

6.4.4.4 Modelled PAR and TSS Correlation

The Pera Head in-situ light logger was established at the edge of hard coral habitat. This logger was deployed for a period of three months in a depth of approximately –8mLAT. PAR was logged simultaneously with NTU-e using a back scatter sensor and, by applying the calibration coefficient of 7.09 developed from previous field sediment sampling (refer **Section 6.4.2**), data in NTU-e was converted to TSS in mg/L. PAR and TSS data from Pera Head was analysed and a relationship developed to define ambient light regimes and allow predictive impact assessment for reef habitats within the Project study area. TSS ranges of 0 to 100mg/L have been plotted against the equivalent mean daytime PAR light regimes (µm/m^2/sec) ($r=0.85$, $p<0.0001$) and the following exponential trend fitted to the data (refer **Figure 6-32**):

$$PAR = 24.687e^{-0.0465x}$$

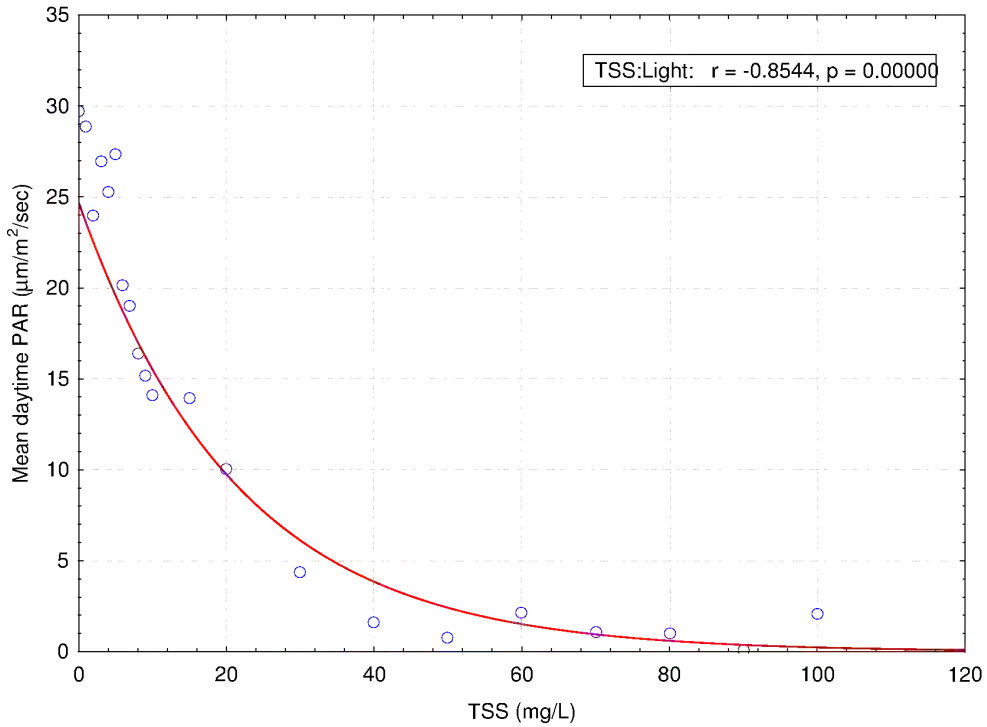


Figure 6-32 Scatterplot of Mean Daytime PAR (µm/m^2/sec) against TSS (mg/L)

By referencing a mean PAR of 500 µm/m^2/sec within the Weipa region (Rothlisberg *et al.* 2005), and adopting the trends presented within the above figure, predicted mean light regimes in 1m depth increments (–8 to –1mLAT) has been completed and light attenuation coefficients (Kd^m) developed for varying ambient TSS regimes (refer **Table 6-9**).

By analysing ambient light regimes, and reviewing lower light thresholds for coral reef survival, a preliminary ranking of the light regime has been developed. These predictions have been developed to help assess impacts from light regime alterations attributable to dredging and discussed within **Section 6.9.2.2**.

The median (50th percentile) of ambient daytime light (PAR) has been recorded at 2µm/m^2/sec from Pera Head. This fits well with published minimal light requirement of 2.0–0.5% surface PAR irradiance for scleractinarian reef building corals (Titlyanov, 1991; Porter *et al.* 1984; and Fricke and Meischner, 1985). Given a mean PAR surface irradiance of 500µm/m^2/sec at Pera Head (Rothlisberg *et al.* 2005) these published minimum light requirements (2.0–0.5%) equate to a PAR light range of approximately 10 to 2µm/m^2/sec. Given a median daytime ambient of 2µm/m^2/sec, the 8m depth contour at Pera Head is considered at the fringe of light regime suited to the long-term survival of inshore corals. Habitats surrounding Pera Head and Boyd Bay confirm a –8mLAT maximum for hard coral growth. Some depth increases in hard coral distribution have been recorded at several locations south of Pera Head. **Table 6-9** presets predicted light regimes down to the 12m depth contour to account for the known maximum hard coral distribution.

Table 6-9 Predicted Mean Light Regimes and Light Attenuation Coefficient (Kd^m) for Varying Ambient TSS Conditions and Depth Intervals (–12 to –1mLAT)

	Depth (mLAT)											
TSS (mg/L)	–12	–11	–10	–9	–8	–7	–6	–5	–4	–3	–2	–1
0	7.2	10.2	14.5	20.7	29.5	42.0	59.8	85.2	121.4	173.0	246.4	351.0
1	6.6	9.4	13.5	19.4	27.9	40.0	57.3	82.2	118.0	169.3	242.9	348.5
2	6.0	8.7	12.6	18.2	26.3	38.0	54.9	79.3	114.7	165.7	239.4	346.0
3	5.8	8.4	12.2	17.7	25.7	37.2	54.0	78.2	113.3	164.3	238.1	345.0
4	5.1	7.4	10.9	16.0	23.4	34.3	50.3	73.8	108.2	158.6	232.6	341.0
5	4.9	7.2	10.6	15.6	23.0	33.8	49.7	73.0	107.2	157.6	231.5	340.3
6	4.5	6.6	9.8	14.5	21.5	31.9	47.3	70.1	103.8	153.8	227.8	337.5
7	4.1	6.1	9.1	13.6	20.3	30.3	45.2	67.5	100.8	150.4	224.5	335.0
8	3.7	5.6	8.5	12.7	19.1	28.8	43.2	65.0	97.8	147.0	221.1	332.5
9	3.5	5.4	8.1	12.2	18.4	27.9	42.1	63.6	96.0	145.1	219.1	331.0
10	3.0	4.5	6.9	10.6	16.3	25.0	38.4	58.9	90.4	138.6	212.6	326.0
15	2.1	3.4	5.3	8.4	13.2	20.8	32.8	51.6	81.3	128.0	201.6	317.5
20	1.4	2.3	3.7	6.0	9.8	16.1	26.3	42.9	70.1	114.6	187.3	306.0
30	0.6	1.0	1.8	3.2	5.6	9.8	17.1	30.1	52.8	92.6	162.5	285.0
40	0.3	0.6	1.1	2.0	3.6	6.7	12.4	23.0	42.5	78.7	145.8	270.0
50	0.1	0.2	0.5	1.0	2.0	3.9	7.8	15.6	31.3	62.5	125.0	250.0
60	0.1	0.1	0.3	0.6	1.2	2.5	5.4	11.5	24.4	51.9	110.5	235.0
70	0.0	0.1	0.1	0.3	0.7	1.6	3.6	8.2	18.7	42.6	96.8	220.0
80	0.0	0.0	0.1	0.2	0.4	1.0	2.4	5.8	14.1	34.5	84.1	205.0
90	0.0	0.0	0.1	0.1	0.3	0.8	2.0	5.1	12.8	32.0	80.0	200.0
100	0.0	0.0	0.0	0.0	0.1	0.3	0.9	2.6	7.5	21.4	61.3	175.0

* TSS and PAR results recorded from logger at Pera Head situated at –8mLAT.
Colour regimes indicate (favourable for hard coral growth), (light limited) and (unsustainable for hard coral growth).
TSS = Total Suspended Solids

Given the limits described above, a PAR of 2µm/m^2/s has been set as the lower end of the "light limited" threshold for this study. The upper bound of "light limited" conditions has been set conservatively at 23µm/m^2/s, being the upper quartile boundary of the ambient light distribution, and above the upper light limited range, described by Titlyanov (1991), of 10µm/m^2/sec. Light regimes greater than a predicted daytime mean of 23µm/m^2/s are considered "favourable" for coral habitats and those below a daytime mean of 2µm/m^2/s "unsustainable".

6.4.4.5 Duration of Turbidity Events

Ambient turbidity events in the Project area can last for several weeks, as demonstrated by long-term water quality logger monitoring results.

Pera Head data loggers deployed during 2007–2008 recorded ambient turbidity events of 9 days and 24 days duration at median event TSS concentrations of 248mg/L and 127mg/L respectively (refer **Figure 6-33**). Data captured from Boyd Point (GHD 2008) reported ambient turbidity events of 23 days and 25 days duration, recording median event TSS concentrations of 163mg/L to 184mg/L respectively (refer **Figure 6-34**).

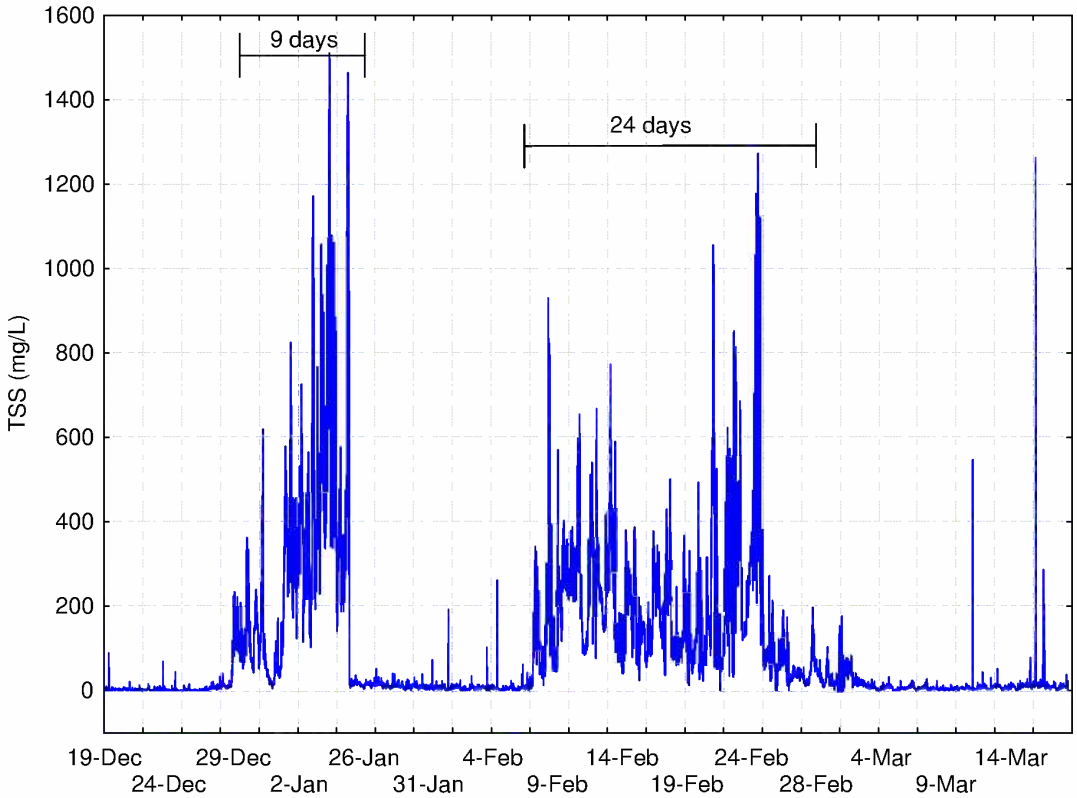


Figure 6-33 Recorded Ambient Turbidity Event Durations December 2007 to March 2008 – Pera Head

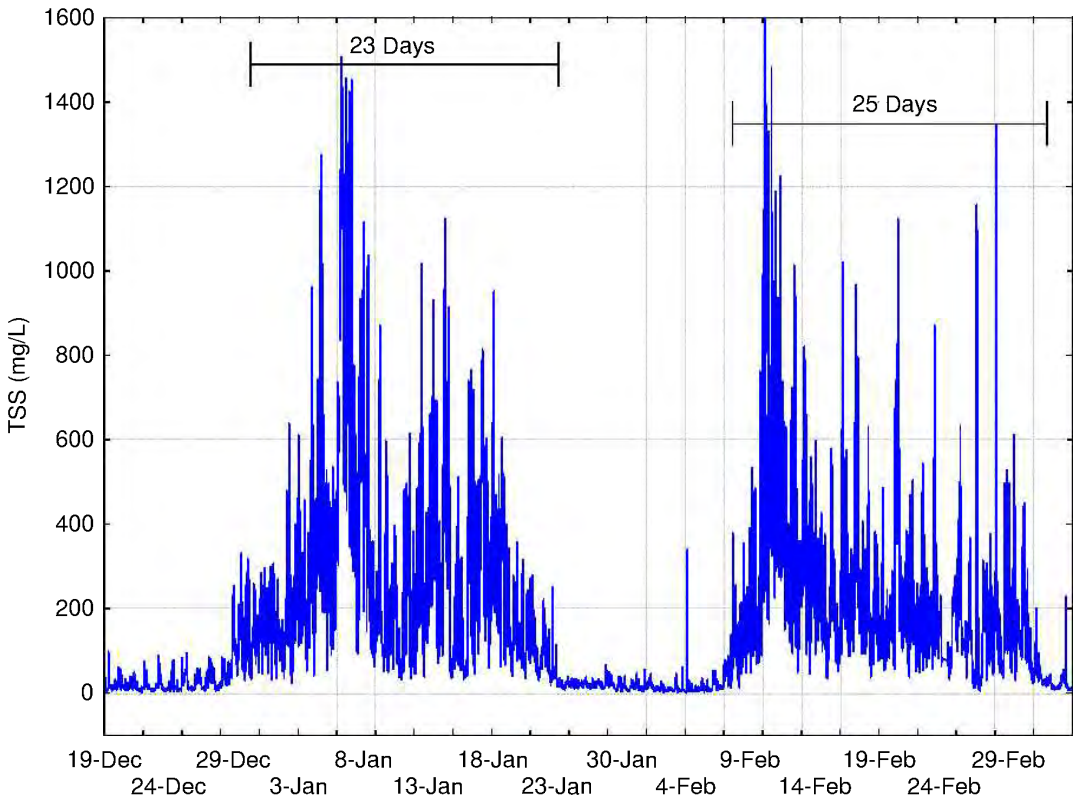


Figure 6-34 Recorded Turbidity Event Durations December 2007 to February 2008 – Boyd Point

Two distinct high ambient turbidity events occurred during the monitoring period from November 2007 to March 2008. These events represent the effects of tropical cyclones and monsoonal lows, which passed through the Gulf region during that period. Although the duration of physical wave and wind effects attributable to these events were experienced at each site over the same period, an extended duration of increased turbidity was recorded at the proposed port location compared to that over nearby Pera Head reef habitat. Field data indicates that even under typical conditions, the coast between Pera Head and Boyd Point, which includes the proposed port area, experiences a general elevation in ambient turbidity over nearby reef habitat. These differences are likely related to prevailing bathymetry, water depth, current dynamics, and increased proportion of fine sediment grain size. Although the Pera Head logger was located in much shallower waters than the port location logger (8m depth versus 12m depth) it exhibited almost 10 days less turbidity elevation.

6.4.4.6 Reef Habitat Turbidity

Ambient turbidity observed at different survey locations can be influenced by the depth, level of wind and wave exposure, bathymetric profile and prevailing sediment characteristics. Detailed video inspection confirmed a general increase in sediment grain size at locations surrounding Pera Head and Boyd Point compared with that of the bay between them. The shallow nature of these reef areas drives mobilisation of fine sediments through the area, with relatively minor wind and wave events being sufficient to mobilise fines and keep these materials in suspension. In combination with the presence of outcropping iron stone, shallow water, and increased light availability, fine sediment mobilisation is considered an important process facilitating the presence of hard coral around Boyd Point, Pera Head and reefs south to Thud Point. Summary statistics confirm these reef areas are subject to increased mean PAR levels (refer **Table 6-8**) and reduced mean turbidity concentrations (refer **Table 6-7**) compared to adjacent nearshore

habitats that don't experience significant sediment remobilisation, such as at the proposed port area between Pera Head and Boyd Point.

6.4.4.7 Key Turbidity Drivers

Turbidity can be generated by a range of natural processes including wind, wave and tidal action.

Wind direction and wind speed data were compared statistically against turbidity data from each logger location (proposed port area, proposed spoil ground and Pera Head reef). Significant differences were observed between wind direction and turbidity values displayed within each logger location ($p<0.05$) (refer **Figure 6-35**). Analysis using Tukeys unequal N HSD (StatSoft 2008) identified significantly higher turbidity values when wind was blowing onshore (westerly direction) compared with offshore (easterly) ($p<0.05$). The increased fetch over open water increases the energy imparted to the system from onshore winds. This process induces waves/swell or local sea chop, which mobilise sediments from the sea floor. Onshore westerly winds dominate the summer monsoon period at the proposed port facility, and can be expected to result in a naturally elevated background turbidity regime at this time.

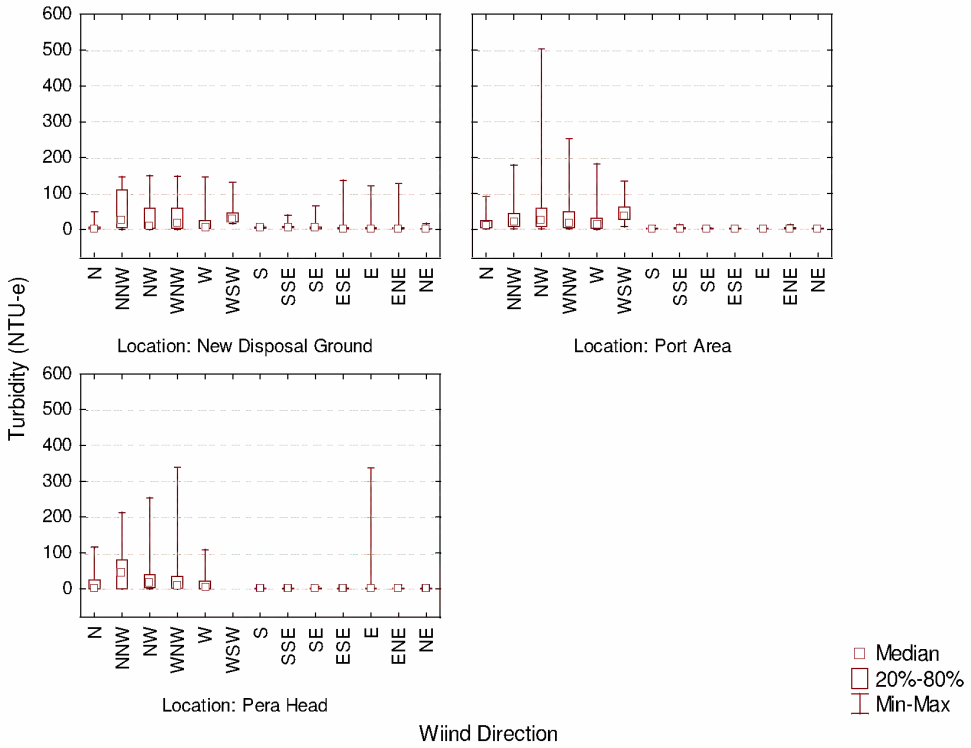


Figure 6-35 Turbidity (NTU-e) and Wind Direction at Project Turbidity Logger Locations

Data for the analysis of tidal influences over turbidity were extracted from Seafarer/Tides (Australian Hydrographic Service 2007) for Weipa Port. Tide data was divided into spring and neap tidal phases defined by tidal amplitude. Generally, neap tides displayed significantly higher turbidity at Pera Head and the proposed new spoil ground ($p<0.05$). However, no significant turbidity differences were identified within the port area between neap and spring tidal phases ($p>0.05$) (refer **Figure 6-36**). Neap tides result in reduced current flow and lower ambient energy within the water column. In the absence of significant wind and wave forces, increased turbidity at the seabed and subsequent sediment deposition can coincide with neap tidal periods.

Wave height and direction is also a critical factor in how ambient water quality is driven at the study site. This is demonstrated to some extent in **Figure 6-35**, which clearly shows the effect that wind direction, and more importantly, the waves generated from it, has on the observed turbidity. Under "event" based wind and wave conditions, the role of spring and neap tidal states in driving observed water quality is reduced markedly.

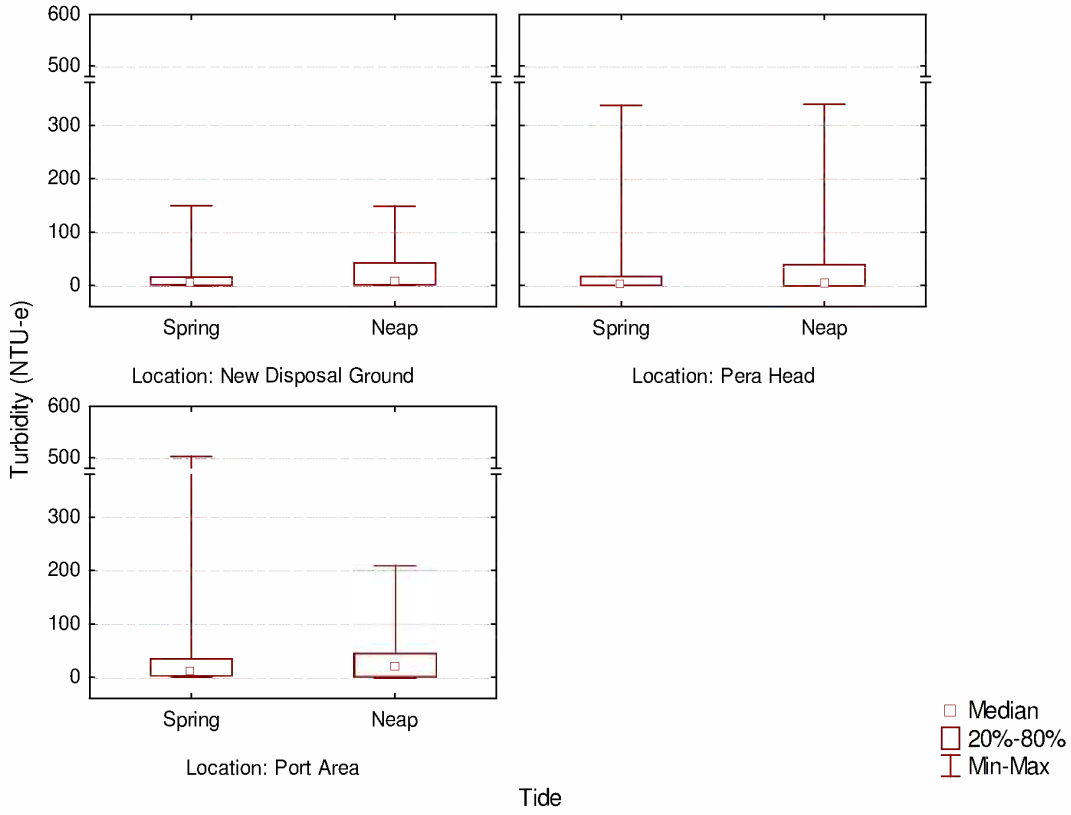


Figure 6-36 Turbidity, Spring and Neap Tidal Phases at Project Turbidity Logger Locations

6.4.4.8 Boyd Point Turbidity

Chalco surveys of Boyd Point turbidity during 2006–2007 confirm the trends identified during these studies for the Project (November 2007 – March 2008). As found in the Project study, it was concluded (GHD 2007c-h) that a coarser sediment fraction at shallow reef systems resulted in a generally reduced turbidity. Data collected from a deeper water logger at Boyd Point (–10mLAT) showed elevated turbidity concentrations, similar to those at the proposed port facility.

6.5 Sediment Characteristics

Dredging of sediments is required at the proposed port development site between Pera head and Boyd Point, and at the barge/ferry terminals at Hornibrook, Humbug and Hey River.

6.5.1 Port Area Dredging and Spoil Disposal Requirements

Approximately 6,500,000m^3 would be dredged as part of the proposed port development, including berth areas and departure channel. The dredging volume required is based on the assumption that the port has to be capable of accepting bulk carrier vessels up to 185,000 dead

weight tonnage (dwt) and 18.1m draft. For the purposes of evaluation studies, it has conservatively been assumed that vessel departures are unrestricted by tides and hence the depth of dredging required has been matched to this assumption.

Dredging is proposed to be undertaken using a cutter suction dredge (CSD), discharging the material part way up the ladder and leaving the material on the seabed for short duration before being extracted by a large trailing suction hopper dredge (TSHD). The cutter suction dredge would work in campaigns of approximately two weeks. This method, which requires rehandling, was selected to minimise the amount of time in overflow mode while using the TSHD compared with loading straight from the CSD to hopper barges. The selected method almost halves the potential overflow period, and fines generation. Overflow would be reduced from approximately 100 hours per week to 60 hours per week. Furthermore, the hopper of the TSHD would be significantly larger than a hopper barge and would provide a greater opportunity for fines to settle during loading. Alternative methods such as bucket dredgers loading into hopper barges would result in an impractically long dredging campaign as their rate of dredging is significantly slower than CSD or TSHD.

Once the TSHD dredge has filled its hopper the sediments will be transported by the TSHD to the proposed new spoil ground located approximately 17km west (central point) of Boyd Bay. Upon entering the designated area for dumping, the dredge would typically slow whilst material is being placed, however, a minimum steaming speed is required to maximise agitation within the hopper and clear dredged material, which would not otherwise be effected if the dredge were to remain stationary. Spoil will be discharged below keel level to minimise turbidity generation. Placement of spoil material at the spoil disposal ground would be completed so as to achieve a relatively uniform cover. The duration of each dump event would be approximately 30 minutes.

The route from loading to the disposal ground is a direct line west-north west from the loading area. There are no obstacles or hazards along this route. The return trip from the dredge area is approximately 4 – 4.5 hours.

Dredging and spoil disposal would be conducted 24 hours a day, seven days a week. Dredging would optimally occur over approximately 36-weeks starting at the beginning of the dry season and continuing until work is completed. This approximate 36-week dredging period does not allow for any delays such as for breakdowns, maintenance, or environmental monitoring, which would extend the duration of dredging but also interrupt suspended sediment plume generation. It also excludes stand-down time for inclement weather which is possible over the tropical wet season. Therefore whilst 36-week continuous dredge period has been conservatively assumed for modelling purposes in the EIS, a two-year Sea Dumping Permit is proposed to allow work to be completed in the following dry season if required. If all necessary approvals are attained, the dredging would occur between May 2012 and October 2013

Detailed dredging procedures would be developed with the dredging contractor following engagement. These procedures will be outlined in the Dredge Management Plan (DMP). A framework for the DMP is provided in **Section 6.10**. The DMP would be developed for approval by DSEWPaC.

Alternative spoil disposal options are not feasible for construction schedule and environmental reasons (refer **Section 1.6.11**). There is no requirement for reclamation in the Port area as part of the Project. Beach nourishment is not feasible due to the high clay content and deposition would likely result in impacts to turtle nesting and hatching success through smothering and change of beach profile. Placement of material on land is not feasible due to the significant volumes involved and the potential for saline water intrusion into a limited fresh groundwater resource. Sea disposal was considered the only viable option for spoil disposal.

6.5.2 Ferry and Barge Terminals Dredging and Spoil Disposal Requirements

The development of barge and ferry terminals at Hornibrook, Humbug and in the Hey River is proposed as part of the Project to provide a transport route for equipment and personnel. Minor capital dredging would be required in each of these areas to accommodate barge and/or ferry access to the proposed terminals. Respective dredge volumes and dredge footprint areas are:

- approximately 18,700m^3 to be removed from the Hornibrook ferry terminal over an area of 10,450m^2;
- approximately 17,300^3 to be removed from the Hey River barge/ferry terminal over an area of 8,250m^2; and
- approximately 10,700m^3 to be removed from the Humbug barge terminal over an area of 5,420m^2.
- annual maintenance dredging of approximately 7,000m^3 combined from each terminal post construction.

All dredge areas would be required to be dredged to a target depth of –2.0mLAT, corresponding to 0–2m of material being removed. Dredged material from these areas is proposed to be placed at the existing Albatross Bay spoil ground.

The dredging contractor has yet to be appointed and final details of dredging method will be determined with the dredging contractor. However, following a review of dredging equipment options for the Project, dredging for offshore spoil disposal is anticipated to be undertaken using a barge-mounted backhoe/dipper dredge, with a bucket up to approximately 13m^3.

The excavator/dipper type of dredge is not self-propelled but can move itself during the dredging process by manipulation of spuds and the excavator / dipper arm. A typical sequence of operation is as follows:

- The dredge, scow barges, and attendant plant are moved to the work site.
- The dredge is moved to the point where work is to start; part of the weight is placed on the forward spuds to provide stability.
- A split hull barge is brought alongside and moored into place by winches and cables on the excavator/dipper dredge.
- The dredge begins digging and placing the material into the moored barge.
- When all the material within reach of the bucket is removed, the dredge is moved forward by lifting the forward spuds and manoeuvring with the bucket and stern spud.
- The loaded barges are towed to the disposal area and emptied by bottom dumping. These procedures are repeated until the dredging operation is completed.

Material will be disposed of at the spoil ground via a split hull barge. The barge would typically dump the material in an arc within the spoil ground as it turned to return to the dredging site. Placement of spoil material at the disposal ground would be completed so as to achieve a relatively uniform cover. Disposal would be undertaken at a speed of approximately five to ten knots, typical for such a disposal operation. The duration of each disposal event within the spoil ground would be approximately 15-25 minutes.

The route from loading to the disposal ground is a direct line north-west from the end of the South Channel. There are no obstacles or hazards along this route. It is assumed that two barges would complete the return trip to the spoil ground in approximately three to four hours, travelling at 11 knots.

Dredging and spoil disposal would be conducted 24 hours a day, seven days a week. Dredging at the barge/ferry terminals should take only one to two weeks each and would preferably be undertaken in the dry season. This approximate 6-week dredging period does not allow for any delays such as for breakdowns, maintenance, or environmental monitoring, which would extend the duration of dredging but also interrupt suspended sediment plume generation. It also excludes stand-down time for inclement weather which is possible over the tropical wet season. A two-year Sea Dumping Permit is proposed to allow work to be completed in the following dry season if required. If all necessary approvals are attained, the dredging would occur between January 2012 and December 2013.

Detailed dredging procedures would be developed with the dredging contractor following engagement.

Alternative spoil disposal options for the Embley and Hey River barge terminals were not considered to be viable (refer **Section 1.6.11**) even though minor reclamation is required at each location (refer **Section 3.9**). The use of silty-clay marine sediments presents significant dewatering, material strength and settling issues when being considered for engineering uses, including routine support of heavy machinery. Placement of the small volumes of material at the existing Albatross Bay spoil ground was considered to be the only viable option and was considered to be a relatively benign option.

6.5.3 Sediment Assessment Framework

Australia is party to the *1996 Protocol to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter 1972*, now known as the London Protocol. The aims of the London Protocol are to protect and preserve the marine environment from all sources of pollution and to prevent, reduce and eliminate pollution by controlling the dumping of wastes and other materials at sea. The London Protocol limits the types of materials that may be considered for ocean disposal. Annex 2 of the London Protocol outlines a procedure for considering disposal at sea and includes guidance on waste prevention, pollution prevention, monitoring and assessment. Parties to the London Protocol must adopt administrative or legislative measures to ensure that issuance of permits and permit conditions comply with provisions of Annex 2.

The loading and disposal of dredged material in Australian waters is regulated by DSEWPaC under the *Environment Protection (Sea Dumping) Act 1981* (Sea Dumping Act). To gain a permit for ocean disposal, sediments are required to be assessed using the framework of the *National Assessment Guidelines for Dredging* (NAGD) (Commonwealth of Australia 2009), which supersedes the *National Ocean Disposal Guidelines for Dredged Materials* (NODGDM) (Commonwealth of Australia 2002), to demonstrate their chemical and physical nature is suitable for placement at sea and would not adversely affect the marine environment.

The sections below describe the sampling and analyses completed at the proposed port area, and the Hornibrook, Humbug and Hey River Terminal locations, in accordance with NAGD/NODGDM sediment assessment frameworks. Characteristics of sediments at the proposed new spoil ground are also provided. The assessment of dredged material for the Project is consistent with the assessment guidance described in *National Assessment Guidelines for Dredging* (NAGD), Annex 2 of the London Protocol, and the *Waste Specific Guidelines for Assessment of Dredged Material* (IMO 2000). Alternative options for disposal of dredged material are presented in **Section 1.6.10**.

6.5.4 Port Area Sediment Characterisation

The proposed port is located in a remote and largely undeveloped area. The coastal land from Aurukun in the south to Weipa in the north is undeveloped and largely undisturbed, except for mineral exploration activities. As such, there have been no prior land use activities of a nature that may have contaminated existing coastal sediments.

The pristine nature of the port development site between Boyd Point and Pera Head, its remote location and current lack of potential contaminant sources, either from shipping activity or from land use, suggests there should not be any anthropogenic contaminants present in the sediments to be dredged and that concentrations present would represent natural background levels.

Sampling and analysis of the sediment material at the proposed port has been undertaken on several occasions to determine background concentrations of trace metals, particle size distribution, and nutrients prior to development. Acid sulphate soil potential was also assessed early in sediment characterisation studies for the inshore berth area only in the event that material was required to be placed on land. Organotin concentrations were analysed to confirm their absence and provide a baseline for comparison during future maintenance dredging.

6.5.4.1 Summary of Sediment Sampling and Analysis Program

Sampling was completed over the following three stages due to Project changes: 20 to 22 October 2007, 30 June 2009 and 18 to 21 June 2010. Sediment sampling and analysis plans (SAP) were submitted to the DSEWPaC and approved for each phase of sampling.

2007 Sediment Sampling and Analysis

A draft sediment SAP was submitted to DSEWPaC in September 2007 and comments were responded to in a sediment characterisation report submitted in February 2008. The approach to sampling and analysis recognised the remote location of the proposed dredge area with no likely input of contaminant substances from the surrounding catchment. A pilot-program level of assessment comprising 20% of the total number of sample locations required under Table 1 of the NODGDM (Commonwealth of Australia 2002) was adopted.

The October 2007 sampling included collection of sediments at five sites (SoE1 – SoE5; refer **Figure 6-37**) using a pneumatic head vibrocorer operated by GeoCoastal Pty Ltd off the stern of the James Cook University research vessel *James Kirby*. A total of nine samples were collected from a maximum of two horizons (A horizon 0–0.5m and B horizon 0.5–1.0m) depending largely on the depth of surface sediments overlying stiff clays. Power analysis of results indicated the number of samples taken was sufficient to provide a statistically rigorous comparison with the NODGDM screening levels for contaminants. Sampling to the intended dredge depth through stiff clays was not possible as the vibrocorer met resistance typically from 0.2–0.5m sediment depth and refusal marginally beyond that. Typically, at least half the lower horizon sample (B horizon 0.5-1.0m) submitted consisted of stiff clay material. It is extremely unlikely that any anthropogenic contaminants could have been introduced to the underlying clay material due to the high binding capacity of the clay sediments and lack of porosity. Accordingly, the NAGD does not normally require chemical testing of consolidated natural geological materials.

The collected sediment samples were consigned to NATA registered laboratories (Advanced Analytical Australia (AAA) and Australian Laboratory Services (ALS)) and analysed for the constituents detailed below:

- Total trace elements (Ag, Al, As, Cd, Cu, Co, Cr, Fe, Mn, Pb, Hg, Ni, Sb, Se, V, Zn);
- Bioavailability of trace elements using dilute acid extraction (1M HCl; DAE) (Ag, Al, As, Cd, Cu, Co, Cr, Fe, Mn, Pb, Hg, Ni, Sb, Se, V, Zn);
- Elutriate concentration of trace elements (Ag, Al, As, Cd, Cu, Co, Cr, Fe, Mn, Pb, Hg, Ni, Sb, Se, V, Zn);
- Organotin compounds (MBT, DBT, TBT);
- Nutrients (TN, NO_2, NO_3, TKN, TP);
- Total Organic Carbon (TOC);
- Particle size distribution (PSD); and
- Acid sulphate soils (ASS).

Analysis of metals in elutriate water and metals bioavailability was undertaken as published studies of sediments within northern Australia by Munksgaard and Parry (2002) indicated total metals concentrations could naturally exceed relevant guideline screening levels.

Following correspondence, DSEWPaC (formerly DEWHA) confirmed on 15 October 2008 that sediment characterisation had been characterised according to the NODGDM.

2009 Sediment Sampling and Analysis

In 2009, the volume of proposed dredging was increased to 505,800m^3. A supplementary SAP was submitted to DSEWPaC (formerly DEWHA) on 5 June 2009 and approved for implementation on 27 July 2009. Sampling for the expanded dredge area was completed at 10

sites (2SoE6-10, 2SoE12, 2SoE14, 2SoE18-20), making a total of 15 sites over the whole dredge area over the 2007 and 2009 surveys. Elutriate and porewater analyses were undertaken on samples from seven locations making a total of 12 sampling locations over the 2007 and 2009 surveys. Sampling locations are shown on **Figure 6-37**.

Based on the prior experience of there being a relatively thin layer of unconsolidated material overlying stiff clays, surface samples only were collected using a stainless steel grab instead of a coring device.

Samples were tested for the same suite of analyses as in the 2007 survey. The results were combined with 2010 data and provided to DSEWPaC in December 2010.

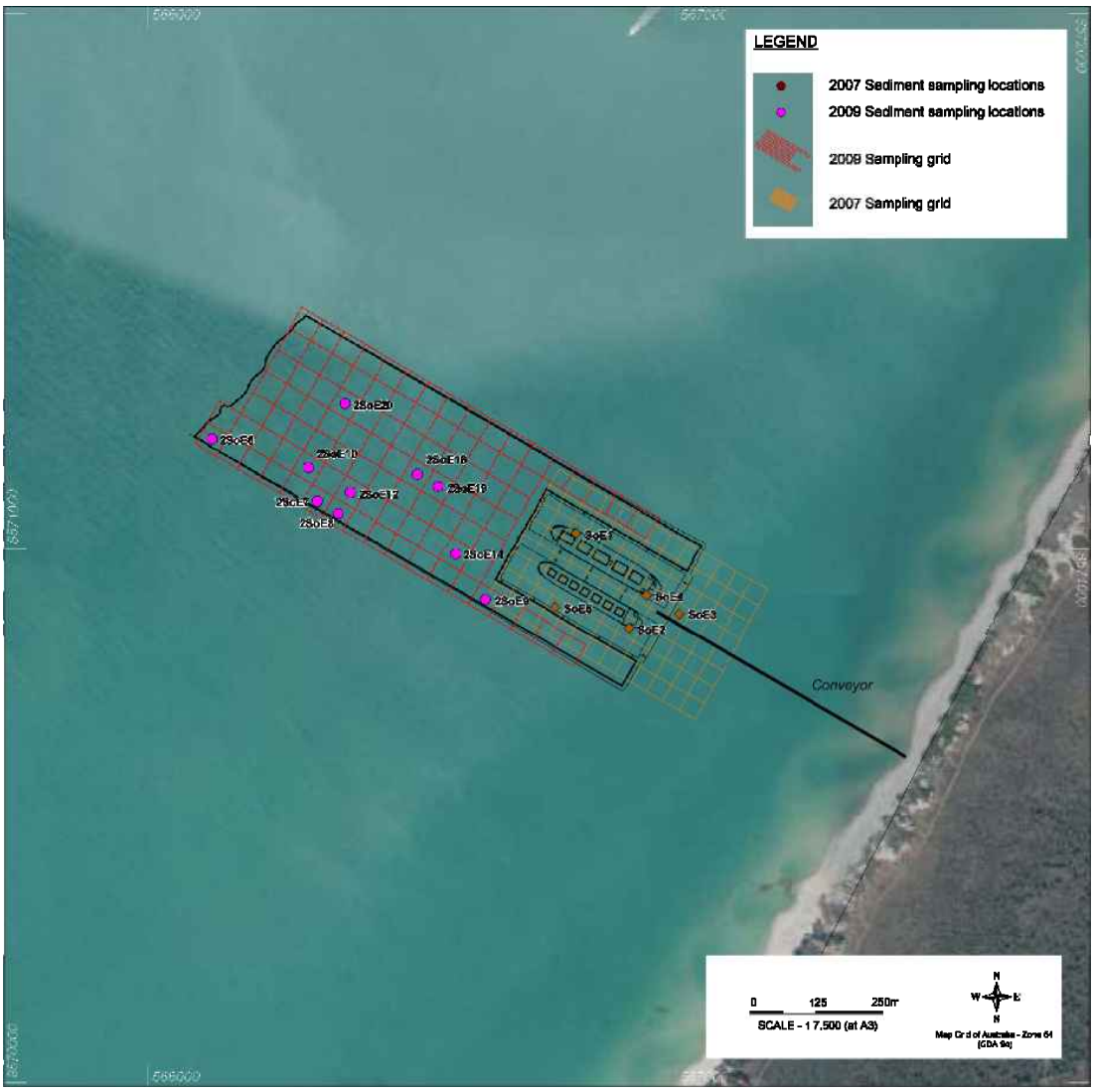


Figure 6-37 2007 and 2009 Sediment Sampling Sites at the Port Berth and Departure Area

2010 Sediment Sampling and Analysis

A new SAP was developed in 2010 to accommodate a major expansion in dredge footprint, which now included a 5.5km departure channel, and increase in proposed dredge depth to –20.2mLAT and volume increase to approximately 6,500,000m^3.

Sampling was undertaken at 20 locations, more than the minimum 17 locations required for the conservatively estimated volume of 730,000m^3 of "potentially contaminated" loose surface sediments overlying stiff clays. The volume of "potentially contaminated" material determines the number of sampling locations under the NAGD. The NAGD recommends that for capital dredging projects, this volume would be represented by the upper 1m of sediment over the dredging footprint area. The volume of "potentially contaminated" sediments was calculated from the proposed dredge footprint of 1,460,062m^2 and a typically maximum depth of 0.5m to stiff underlying clays. The number of sampling locations required under the NAGD (34) was halved on the basis that there was good quality current data available for the area from the two previous sampling campaigns in 2007 and 2009. The position of sampling locations is provided in **Figure 6-38**. Samples were collected using a vibrocorer, deployed from the research vessel *James Kirby*.

Penetration into the substrate was again limited by the stiff underlying clays, with a maximum of 0.6m but typically less than 0.2m, particularly along the departure channel. Because of the shallow penetration, samples were submitted as single horizons.

Samples were analysed only for metals and particle size distribution since organotin concentrations were previously not detected. The sediment characterisation report was provided to DSEWPaC in December 2010 and this EIS provides a summary of the results.

Assessment Methodology

Given the inshore nature of the 2007 and 2009 surveys, results were pooled for the purposes of assessment against the NAGD Table 2 screening levels at the 95% confidence level of the mean (95%UCL; i.e. the upper limit of the sample mean, with 95% confidence). 2010 results were assessed separately to the 2007 and 2009 sampling due to the significantly different dredge footprint areas assessed.

For the purposes of calculation of 95%UCLs, values below detection limit (laboratory Level of Reporting, LOR) were set to half of the detection limit in accordance with NAGD recommendations. Results for organic parameters were normalised to 1% total organic carbon (TOC) where the recorded value was within the range of 0.2–10%. Organic contaminants below detection limits were not normalised to 1% TOC in 95%UCL calculations. The methods used to calculate the 95%UCLs were based on the methods required in Appendix A of the NAGD. According to the NAGD sediment assessment framework, if total contaminant concentrations are below respective screening levels at the 95%UCL then dredged material is considered chemically suitable for unconfined ocean disposal.

Under the NAGD sediment assessment framework, elutriate and bioavailability assessment is generally only required if sediments do not pass screening level assessment. Even though contaminants were typically below NAGD screening levels in the present study, elutriate and bioavailability assessments for trace elements were undertaken. The analytical procedures were undertaken in accordance with NAGD requirements and are described briefly below.

- Elutriate analysis is achieved by shaking one part sediment with four parts sea water for 30 minutes, allowing to settle for one hour and analysing filtered/centrifuged supernatant for ultratrace contaminant concentrations. This investigates release of contaminants from the sediments to the water column during dredged material disposal. Results of elutriate analysis are compared with ANZECC/ARMCANZ (2000) marine water quality guidelines at the 95% species protection level as detailed in Appendix A of the NAGD. According to the NAGD, if concentrations of contaminants are below respective guideline levels after allowing for initial mixing that takes place during material placement and over the following four hour period, then dredge material is considered chemically suitable for unconfined sea disposal.

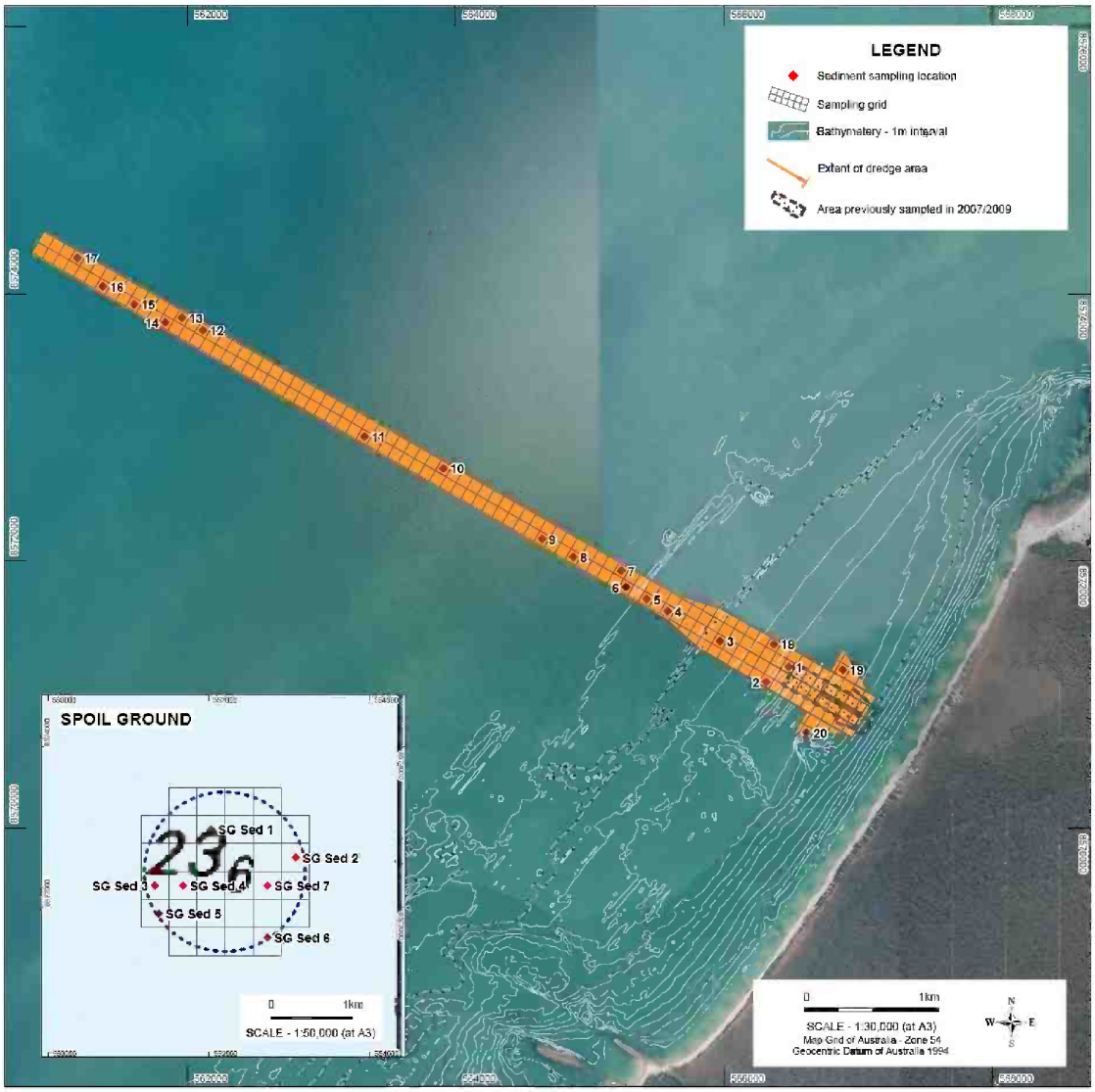


Figure 6-38 2010 Sediment Sampling Locations at the Port Berth, Departure Apron, Departure Channel Areas and Proposed New Spoil Ground (inset)

- Dilute acid extraction (DAE) provided an estimate of bioavailability of metals in sediments. Analysis is achieved by mildly extracting metals from sediments using 1M HCl acid. This approximates metal concentrations bioavailability to sediment ingesting organisms. Each of the 16 DAE metal and metalloid concentration results were compared to screening levels in NAGD in the same manner as for total sediment concentrations. According to NAGD, if DAE concentrations are below respective screening levels at the 95%UCL then dredged material is considered suitable for unconfined ocean disposal from a toxicant bioavailability perspective.

An assessment of data quality was undertaken and the data were considered suitable to assess the material's suitability for sea dumping.

Full sediment characterisation reports have been provided to DSEWPaC for respective dredge areas. This Environmental Impact Statement (EIS) contains summary information.

6.5.4.2 Physical Characteristics – Port Area

Sediment sampling identified the sediment profile at the proposed port area – including berth areas, departure apron and departure channel – as generally comprising a relatively thin, moist, silty-clay surface layer (0.1m–0.5m) overlying a mottled, stiff, relatively dry sandy-clay layer (refer **Figure 6-39**).

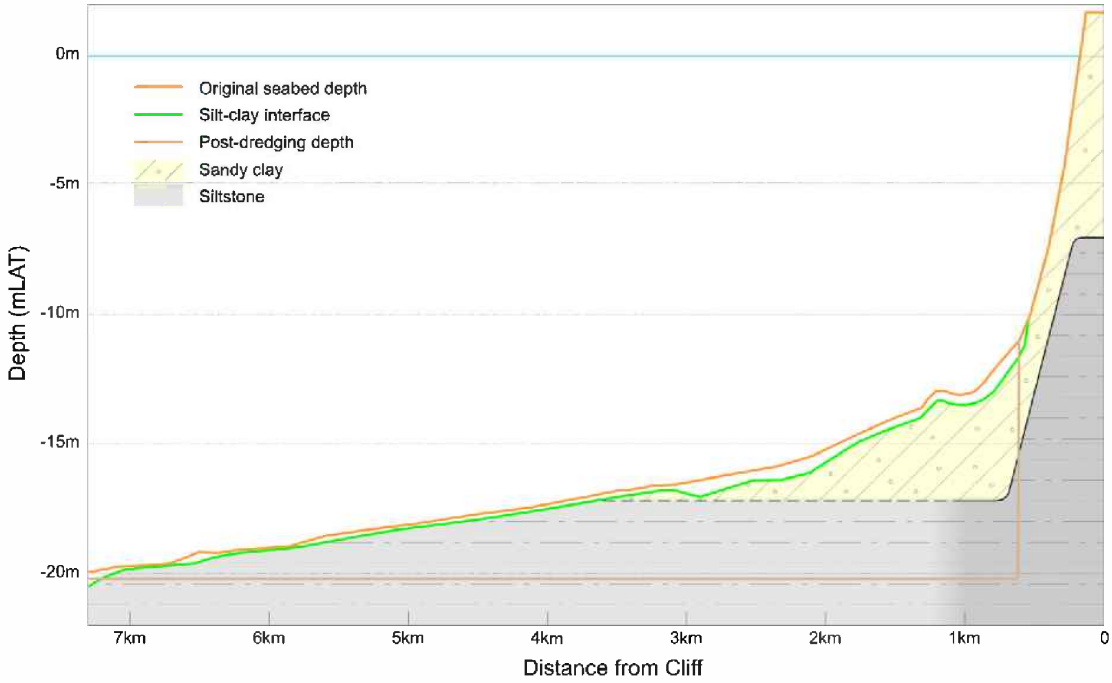


Figure 6-39 Longitudinal Sediment Profile along Dredging Footprint

Subsequent inspection of geotechnical cores (refer **Plate 6-7**) taken within the jetty/berth area identifies that siltstone is present below the stiff sandy clay layer. While the extent of the geotechnical investigations are limited to the nearshore area, geotechnical consultants to the Project (Coffey Geotechnics) consider that it is reasonable to assume that the siltstone unit continues seaward at a similar level as identified by the nearshore boreholes. The level at which siltstone occurs corresponds to approximately –17m LAT. The overlying stiff sandy-clay layer is believed to be weathered siltstone material.

All sediment samples were physically described and photographed in the field. Samples were also collected and analysed for particle size distribution. A graphical summary of the PSD results for port development area sediments in 2007, 2009 and 2010 surveys is presented in **Figure 6-40**. 2007 sampling results have greater sand and gravel content than 2009 samples; however this is likely to be due to different sample collection methods. 2007 samples were collected using a vibrocorer, while 2009 samples were collected using a sediment grab. The vibrocorer was able to partially penetrate the underlying stiff clays, while sediment grabs collected only surface sediments up to about 0.1m depth.

2010 samples were collected using a vibrocorer and demonstrate a significant change in particle size distribution approximately 4km offshore in about –17mLAT water depth, between sampling locations 9 and 10. Due to the significant change of PSD, summary statistics are provided separately for inshore sample locations (locations 1–9) and offshore sample locations (locations 10–17) shown in **Table 6-10** and **Table 6-11** respectively and in **Figure 6-40**.

Inshore surface sediments (unconsolidated silts and underlying stiff sandy clays) are dominated by silt and clay fractions, comprising 71 to 96% (mean 84%) of the sediments (refer **Table 6-10**); the remainder of the sediments contain gravel and sand in similar proportions. Offshore

sediments are dominated by sand particles, comprising about 66% of the sediments (refer **Table 6-11**); the remainder of the sediments contain a slightly greater proportion of silts and clays (19%) than gravel (15%).

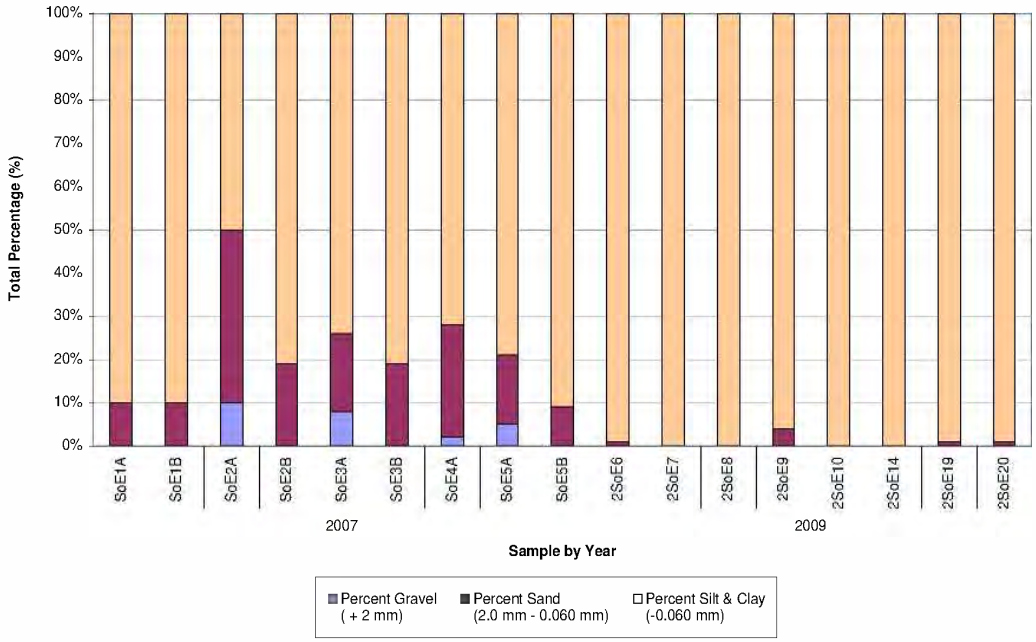
Plate 6-7 Geotechnical Core from within the Port Jetty/Berth Area

Table 6-10 Summary of 2010 Inshore Particle Size Distributions

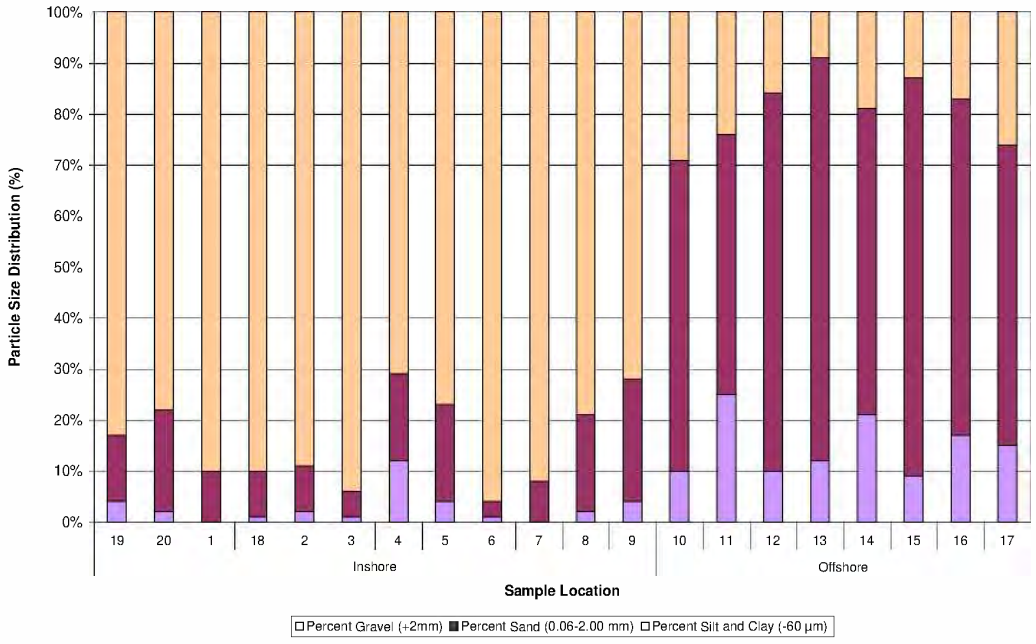
Statistic	Gravel (>2mm)	Sand (2mm–0.060mm)	Silt & Clay (<.060mm)
Number of samples	12	12	12
Mean (%)	13	13	84
Standard deviation (%)	3	7	9
Minimum (%)	0	3	71
Maximum (%)	12	24	96

Table 6-11 Summary of 2010 Offshore Particle Size Distributions

Statistic	Gravel (>2mm)	Sand (2mm–0.060mm)	Silt & Clay (<0.060mm)
Number of samples	8	8	8
Mean (%)	15	66	19
Standard deviation (%)	6	10	7
Minimum (%)	9	51	9
Maximum (%)	25	79	29



Note: 2007 sample suffixes relate to depth horizons: A = 0–0.5m; and B = 0.5–1m. 2009 samples were surface grabs so contain only one horizon.



Note: 2010 samples were surface grabs so contain only one horizon.

Figure 6-40 Particle Size Distribution at the Proposed Port Dredging Area during 2007 and 2009 (top) and 2010 Surveys (bottom)

Particle size analysis performed on geotechnical core material identified that the stiff sandy clays contained clay, silt and fine sand in proportions of 11%, 50% and 20% respectively. Siltstone material was found to be comprised of clay, silt and fine sand in 13%, 10% and 47% respectively. The remainder of the fractions were made almost entirely of coarse sand. Beach sediments were analysed to provide particle size distributions and sand grain fall velocities for use in sediment mobilisation modelling. **Plate 6-8** shows the composition of the upper beach

sediments and the individual sand grains, which are a mixture of well sorted, rounded, calcareous and silica material containing 11% gravel, 88% sand, and less than 1% clay. Grains of ironstone and pisolitic (bauxite) material are present.

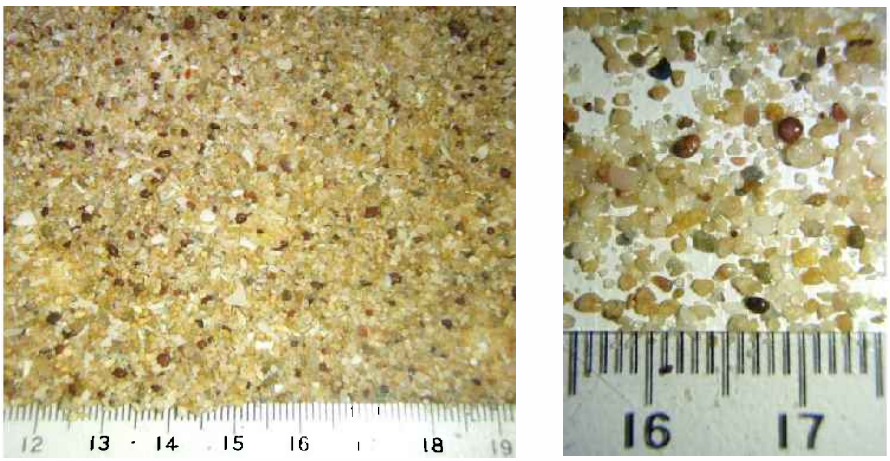


Plate 6-8 Upper Beach Sediment and Individual Grains

6.5.4.3 Chemical Characteristics – Port Area

Chemical characteristics of the sediments within the dredge footprint of the proposed port area are summarised below.

Trace metals – Totals

Total trace metals results are summarised in **Table 6-12** and **Table 6-13** and identify the following:

- Total metals concentrations commonly were similar across the three sampling events although the 2007 results demonstrated higher variability than those of 2009 and 2010, particularly for: antimony, cadmium, copper, manganese, mercury, nickel and zinc. The differences likely reflect the 2007 survey footprint, being the most inshore of all the surveys and hence with a likely greater content of beach sand, which contains ironstone and pisolitic material (bauxite) eroded from the adjacent cliff faces;
- Except for nickel and antimony, all total metals concentrations for individual samples were below respective NAGD screening levels in all three surveys. In 2007 only, nickel and antimony exceeded respective screening concentrations at sites SoE1 (upper and lower horizon) and SoE 4 (upper horizon);
- The mean and 95%UCLs of the mean for nickel and antimony were below respective NAGD screening levels for combined inshore (2007 and 2009) surveys and for the 2010 survey over the extended dredge footprint;
- Mercury concentrations were below the LOR of 0.01 mg/kg except for three samples collected in 2007, which were well below the NAGD screening level; and
- Silver was not detected at any location in any survey.

Graphing of metals concentrations from inshore to offshore locations (refer **Figure 6-41**) demonstrates a distinct reduction in total concentrations at sampling locations 9 and 10 approximately 4km from shore. The trend in metals concentrations is consistent with a reduction in silt and clay (fines) content.

Table 6-12 Summary of Sediment Quality for Metals and Organotins – Port Berth and Departure Area in 2007 and 2009

					2007 Sampling Campaign										2009 Sampling Campaign										Summary Statistics			
Analytical Parameter	**Units**	**LOR**	**NAGD PQL**	**NAGD Screening Level**	**SoE1A**	**SoE1B**	**SoE2A**	**SoE2B**	**SoE3A**	**SoE3B**	**SoE4A**	**SoE5A**	**SoE5B**	**2SoE6**	**2SoE7**	**2SoE8**	**2SoE9**	**2SoE10**	**2SoE12**	**2SoE14**	**2SoE18**	**2SoE19**	**2SoE20**	**Mean/ Geomean**	**Standard Deviaiton**	**95% UCL**	**Normal (N) Lognormal (L) Neither (X)**
Horizon Depth (m)					0-0.5	0.5-1.0	0-0.5	0.5-1.0	0-0.5	0.5-1.0	0-0.5	0-0.5	0.5-1.0	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5				
Date sampled					20/10/07	20/10/07	21/10/07	21/10/07	21/10/07	21/10/07	22/10/07	21/10/07	21/10/07	30/06/09	30/06/09	30/06/09	30/06/09	30/06/09	30/06/09	30/06/09	30/06/09	30/06/09	30/06/09				
Moisture Content	%	< 0.1	0.1		45.1	27.2	24.7	24.6	28.4	24.3	25.6	24.8	24.6	63.6	67.9	66.2	69	67.2	66.3	70.4	68.3	70.6	69	48.83	21.12	57.24	X
Total Organic Carbon	%	0	0.1		1.1	0.74	1.1	1.4	1.3	1.6	1.3	0.61	1.3	1.4	1.5	1.4	1.1	1.6	1.4		1.7	1.5	1.6	1.314	0.293	1.434	X
Trace Elements																												
Aluminum	mg/kg	<0.1	200	-	6800	6300	3800	4100	3800	3800	5000	4200	3900	17238	19642	19511	20023	20735	15934	17843	17816	17097	17135	11825	7138	14665	X
Antimony	mg/kg	<0.3	0.5	2	5.1	3.4	0.88	0.64	0.5	<0.3	13	0.77	<0.3			<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.88	1.13	1.37	X
Arsenic	mg/kg	<0.1	1	20	5.9	5.7	5.8	5.4	7.3	11	8	13	15	5.1	5.1	5.6	5.1	5.3	5.2	5.2	4.7	4.9	4.9	6.75	2.97	7.93	X
Cadmium	mg/kg	<0.1	0.1	1.5	0.81	0.92	0.21	0.18	0.12	0.15	0.59	0.31	0.15	0.14	0.11	0.13	<0.1	<0.1	0.11	0.11	0.11	0.11	<0.1	0.23	0.25	0.33	X
Chromium	mg/kg	<0.1	1	80	15	8.7	5.7	5	4.6	4.3	7.7	5.1	4.3	33	39	36	39	39	35	40	39	38	38	23.0	16.1	29.4	X
Cobalt	mg/kg	<0.1	0.5	-	23	38	1.6	1.8	2	1.4	33	1.6	1.4			4.1		4.5	3.9	4.4	4.3	4.2	4.2	8.3	11.8	13.5	X
Copper	mg/kg	<0.1	1	65	42	40	8	11	16	11	24	14	15	5.8	6.5	6.2	6.3	6.6	5.8	6.3	6.4	6.2	6.2	12.8	11.1	17.2	X
Iron	mg/kg	<0.1	100	-	38000	47000	9000	7100	2800	6500	29000	15000	6900	22000	25000	25000	25000	25000	23000	25000	25000	24000	25000	21332	11221	25796	X
Lead	mg/kg	<0.1	1	50	5	7	4.4	4.3	8.8	9.2	4.7	4.9	9.3	5.2	6	5.7	6	6.1	6	6.5	6.3	6.2	6.2	6.0	1.5	6.8	L
Manganese	mg/kg	<0.1	10	-	120	99	15	5.6	9.5	4.5	56	5.7	3	170	190	180	180	190	170	200	190	180	190	114	82	146	X
Mercury	mg/kg	<0.01	0.01	0.15	0.02	0.03	<0.01	<0.01	0.04	<0.01	<0.01	<0.01	0.03	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.011	0.011	0.015	X
Nickel	mg/kg	<0.1	1	21	31	12	2.9	3.4	3.2	2.9	27	2.8	2.9	11	12	11	12	12	11	12	12	12	12	12.4	10.5	16.5	X
Selenium	mg/kg	<0.43	0.1	-	0.52	<0.43	<0.43	<0.43	<0.43	<0.43	<0.43	<0.43	<0.43			0.51		0.63	0.62	0.61	0.53	0.88	0.55	0.41	0.22	0.51	X
Silver	mg/kg	<0.1	0.1	1.0	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1			<0.1		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.000	<0.1	X
Vanadium	mg/kg	<0.16	2	-	26	22	11	9.5	9.6	17	23	23	11			33		36	32	36	34	32	33	24.3	10.0	28.6	X
Zinc	mg/kg	<0.1	1	200	120	170	11	13	23	13	110	31	14	17	19	18	19	20	17	19	19	18	18	36.3	44.7	54.0	X
Nutrients																												
Phosphorus	mg/kg	<0.1	0.1	-	550	530	350	310	410	510	480	460	510	610	700	650	680	710				690		543	129	602	N
Nitrate-N	mg/kg	<0.5	100	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.1	<0.1	<0.1	<0.1	<0.1				<0.1		<0.5	0	<0.5	-
Nitrite-N	mg/kg	<0.5	100	-	<0.5	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	1	<0.1	<0.1	<0.1	<0.1	<0.1				<0.1		0.31	0.26	0.45	X
Total Kjeldahl Nitrogen	mg/kg	<20	100	-	920	82	190	<20	120	<20	270	49	<20	1820	1950	1930	1870	2010				2050		949	918	1383	X
Total Nitrogen	mg/kg	<20	100	-	920	82	190	<20	120	<20	270	49	<20	1820	1950	1930	1870	2010				2050		949	918	1383	X
Total Ammonia as N														3.5	5	5	4	7				6.5		5.17	1.37	6.29	N
Organotins																												
Monobutyl tin	µgSn/kg	<0.5	1	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<1.0	<1.0	<1.0	<1.0	<0.5	<1		<1	<1	<1	<1	0	<1	-
Dibutyl tin	µgSn/kg	<0.5	1	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<1.0	<1.0	<1.0	<1.0	<1.0	<1		<1	<1	<1	<1	0	<1	-
Tributyl tin	µgSn/kg	<0.5	1	9	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<1.0	<1.0	<1.0	<1.0	<1.0	<1		<1	<1	<1	<1	0	<1	-

Legend for Table 6-22	■	Value exceeds NAGD Screening Level
	mg/kg	milligrams per kilogram
	µgSn/kg	microgram of tin per kilogram

Table 6-13 Summary of Sediment Quality for Metals – Port Berth, Departure Area and Departure Channel Area in 2010.

					Sample Location																		Summary Statistics			
	Units	LOR	NAGD PQL	NAGD Screening Level	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Mean/ Geomean	Standard Deviation	95% UCL	Normal (N) Log-normal (L) Neither (X)
Horizon (m)					0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5				
Moisture Content	%	1			64.4	68.4	61.1	41.5	54.6	60.5	56	43.5	52.2	30.5	35.1	26.8	33	26.8	30.3	30.2	29.8	63.4	67.3	63.7	47.16	15.28	53.06	X
Total Metals																												
Aluminium	mg/kg	50	200	-	18100	18600	17300	11900	11300	13200	16500	11500	14400	3790	3890	2750	1760	2190	1480	2830	2700	16800	18000	15000	10200	6654	12772	X
Antimony	mg/kg	0.5	0.5	2	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	-	<0.50	-
Arsenic	mg/kg	1	1	20	5.38	5.21	5.15	4.01	4.28	9.37	4.92	3.08	4.79	3.34	1.88	1.86	2.43	2.01	1.66	2.02	2.26	5.83	4.86	4.66	3.54	1.9	4.69	L
Cadmium	mg/kg	0.1	0.1	1.5	0.1	0.1	0.2	<0.1	0.1	0.1	0.2	0.1	0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	0.1	0.09	0.05	0.11	X
Chromium	mg/kg	1	1	80	41.6	41.7	40.8	26.8	25.6	33	38.8	25.5	34.3	13.2	8.8	9.2	6.9	6.8	4.3	7.5	7.6	41.5	41.9	35.2	24.55	14.79	30.27	X
Cobalt	mg/kg	0.5	0.5	-	7	7.2	5.9	10.1	5	6	5.3	4.9	4.8	4.6	1.4	1.2	1	1	0.8	1.3	1.3	7.1	6	4.8	4.34	2.7	5.38	X
Copper	mg/kg	1	1	65	9.4	8.1	5.8	10.4	15.3	13.6	5.6	13.2	5	3.4	3.5	1	<1.0	1.2	<1.0	1	1.8	13.8	6.2	15.1	7.41	5.11	9.51	N
Iron	mg/kg	50	100	-	24600	23500	22800	18800	16000	34700	21100	13100	20100	16200	11600	6110	6030	5430	3610	4880	6240	23100	23700	19500	16055	8608	19383	N
Lead	mg/kg	1	1	50	9	8.9	8.7	6.7	6.2	8	8.5	7.9	7.9	4.2	2.6	3.1	2.5	2.5	2	2.6	2.6	9	8.6	8	5.98	2.8	7.06	X
Manganese	mg/kg	10	10	-	233	209	233	171	188	158	236	123	215	110	78	81	57	60	48	91	84	231	208	172	149.3	68.25	175.7	X
Mercury	mg/kg	0.01	0.01	0.15	0.02	0.02	0.02	0.12	0.04	0.02	0.02	0.02	0.02	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	0.02	0.02	0.02	0.02	0.03	0.03	X
Nickel	mg/kg	1	1	21	15.2	14.7	13.4	17.7	9	12.3	12.3	9.6	10.6	3.8	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	15.5	13	10.3	12.11	3.56	13.87	N
Selenium	mg/kg	0.1	0.1	-	0.8	0.4	0.4	0.6	0.8	1.8	0.5	2.9	0.4	0.2	0.2	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.7	0.7	0.5	0.56	0.69	0.83	X
Silver	mg/kg	0.1	0.1	1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	<0.1	-
Vanadium	mg/kg	2	2	-	40.2	40.5	37	26.6	35.9	61.1	34	34.4	31.1	20.6	43.7	11.2	10.1	10.2	5	7.7	12.8	39.5	42.4	40.2	29.21	15.36	35.15	N
Zinc	mg/kg	1	1	200	32.7	28.8	23.8	42.9	20.7	32	21.5	23.3	19.2	17.3	5.9	3.4	2.1	2.7	2	3.6	3.4	29.9	24.2	19.2	17.93	12.43	22.74	N

Legend

Note	When calculating averages and 95% UCLs, values below detection for individual results were set to half the detection levels, consistent with the NAGD
PQL	Practical Quantitation Limit
LOR	Laboratory Limit of Reporting
50	Value exceeds NAGD Screening Level

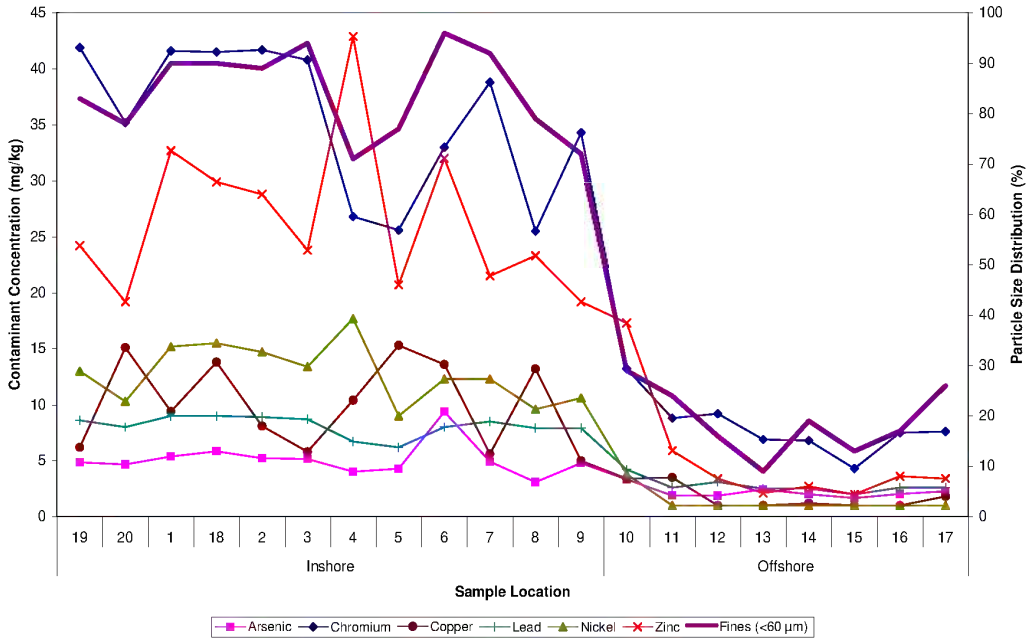


Figure 6-41 NAGD Metals Contaminant Concentrations and Percentage Fines Content from Inshore to Offshore in 2010 Survey

Organotins

- In 2007 and 2009, organotin concentrations (MBT, DBT, and TBT) at each sampling location were less than the LOR of 0.5µgSn/kg and the NAGD screening level for TBT (9µgSn/kg).
- Organotins were not tested for in 2010.

Nutrients

Nutrients were analysed in 2007 and 2009.

- Nitrate was below detection levels across all sites;
- Nitrite was below detection levels across all sites in all surveys, except two sites in 2007;
- Total nitrogen across all sites was comprised entirely of organic nitrogen (TKN). Total nitrogen concentrations ranged from <20 to 2050mg/kg;
- Total phosphorus concentrations ranged from 310 to 710mg/kg;
- Total ammonia was analysed in the 2009 sampling campaign and ranged from 3.5 to 7mg/kg across sites; and
- There are no guideline values for nutrients in sediments.

Trace metals – Dilute Acid Extraction

Summary results of DAE analysis are provided in **Table 6-14** and **Table 6-15** and identify the following:

- Results of the DAE analyses indicate bioavailable metal concentrations are below respective NAGD screening levels across all samples in all surveys. The 95%UCL of the mean for metals was also below NAGD screening levels.

Table 6-14 Summary Results for DAE Analysis on Metals – Port Berth and Departure Area in 2007 and 2009

					2007 Sampling Campaign									2009 Sampling Campaign							Summary Statistics			
Sample	**Units**	**LOR**	**NAGD PQL**	**NAGD Screening Level**	**SoE1A**	**SoE1B**	**SoE2A**	**SoE2B**	**SoE3A**	**SoE3B**	**SoE4A**	**SoE5A**	**SoE5B**	**2SoE8**	**2SoE10**	**2SoE12**	**2SoE14**	**2SoE18**	**2SoE19**	**2SoE20**	**Mean/ Geomean**	**Standard Deviaiton**	**95% UCL**	**Normal (N) Lognormal (L) Neither (X)**
Horizon	m				0-0.5	0.5-1.0	0-0.5	0.5-1.0	0-0.5	0.5-1.0	0-0.5	0-0.5	0.5-1.0	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5				
Date sampled					21/10/07	21/10/07	21/10/07	21/10/07	21/10/07	21/10/07	21/10/07	21/10/07	21/10/07	30/06/09	30/06/09	30/06/09	30/06/09	30/06/09	30/06/09	30/06/09				
Aluminium	mg/kg	<0.2	200		1100	760	330	400	540	460	570	440	410			2080	2147	2306	2237	2216	1143	838.4	1539	X
Antimony	mg/kg	<0.5	0.5	2	<1.37	<1.37	<1.37	<1.37	<1.37	<1.37	<1.37	<1.37	<1.37	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0	<0.5	-
Arsenic	mg/kg	<1.0	1	20	<1.82	<1.82	<1.82	<1.82	<1.82	2.5	<1.82	<1.82	<1.82			1.9	2.2	1.7	1.6	1.8	1.4	0.6	1.6	X
Cadmium	mg/kg	<0.1	0.1	1.5	<0.09	<0.09	<0.09	<0.09	<0.09	<0.09	<0.09	<0.09	<0.09			0.13	<0.1	0.11	0.13	<0.1	0.06	0.03	0.08	X
Chromium	mg/kg	<0.1	1	80	2.8	0.59	0.73	0.37	0.4	<0.18	0.89	0.25	<0.18			10	11	11	11	10	4.23	4.98	6.59	X
Cobalt	mg/kg	<0.2	0.5		0.46	0.41	<0.27	0.52	0.31	<0.27	<0.27	<0.27	<0.27	0.84	0.9	0.85	0.94	0.93	0.86	0.92	0.538	0.344	0.689	X
Copper	mg/kg	<0.1	1	65	5.4	6.4	1.2	2.2	3.7	2.2	4	2.7	4.4			2.4	2.5	2.6	2.5	2.4	3.2	1.4	3.9	N
Iron	mg/kg	<0.5	100		1700	350	850	360	520	270	780	840	420			5300	5600	5900	6300	5900	2506	2580	3727	X
Lead	mg/kg	<0.3	1	50	1.9	1.1	0.62	<0.55	0.73	1.1	1.2	<0.55	0.71			6.1	6.6	6.5	6.2	6.2	2.8	2.7	4.1	X
Manganese	mg/kg	<0.1	10		34	9.8	12	4.8	7.8	2.1	11	22	2.2			130	150	140	140	140	23	64	88	L
Mercury	mg/kg	<0.01	0.01	0.15	<0.018	<0.014	<0.013	<0.013	<0.014	<0.013	0.13	0.01	0.01			<0.01	<0.01	<0.01	<0.01	<0.01	0.0155	0.033	0.0312	X
Nickel	mg/kg	<0.15	1	21	1.1	0.66	0.54	0.6	0.49	0.4	0.53	0.4	0.28			2	2.2	2.3	2.4	2.1	1.143	0.843	1.542	X
Selenium	mg/kg	<0.5	0.1		<1.82	<1.82	<1.82	<1.82	<1.82	<1.82	<1.82	<1.82	<1.82	0.55	0.52	0.56	0.53	0.53	<0.5	<0.5	0.71	0.25	0.82	X
Silver	mg/kg	<0.1	0.1	1	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0	<0.1	-
Vanadium	mg/kg	<0.16	2		3.3	0.5	1.2	0.76	3.4	1.7	3.2	2	1.8	11	11	11	12	11	11	11	6.0	4.8	8.1	X
Zinc	mg/kg	<0.2	1	200	5.3	3.6	1.9	1.9	5.3	2.1	2.9	7.8	3.5			3.7	4.2	4.1	3.8	3.9	3.9	1.5	5.0	N

Legend

Note When calculating averages and 95% UCLs, values below detection for individual results were set to half the detection levels, consistent with the NAGD

PQL Practical Quantitation Limit

LOR Laboratory Limit of Reporting

Value exceeds NAGD Screening Level

Table 6-15 Summary Results for DAE Analysis on Metals – Port Berth Area, Departure Apron and Departure Channel in 2010

					Sample Location																		Summary Statistics			
	Units	LOR	NAGD PQL	NAGD Screening Level	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Mean/ Geomean	Standard Deviation	95% UCL	Normal (N) Log-normal (L) Neither (X)
Aluminium	mg/kg	50	200	-	1780	1900	1560	1100	1120	1690	1400	1180	1270	500	280	460	340	400	300	440	470	1730	1710	1260	1045	585	1271	X
Antimony	mg/kg	1	0.5	2	<1.0	<1.0	<1.0	1*	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	-	<1.0	-
Arsenic	mg/kg	1	1	20	1.5	2	1.7	1.1	1.3	1.7	1.6	<1.0	1.5	1.1	<1.0	1.2	1.2	<1.0	<1.0	<1.0	<1.0	1.5	1.6	1.8	1.19	0.52	1.39	X
Cadmium	mg/kg	0.1	0.1	1.5	<0.1	<0.1	0.1	0.1	<0.1	0.1	0.1	<0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.06	0.02	0.07	X
Chromium	mg/kg	1	1	80	8.4	8.6	7.3	4.3	4.7	7.4	6.3	4.2	5.5	1.8	1.4	1.8	1.6	1.6	1.2	1.8	2	8	6.4	5	4.47	2.59	5.49	X
Cobalt	mg/kg	0.5	0.5	-	0.6	0.9	0.6	0.7	<0.5	0.5	0.6	<0.5	0.7	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	1	0.5	<0.5	0.44	0.25	0.54	X
Copper	mg/kg	1	1	65	2.9	7.4	2.3	3.5	2.5	2.1	2	3.1	2	1.2	1	<1.0	<1.0	1.1	<1.0	<1.0	1.9	3.6	2.2	11.4	1.82	2.6	3.62	L
Iron	mg/kg	50	100	-	3710	3980	3140	1930	2020	3210	2650	1800	2590	1660	1610	1390	1140	1220	1050	1180	1230	3170	3510	2700	2245	960	2616	N
Lead	mg/kg	1	1	50	6.7	7.2	6.2	4.2	4.6	6.2	5.3	3.7	5.3	2.6	2	2.1	2	1.7	1.4	1.8	2.2	6.4	6	5.9	4.18	2.02	4.96	X
Manganese	mg/kg	10	10	-	118	124	123	84	80	120	106	71	108	66	59	60	62	48	32	62	71	120	108	103	86.25	28.66	97.33	N
Mercury	mg/kg	0.1	0.01	0.15	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	-	<0.10	-
Nickel	mg/kg	1	1	21	2.2	1.9	1.4	<1.0	1	1.5	1.4	<1.0	1.4	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.6	1.4	1.5	1.02	0.57	1.24	X
Selenium	mg/kg	0.5	0.1	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	-
Silver	mg/kg	1	0.1	1	<1.0	<1.0	<1.0	1*	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	-	<1.0	-
Vanadium	mg/kg	2	2	-	10.3	10.5	9.2	8	7.9	9.2	7.9	6.9	7.6	2.5	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	2.4	10.6	9.2	8.4	5.83	3.88	7.33	X
Zinc	mg/kg	1	1	200	3.2	5.5	2.7	4.7	2.1	2.2	2.2	2.1	3.5	2.2	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	3.3	5.7	2.6	2.28	1.68	2.93	X

Legend

1*	Results were adjusted to the LOR given that they were recorded above total concentrations, which is not plausible
Note	When calculating averages and 95% UCLs, values below detection for individual results were set to half the detection levels, consistent with the NAGD
PQL	Practical Quantitation Limit
LOR	Laboratory Limit of Reporting
50	Value exceeds NAGD Screening Level

Trace Metals – Elutriate Analysis

Summary results of elutriate analysis over 2007, 2009 and 2010 surveys are provided in **Table 6-16** and **Table 6-17** and identify the following:

- Elutriate metal concentrations were generally below respective ANZECC/ARMCANZ (2000) marine water quality guidelines at the 95% species protection level. The exceptions to this are cobalt and copper during the 2007 survey and zinc in 2010 survey. It should be noted that total copper, cobalt and zinc concentrations within respective surveys were below NAGD screening levels;
- Cobalt exceeded the ANZECC/ARMCANZ (2000) guideline for 95% species protection level at two sites (SoE1 and SoE3) in 2007 and occurred in the sub-surface horizon. Exceedances do not take into account dilution during placement;
- Copper exceeded the ANZECC/ARMCANZ (2000) guideline for 95% species protection level at four sites for samples SoE1, SoE3a, SoE4a, SoE5a and SoE5b in 2007. Exceedances do not take into account dilution during placement at the spoil ground;
- Zinc exceeded the ANZECC/ARMCANZ (2000) guideline for 95&% species protection level at one sampling location (site 4) in 2010. This single result appears to be an outlier, given it is about 20 times greater than other concentrations in 2010; and
- Cobalt, copper and zinc marginally exceed the ANZECC/ARMCANZ (2000) guideline for 95% species protection level at the 95th percentile value, prior to allowing any dilution following disposal. Exclusion of the 2010 zinc outlier results in a concentration of 7.1µg/L, less than half the guideline.

While cobalt, copper and zinc exceed the guidelines, the NAGD recommends the application of an initial mixing within the spoil disposal area when making an assessment of suitability for sea disposal. The NAGD states: "*The elutriate test uses a dilution of 1:4, wet sediment: added seawater, and will greatly overestimate water quality impacts given that, within the four hour period, dilutions of the order of a hundred times or more would normally be expected*". In the present study, minimal dilution of up to four times would be required for the material to achieve concentrations less than the ANZECC/ARMCANZ (2000) water quality guideline level. A conservative estimate of immediate dilution alone over the spoil ground is at least 13 times, prior to any allowance for dilution over the next four hours.

Acid Sulphate Soils

Potential Acid Sulphate Soils (PASS) were investigated in 2007 and 2009 and tested using the Suspension Peroxide Oxidation Combined Acidity and Sulphate (SPOCAS) suite of analyses. Analysis of departure area or departure channel sediments has not been undertaken. A summary of the results of acid sulphate soil analysis from the port area is provided below:

- Sediments pH ranged from 6.6 to 8.4, indicating no sulphur oxidation has yet taken place;
- Titratable Actual Acidity (TAA), which measures the sediment's actual acidity prior to any oxidation taking place, was below the detection level for all samples. This indicates no acid generation has yet taken place in the sediments;
- Potential sulphidic acidity (S_{POS}) indicated the oxidisable sulphur content was higher than the corresponding Queensland Acid Sulphate Soils Investigation Team (QASSIT) action criteria in samples from several sites. This indicates some of the material at these sites has the potential to generate sulphidic acidity. The remaining sites were below QASSIT action criteria, if detected;
- Retained acidity, net acid soluble sulphur (S_{NAS}), was below detection limits in several samples. Low retained acidity is also indicated since all samples had a pH higher than 4.5, indicating no sulphur oxidation has yet taken place;
- Net acidity, which is used to predict the acid risk of a soil, was lower than detection limit across all sites tested;

Table 6-16 Summary Results for Elutriate Analysis of Metals – Port Berth and Departure Area in 2007 and 2009

				2007 Sampling Campaign									2009 Sampling Campaign							
Sample	**Units**	**LOR**	**ANZECC/ ARMCANZ 95% Species Protection Level**	**SoE1A**	**SoE1B**	**SoE2A**	**SoE2B**	**SoE3A**	**SoE3B**	**SoE4A**	**SoE5A**	**SoE5B**	**2SoE8**	**2SoE10**	**2SoE12**	**2SoE14**	**2SoE18**	**2SoE19**	**2SoE20**	**95th Percentile (and dilution factor required to meet WQ Guideline)**
Date sampled				21/10/07	21/10/07	21/10/07	21/10/07	21/10/07	21/10/07	21/10/07	21/10/07	21/10/07	30/06/09	30/06/09	30/06/09	30/06/09	30/06/09	30/06/09	30/06/09	
Aluminium	µg/L	<20		710	860	320	340	570	290	170	190	280			<20	<20	<20	<20	<20	763
Antimony	µg/L	<30		<30	<30	<30	<30	<30	<30	<30	<30	<30	2.2	1.3	1.4	<1	1.3	1.8	1.1	15
Arsenic	µg/L	<1		2	<1	2	<1	4	<1	3	3	1			9.3	<5	6.3	11	6.5	9.9
Cadmium	µg/L	<0.7	5	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1			<0.7	<0.7	<0.7	<0.7	<0.7	<0.7
Chromium	µg/L	<2	4.4	<1	<1	<1	<1	<1	<1	<1	<1	<1			<2	<2	<2	<2	<2	<2
Cobalt	µg/L	<1	1	<1	2	<1	1	<1	2	<1	1	<1	<1	<1	<1	<1	<1	<1	<1	2 (2)
Copper	µg/L	<1	1.4	<1	4	<1	<1	2	<1	2	4	2			<1	<1	<1	<1	<1	4 (4)
Iron	µg/L	<20		570	1200	220	250	270	180	150	170	190			<20	<20	<20	<20	<20	790
Lead	µg/L	<1	4.4	<1	<1	<1	<1	<1	<1	<1	<1	<1			<1	<1	<1	<1	<1	<1
Manganese	µg/L	<2		7	6	3	7	<2	10	<2	2	3			2.3	14	10	36	13	21.7
Mercury	µg/L	<0.1	0.4	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1			<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Nickel	µg/L	<6	120	9	10	10	30	10	30	6	10	10			3	3	3	3	3	30
Selenium	µg/L	<40		<40	<40	<40	<40	<40	<40	<40	<40	<40	<2	<2	<2	<2	<2	<2	<2	<40
Silver	µg/L	<1	1.4	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Vanadium	µg/L	<4	100	<4	<4	<4	<4	<4	<4	<4	<4	<4	20	15	24	9.9	15	21	17	21.8
Zinc	µg/L	<5	15	<4	10	9	4	7	10	<4	<4	<4			<5	<5	<5	<5	<5	10.0

Legend

Value exceeds ANZECC/ARMCANZ (2000) water quality toxicant guideline for 95% species protection

Table 6-17 Summary Results for Elutriate Analysis of Metals – Port Berth, Departure Apron and Departure Channel in 2010

				Sampling Location																				
Analyte	Units	LOR	ANZECC/ ARMCANZ 95% Species Protection Level	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Seawater Blank	95th Percentile (and dilution factor required to meet WQ Guideline)
Aluminium	µg/L	10		<10	<10	<10	20	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	6.5
Antimony	µg/L	0.5		2.1	1.5	3	2.1	1.7	2.5	2.9	2.1	3.8	0.9	0.6	<0.5	0.6	0.9	<0.5	<0.5	1.3	2	1.4	1.2	<0.5	3.08
Arsenic	µg/L	0.5		12.4	9.8	13.3	10.3	10.8	9.9	12.6	13.3	9.2	3.5	7.9	7.3	6.4	15.7	7.1	18.9	13.5	13.1	7.3	7.1	1.2	16.02
Cadmium	µg/L	0.2	5.5	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.3	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Chromium	µg/L	0.5	4.4	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Cobalt	µg/L	0.2	1	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.2	<0.2	<0.2	0.2	<0.2	0.2	<0.2	0.2	<0.2	<0.2	<0.2	<0.2
Copper	µg/L	1	1.4	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Iron	µg/L	5		<5	9	5	5	<5	<5	7	<5	<5	12	22	7	6	<5	<5	6	7	<5	6	<5	<5	13
Lead	µg/L	0.2	4.4	<0.2	0.3	<0.2	<0.2	0.4	0.3	<0.2	<0.2	<0.2	<0.2	0.5	<0.2	0.3	<0.2	0.2	<0.2	<0.2	0.2	0.2	<0.2	<0.2	0.41
Manganese	µg/L	0.5		1.7	1.8	24.1	1.3	1.5	1.6	2.9	<0.5	2.5	4.1	2.4	3.1	2.5	3.7	1.7	4.1	2.5	1	3.9	5	<0.5	6.1
Mercury	µg/L	0.1	0.4	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Nickel	µg/L	0.5	120	0.7	<0.5	1.4	<0.5	<0.5	<0.5	<0.5	0.9	1.1	0.8	1.6	1.1	0.7	1.1	<0.5	1.7	1.2	<0.5	<0.5	<0.5	<0.5	1.61
Selenium	µg/L	2		<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Silver	µg/L	0.1	1.4	0.1	0.5	0.1	0.1	0.3	<0.1	0.2	0.2	0.1	0.2	0.2	0.1	0.4	0.2	0.2	0.2	0.3	0.1	0.2	0.2	<0.1	0.41
Vanadium	µg/L	0.5	100	18.2	14.9	15.7	15.3	14.8	14.2	15.6	16.5	14.4	5.7	3.8	7.1	3.8	7.4	3.4	4.6	8.4	19.8	11.5	8.9	1.4	18.4
Zinc	µg/L	5	15	<5	6	<5	100	<5	<5	<5	7	<5	<5	<5	<5	<5	<5	<5	<5	<5	8	<5	<5	<5	17.2 (2)

Legend

Value exceeds ANZECC/ARMCANZ (2000) water quality toxicant guideline for 95% species protection

- All sites have the ability to neutralise acidity with acid neutralising capacities above detection; and
- Low net acidity and the ability to neutralise some acid means the addition of lime to manage acid generation from the dredged material would not be required if the material was to be placed on land.

Overall, assessment of acid sulphate soils indicated the berth area sediments had potential to generate acidity. However, sediments appeared to have the capacity to neutralise some acid generation and would be unlikely to require the addition of lime to manage acid generation, should the material be placed on land. The placement of material on land however is not considered a viable disposal option.

6.5.4.4 Suitability of Dredged Material for Sea Dumping

In accordance with the potential contaminant assessment framework in the NAGD, there are no chemical impediments to unconfined sea disposal of dredge spoil from the port development site on the basis that:

- despite some samples of antimony and nickel marginally exceeding respective screening levels in 2007, all contaminant substances were below respective NAGD screening levels at the 95%UCL of the mean;
- organotins were not detected in the sediments;
- DAE metal concentrations were not above screening levels; and
- allowing for minimal dilution following disposal at the spoil ground for copper, cobalt and zinc, the dredge material would readily achieve the respective ANZECC/ARMCANZ (2000) 95% species protection level toxicant guideline values.

6.5.5 Proposed Offshore Spoil Ground Sediment Characterisation

The proposed new spoil ground is located approximately 17 km offshore from the proposed new wharf facilities located between Pera Head and Boyd Point, 40km south of Weipa. Specifically, the location of the spoil ground is described as 0.5nm radius around the central point:

S12° 54' 46.44" E141° 28' 51.60" (GDA94; equivalent to WGS84).

The location of the new spoil ground in relation to the proposed SoE port site and existing Albatross Bay spoil ground is shown in **Figure 2-9**. The relevant AusMap is Au301. The reasons that this location was chosen for the proposed spoil ground as well as the alternatives considered are discussed in **Section 1.6.11**.

Sampling and analysis of sediments at the proposed offshore spoil ground was undertaken in 2010. This provides baseline information on concentrations of contaminant substances and particle size at the spoil ground prior to disposal of dredged material. The results of this inform the application for a sea dumping permit for dredging and sea disposal of dredged material.

In accordance with NAGD requirements, seven sites were sampled (refer **Figure 6-38**) and were analysed for trace metals and particle size analysis. Organotins were not analysed as these were not identified in sediments to be dredged from the proposed port area.

Physical Characteristics

A graphical summary of the PSD results is presented in **Figure 6-42** while summary statistics are provided in **Table 6-18**.

The surface sediments are relatively uniform in their composition, being dominated by sand, which had a mean of 57% across all samples. The remainder of the material contains a slightly greater percentage of silt and clay (23%) than gravel (20%). Such sediments would be typical for benthic habitats in the area, judging by the high degree of uniformity observed.

A comparison of proposed spoil ground and port area sediments (refer **Section 6.5.4**) shows the spoil ground sediments are significantly higher in gravel and sand fractions. It is likely that placement of port sediments at the proposed spoil ground would locally increase the fraction of finer sediments; however, it is this fraction that would most easily be mobilised under moderate to high wave and current conditions (refer **Section 6.9.2**), leaving grain sizes similar to the existing habitat.

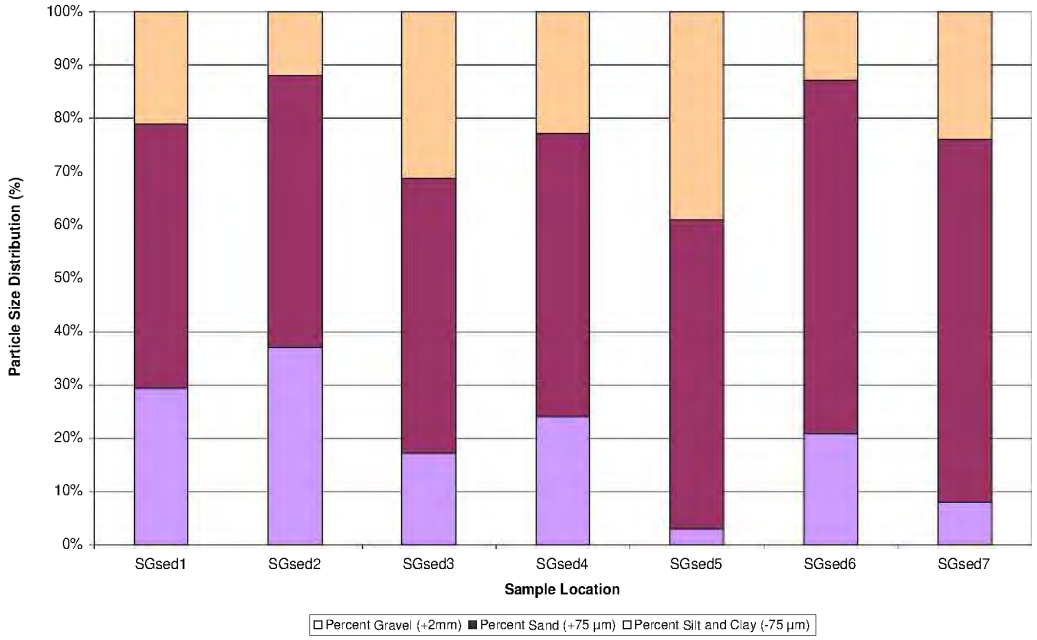


Figure 6-42 Particle Size Distribution for Proposed Spoil Ground Samples

Table 6-18 Summary of Sediment Particle Size at the Proposed Spoil Ground

Statistic	Gravel (>2mm)	Sand (2mm–0.075 mm)	Silt & Clay (<0.075mm)
Number of samples	7	7	7
Mean (%)	20	57	23
Standard deviation (%)	12	8	10
Minimum (%)	3	49	12
Maximum (%)	37	68	39

Chemical Characteristics – Proposed Offshore Spoil Ground

Chemical characteristics of the proposed spoil ground sediments are presented in **Table 6-19**.

All metals contaminant concentrations were very consistent between samples and well below the respective NAGD screening levels. Antimony, cadmium, mercury and silver were not detected at any site. Mean concentrations were all less than one-tenth the NAGD screening levels. The 95%UCL of the mean was a maximum of 12.5% of the NAGD screening levels.

Comparison of trace metals concentrations between proposed spoil new ground sediments, sediments from the port area and regional inshore (Bing Bong, Karumba offshore and Norman Channel) background levels reported by Munksgaard and Parry (2002) is presented in **Table 6-20**. This comparison identifies that:

- the mean of the majority of metals in the proposed dredge area and regional inshore data exceeded the 80th percentile value from the spoil ground. Exceptions were antimony, manganese and silver; and
- the mean of port area sediments was generally consistent with or slightly lower than those reported for regional inshore areas.

Table 6-19 Summary of Sediment Quality for Metals at Proposed Spoil Ground in 2010

	Units	LOR	NAGD PQL	NAGD Screening Level	SGsed1	SGsed2	SGsed3	SGsed4	SGsed5	SGsed6	SGsed7	Mean/ Geomean	Standard Deviation	95% UCL	Normal (N) Log-normal (L) Neither (X)
					05/06/2010	05/06/2010	05/06/2010	05/06/2010	05/06/2010	05/06/2010	05/06/2010				
Moisture Content	%	1			37.4	25.7	35.6	38.3	41.7	34.6	37	35.76	4.976	39.41	N
Total Metals															
Aluminium	mg/kg	50	200	-	3120	690	5100	3870	4760	1940	4620	3443	1632	4642	N
Antimony	mg/kg	0.5	0.5	2	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	-	<0.50	-
Arsenic	mg/kg	1	1	20	1.54	1.14	2.83	1.36	1.96	1.84	1.84	1.787	0.545	2.188	N
Cadmium	mg/kg	0.1	0.1	1.5	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	<0.1	-
Chromium	mg/kg	1	1	80	6.5	1.7	10.2	7.8	10.6	5	10.2	7.429	3.295	9.848	N
Cobalt	mg/kg	0.5	0.5	-	1.2	0.6	1.9	1.4	1.7	1	1.6	1.343	0.447	1.671	N
Copper	mg/kg	1	1	65	2.7	1.6	2.1	1.7	1.9	<1.0	1.6	1.729	0.655	2.217	N
Iron	mg/kg	50	100	-	5110	2260	6960	5570	8100	3980	6700	5526	1970	6973	N
Lead	mg/kg	1	1	50	2.8	1.8	3.7	3	4.7	2.6	3.9	3.214	0.958	3.918	N
Manganese	mg/kg	10	10	-	134	250	229	147	214	120	151	177.9	51.75	215.9	N
Mercury	mg/kg	0.01	0.01	0.15	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	<0.01	-
Nickel	mg/kg	1	1	21	1.2	<1.0	3	1.8	2.7	<1.0	2.8	1.786	1.079	2.578	N
Selenium	mg/kg	0.1	0.1	-	0.2	<0.1	0.3	0.1	0.1	<0.1	<0.1	0.096	0.095	0.191	L
Silver	mg/kg	0.1	0.1	1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	<0.1	-
Vanadium	mg/kg	2	2	-	5	<2.0	8	5.9	7.4	3.9	7.2	5.486	2.448	7.284	N
Zinc	mg/kg	1	1	200	2.8	1.2	4.7	3.5	4.3	1.8	4.5	3.257	1.375	4.267	N

Legend

Note	When calculating averages and 95% UCLs, values below detection for individual results were set to half the detection levels, consistent with the NAGD
PQL	Practical Quantitation Limit
LOR	Laboratory Limit of Reporting
50	Value exceeds NAGD Screening Level

Table 6-20 Comparison of Sediment Quality between Proposed Spoil Ground and Port Area

			Summary Statistics									Regional Data					
			2007 & 2009 Dredge Area			2010 Dredge Area			Spoil Ground 2010			Munksguaard & Parry 2002					
	Units	NAGD Screening Level	Mean/ Geomean	Standard Deviation	95% UCL	Mean/ Geomean	Standard Deviation	95% UCL	Mean/ Geomean	Standard Deviation	80th Percentile	Mean	Max	Mean	Max	Mean	Max
												Bing Bong		Karumba Offshore		Norman Channel	
Aluminium	mg/kg	-	11825	7138	14665	10200	6654	12772	3443	1632	4732						
Antimony	mg/kg	2	0.88	1.13	1.37	<0.50	-	<0.50	<0.50	-	<0.50						
Arsenic	mg/kg	20	6.75	2.97	7.93	3.54	1.9	4.69	1.787	0.545	1.936	nd	nd	3.55	5.38	5.5	8.23
Cadmium	mg/kg	1.5	0.23	0.25	0.33	0.09	0.05	0.11	<0.1	-	<0.1	0.09	0.15	0.09	0.15	0.06	0.14
Chromium	mg/kg	80	23.0	16.1	29.4	24.55	14.79	30.27	7.429	3.295	10.2						
Cobalt	mg/kg	-	8.3	11.8	13.5	4.34	2.7	5.38	1.343	0.447	1.68	10.3	13.4	10	12.9	11.53	21.24
Copper	mg/kg	65	12.8	11.1	17.2	7.41	5.11	9.51	1.729	0.655	2.1	14.6	21.8	13.3	16.6	16.51	24.8
Iron	mg/kg	-	21332	11221	25796	16055	8608	19383	5526	1970	6908	36200	52000	35900	44000	35327	59500
Lead	mg/kg	50	6.0	1.5	6.8	5.98	2.8	7.06	3.214	0.958	3.86	15	19.6	17.2	22.3	20.2	31
Manganese	mg/kg	-	114	82	146	149.3	68.25	175.7	177.9	51.75	226	283	423	366	563	456	1330
Mercury	mg/kg	0.15	0.011	0.011	0.015	0.02	0.03	0.03	<0.01	-	<0.01						
Nickel	mg/kg	21	12.4	10.5	16.5	12.11	3.56	13.87	1.786	1.079	2.84	19.4	22.2	24.4	32.4	22.52	47
Selenium	mg/kg	-	0.41	0.22	0.51	0.56	0.69	0.83	0.096	0.095	0.24						
Silver	mg/kg	1	<0.1	0.000	<0.1	<0.1	-	<0.1	<0.1	-	<0.1						
Vanadium	mg/kg	-	24.3	10.0	28.6	29.21	15.36	35.15	5.486	2.448	7.4						
Zinc	mg/kg	200	36.3	44.7	54.0	17.93	12.43	22.74	3.257	1.375	4.46	41.1	52.1	50.5	60.1	54.2	80.3

0.15 Value exceeds NAGD screening level

0.15 Mean value exceeds 80th percentile of background (spoil ground)

The results of the comparison of port area and proposed spoil ground background concentrations are not unexpected given the presence of pisolitic and ironstone materials in sediments proposed to be dredged from the port area. This material is likely to have originated from the adjacent bauxite cliff face and surrounding geology of the dredge area and, by nature, these geological materials are elevated in a range of metals concentrations. These metals, however, are highly bound and not bioavailable or likely to dissolve into the water column as evidenced from the DAE and elutriate testing (refer **Section 6.5.4.3**).

6.5.6 Barge and Ferry Terminals Sediment Characterisation

The Port of Weipa and its approach channel were developed through capital dredging from 1961 through to 1975 (PCQ 1995). The most recent capital dredging program occurred in 2006 to widen the existing channel and maintenance dredging generally occurs on an annual basis, typically during the dry season (PCQ 2009). Currently within the Port of Weipa there are four wharves located at Lorim Point East, Lorim Point West, Humbug Wharf and Evans Landing. These wharves require maintenance dredging on a regular basis.

Hornibrook Point is an area of land adjacent to Lorim Point and was reclaimed in the 1960s using dredge spoil from the Embley River, including dredge spoil from the original capital dredging of the Lorim Point Wharf. Hornibrook Point has remained as vacant parkland. Humbug Wharf is located approximately 1.25km downstream from Hornibrook Point and is a general cargo wharf currently managed by RTA.

The proposed Hey River terminal site south of Hey Point in the Hey River is an undeveloped area approximately 8km south of Hornibrook Point. No dredging has previously occurred within this area.

The material to be dredged from the barge/ferry terminals has physical characteristics similar to Weipa shipping channel (South Channel) sediments which were characterised by GHD (2005). This material was determined to be suitable for unconfined sea disposal and in addition annual maintenance material from the Port is routinely identified as suitable for unconfined sea disposal. Material at the barge/ferry terminals is considered to be similar to the capital dredging and maintenance dredging material previously disposed of at the spoil ground under NQBP sea dumping permits.

6.5.6.1 Summary of Sediment Sampling and Analysis Program

Sampling of each of the three dredging areas was undertaken in accordance with DSEWPaC approved sediment sampling and analysis plans (Worley Parsons 2009; RTA 2009a). Sampling within the three areas was conducted over two field sampling campaigns, due to slight changes in dredging design:

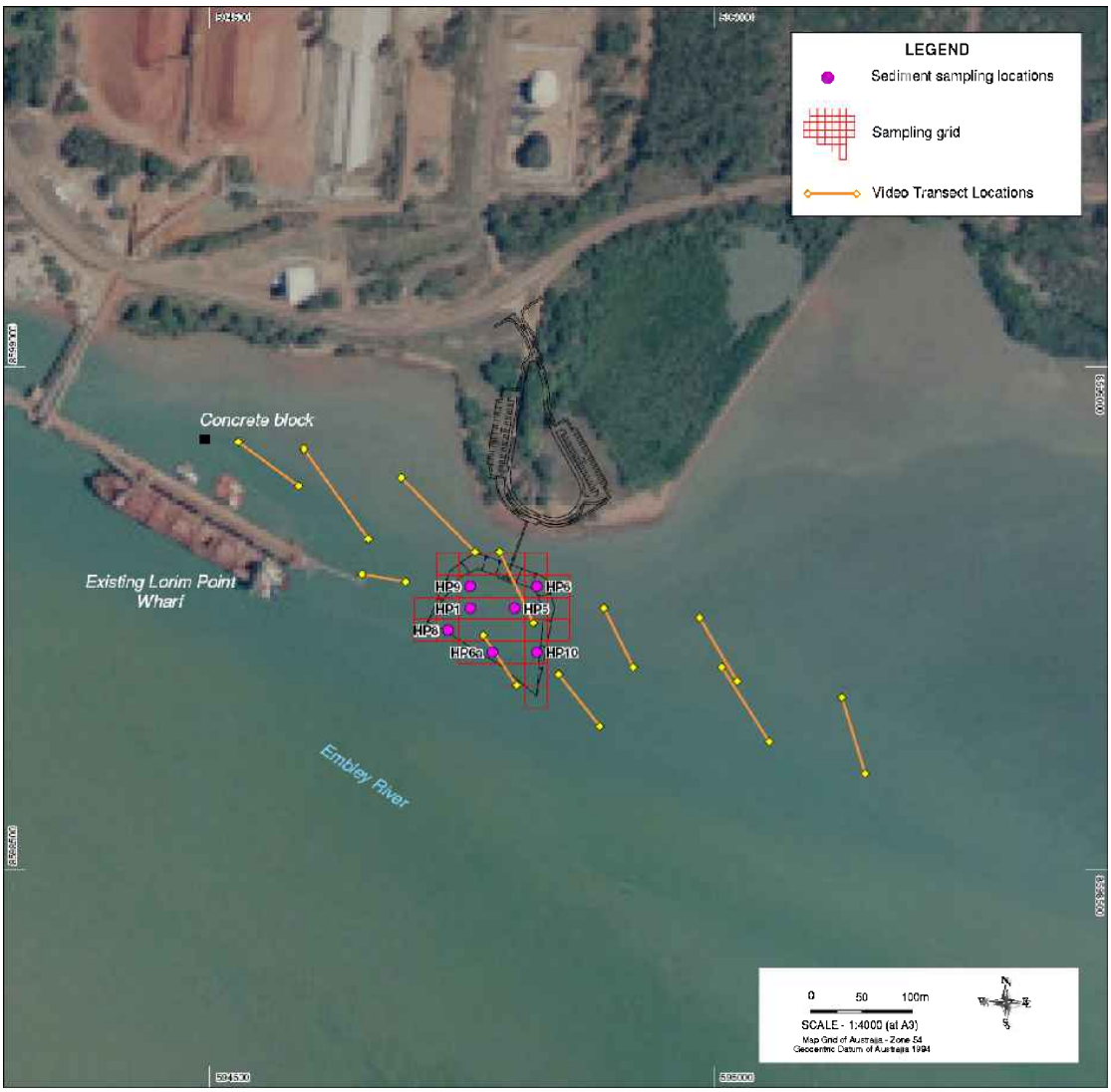
- Hornibrook Terminal – November 2008 and July 2009;
- Hey River Terminal – November 2008; and
- Humbug Terminal – July 2009.

Sampling was undertaken at a total of 20 sites from the three dredge areas: Hornibrook – 7 sites (refer **Figure 6-43**); Humbug – 6 sites (refer **Figure 6-44**); and Hey River – 7 sites (refer **Figure 6-45**). Sampling locations in each area were randomly selected in accordance with NAGD requirements. Sediment was collected using a boat-deployed piston corer to a depth of 1m, or until stiff clays were met. Cores were split into a maximum of three horizons (0–0.5m; 0.5–1m; >1m) where the length of core allowed. Collected samples were transported under refrigerated conditions to the primary analytical laboratory (Advanced Analytical Australia, AAA) and the secondary analytical laboratory (Australian Laboratory Service, ALS) within relevant holding times. Samples were analysed for the following substances:

- trace metals (As, Cd, Cu, Cr, Fe, Pb, Hg, Mn, Ni, and Zn);
- polyaromatic hydrocarbons (PAHs);
- organotin compounds (TBT, DBT, MBT);
- total organic carbon;

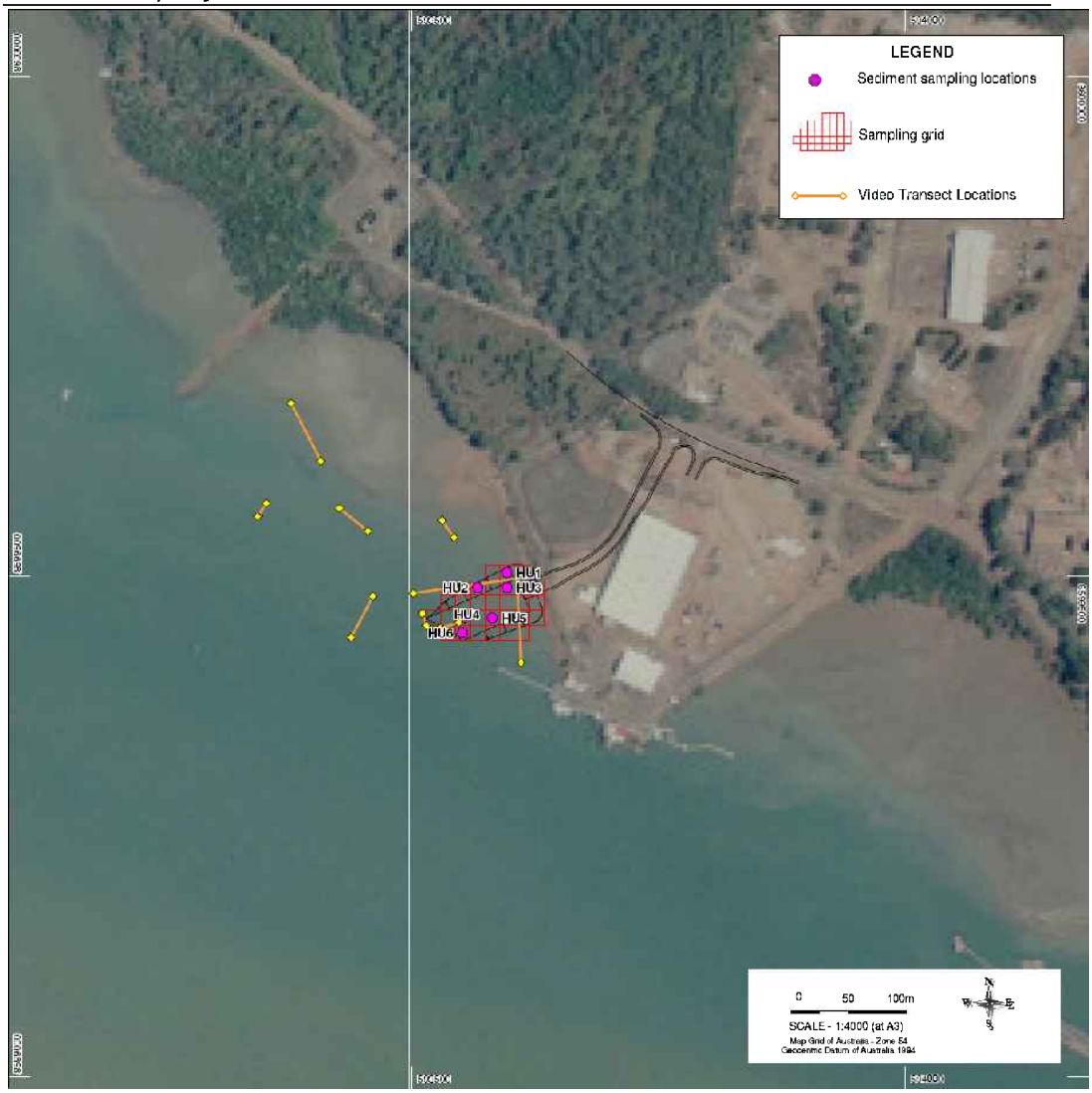
- Acid Sulphate Soils (SPOCAS method);
- particle size distribution; and
- moisture content.

Concentrations of contaminant substances at the 95%UCL of the mean were compared against screening levels listed in Table 2 of the NAGD using the same statistical methods as described for assessment of the proposed port area (refer **Section 6.5.4.1**).



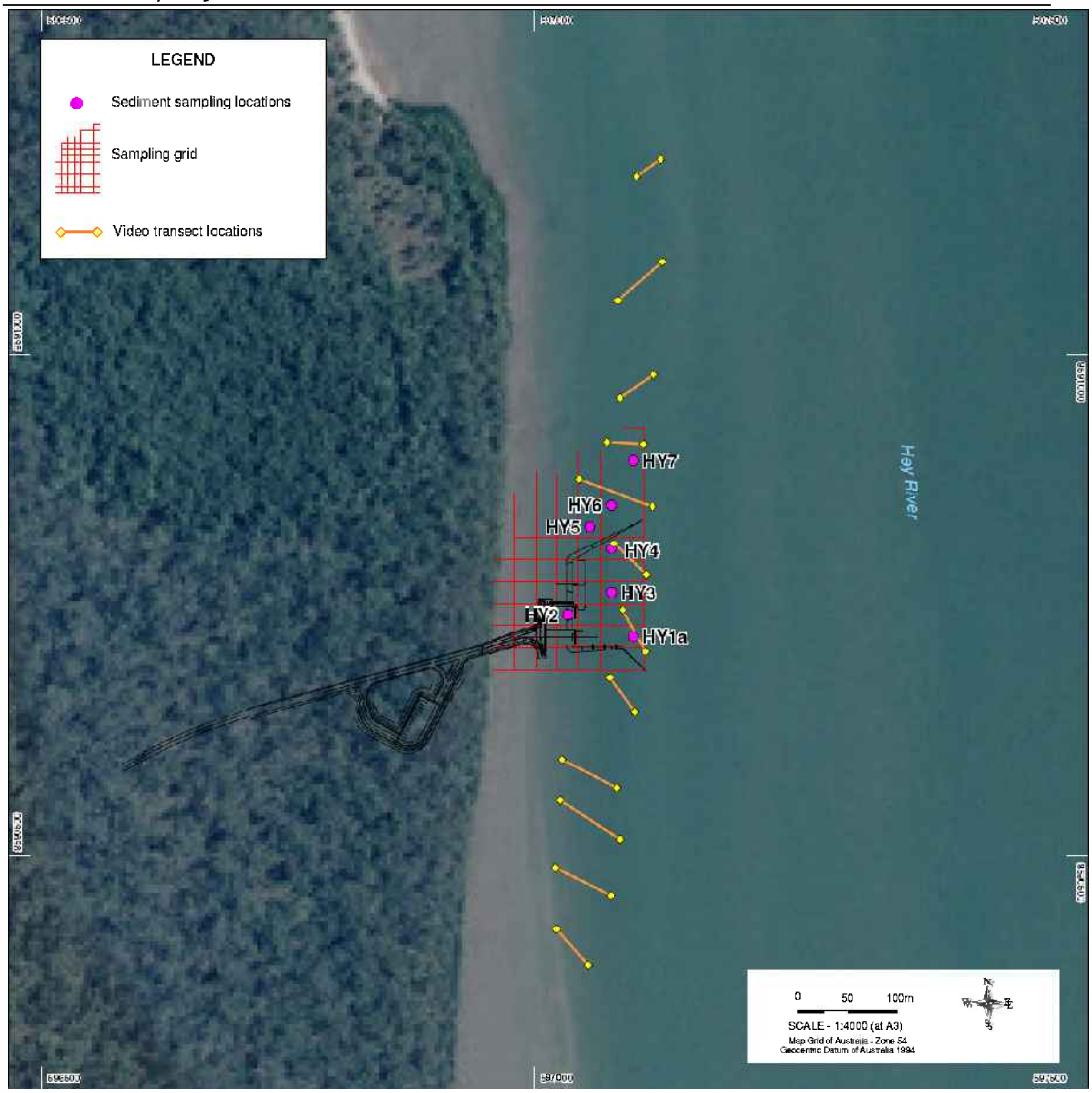
Note: Preliminary seagrass inspection locations not shown.

Figure 6-43 Sediment Sampling Locations and Detailed Seagrass Video Transects at Hornibrook Ferry Terminal



Note: Preliminary seagrass inspection locations not shown.

Figure 6-44 Sediment Sampling Locations and Detailed Seagrass Video Transects at Humbug Barge Terminal



Note: Preliminary seagrass inspection locations not shown.

Figure 6-45 Sediment Sampling Locations and Detailed Seagrass Video Transects at Hey River Barge/Ferry Terminal

6.5.6.2 Physical Characteristics – Hornibrook Terminal

A graphical summary of the PSD results for the Hornibrook Terminal dredging area sediments is presented in **Figure 6-46** while summary statistics are provided in **Table 6-21**.

Generally, the sediment profile within the Hornibrook Terminal dredging area comprises a full depth of moderately soft silt/clay to the depth of required dredging (–2mLAT). Sediments are dominated by silt and clay fractions, which account for a mean of 73% of sediments. There is minimal gravel present. In general there was more sand in the upper horizon (0–0.5m) of each site.

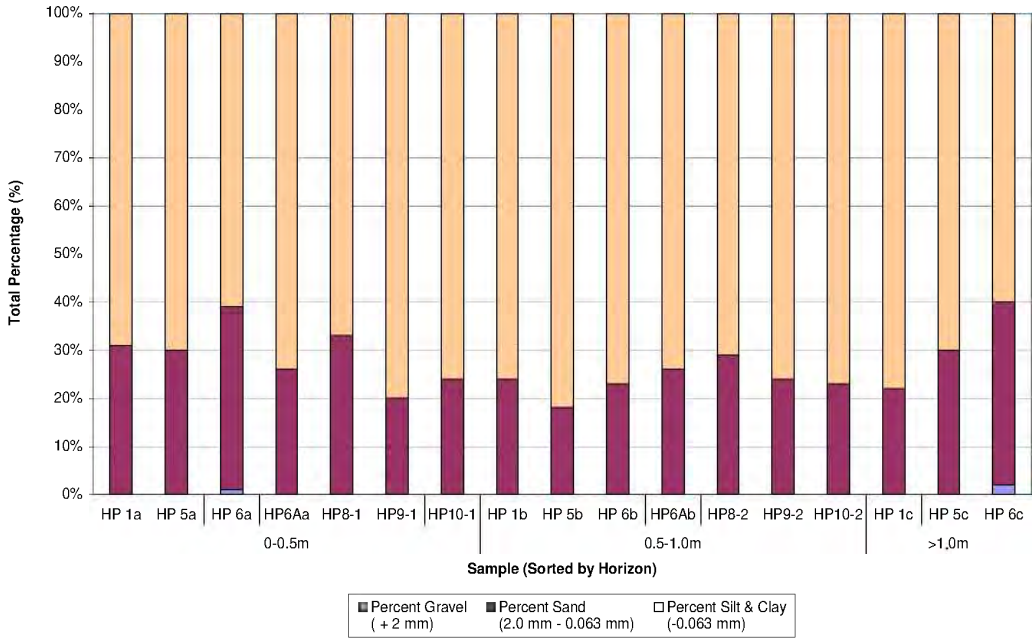


Figure 6-46 Particle Size Distribution within the Hornibrook Terminal Dredging Area

Table 6-21 Summary of Sediment Particle Size within the Hornibrook Terminal Dredging Area

Statistic	Gravel (+2mm)	Sand (2mm – 0.060mm)	Silt & Clay (<0.060mm)
Number of samples	17	17	17
Mean (%)	0.2	27	73
Standard deviation (%)	0.5	6	6
Minimum (%)	0	18	60
Maximum (%)	2	38	82

6.5.6.3 Chemical Characteristics – Hornibrook Terminal

The chemical characteristics of sediment samples collected from the proposed Hornibrook Terminal are presented in **Table 6-22** and summarised below:

Trace Metals - Total

- Mercury and cadmium were detected (i.e. above the laboratory LOR) in samples from one or more horizons from all sites except HP8 (mercury) and HP6A (cadmium). All detections were below respective NAGD screening levels. The mean and 95%UCL of the mean were also below NAGD screening levels.
- All other metals (Al, As, Cr, Cu, Fe, Mn, Ni, Pb and Zn) were detected across all sites and horizons. Concentrations were generally consistent across all samples. All detections were below respective NAGD screening levels. All means and 95%UCL of the mean were also below NAGD screening levels.

Polyaromatic Hydrocarbons (PAH)

- The concentration of naphthalene, 1-methylnaphthalene, 2-methylnaphthalene, acenaphthylene, acenaphthene, dibenz(a,h)anthracene and coronene in samples was less than the LOR across all sites.

- Sites HP5a & c, HP6a-c, and HP8-1 did not record any detection of PAHs. Site HP10-1 recorded only one PAH, fluorene at a concentration equal to the LOR of 5µg/kg.
- The majority of PAH species were detected at sites HP6Aa, HP8-2 and HP9-2.
- There are no NAGD screening levels for individual PAHs for comparison. Total PAHs are below the screening level for the mean and 95%UCL of the mean.

Organotins

- Monobutyltin was below detection levels across all sites.
- Dibutyltin was detected from sites HP6A and HP8–HP10. There are no NAGD screening levels for dibutyltin for comparison.
- Tributyltin was detected from one site only (HP8-1), below the NAGD screening level of 9µgSn/kg. All other sites were below detection levels. The mean and 95%UCL of the mean was also below the NAGD screening level.

Acid Sulphate Soils

A summary of the results of acid sulphate soil analysis is provided below, and the laboratory results are summarised in **Table 6-23**.

- Sediments pH ranged from 7.5 to 8, indicating no sulphur oxidation has yet taken place.
- Titratable Actual Acidity (TAA), which measures the soils actual acidity prior to any oxidation taking place, was below the detection level for all samples, indicating no acid generation has yet taken place in the sediments.
- Potential sulphidic acidity (S_{POS}) indicated the oxidisable sulphur content was higher than the corresponding QASSIT action criteria across all locations tested. This indicates the material has the potential to generate sulphidic acidity.
- Retained acidity, net acid soluble sulphur (S_{NAS}), was below detection limits in all but four sites (HP1b & c, HP5c, HP8-2, HP9-1). Low retained acidity is also indicated since all samples had a pH higher than 4.5, indicating o sulphur oxidation has yet taken place.
- Net acidity, which is used to predict the acid risk of a soil, was lower than detection limit across all sites.
- All sites have the ability to neutralise acidity with acid neutralising capacities above detection.
- Low net acidity and the ability to neutralise some acid means the addition of lime to manage acid generation from the dredged material would not be required if the material was to be placed on land.

Table 6-22 Summary of Sediment Quality – Hornibrook Terminal

Analytical Parameter	Units	LOR	NAGD PQL	NAGD Screening Level	HP 1a	HP 1b	HP1c	HP 5a	HP 5b	HP 5c	HP 6a	HP 6b	HP 6c	HP6Aa	HP6Ab	HP8-1	HP8-2	HP9-1	HP9-2	HP10-1	HP10-2	Mean/ Geomean	Standard Deviaiton	95% UCL
Depth					0 - 0.5	0.5 - 1.0	1.0 - 2.0	0 - 0.5	0.5 - 1.0	1.0 - 2.0	0 - 0.5	0.5 - 1.0	1.0 - 2.0	0 - 0.5	0.5 - 1.0	0 - 0.5	0.5 - 1.0	0 - 0.5	0.5 - 1.0	0 - 0.5	0.5 - 1.0			
Date Sampled					14/10/2008	14/10/2008	14/10/2008	14/10/2008	14/10/2008	14/10/2008	14/10/2008	14/10/2008	14/10/2008	15/11/2008	15/11/2008	1/07/2009	1/07/2009	1/07/2009	1/07/2009	1/07/2009	1/07/2009			
Moisture Content	%	< 0.1	0.1		45.6	45.7	43.7	41.9	43	40.3	31	44.5	31	46.8	41.6	45.1	42.4	44.5	46.6	46.7	47.9	42.8	4.9	44.9
Total Organic Carbon	%	<0.02	0.1		0.93	1	1	0.94	0.88	0.97	0.53	0.8	0.51	0.95	0.88	1.2	1.1	1.3	1.3	1.3	1	0.85	0.18	0.95
Metals																								
Aluminium	mg/kg	<0.1														15530	16865	18643	14884	14300	16335	16093	1559	17375
Arsenic	mg/kg	<0.4	1	20	6.6	6.9	5.5	7.5	7.2	7.2	6.5	7.6	6.6	7	6.9	7.8	8.1	8.7	8.4	8.3	8.4	7.20	0.85	7.73
Cadmium	mg/kg	<0.1	0.1	1.5	0.39	0.88	0.36	0.43	0.44	0.41	0.31	0.44	0.32	<0.1	<0.1	0.11	0.1	0.11	<0.1	0.1	<0.1	0.27	0.22	0.37
Chromium	mg/kg	<0.1	1	80	21	23	19	23	22	21	15	21	16	21	21	25	27	29	24	24	26	22.2	3.6	23.8
Copper	mg/kg	<0.1	1	65	3.1	4.1	3	3.8	4.5	3.3	1.9	4.7	1.7	4.3	3.6	4.1	4.5	4.6	4.3	3.9	4.5	3.76	0.90	4.14
Iron	mg/kg	<0.1	100		17000	18000	16000	18000	19000	19000	14000	19000	14000	18000	19000	21000	23000	23000	20000	20000	22000	18824	2651	19946
Mercury	mg/kg	<0.01	0.01	0.15	0.01	0.01	0.01	0.01	0.02	0.01	<0.01	0.02	<0.01	<0.01	0.01	<0.01	<0.01	0.01	0.01	<0.01	0.01	0.009	0.005	0.011
Manganese	mg/kg	<0.1	10		96	100	88	99	86	93	83	81	86	100	100	110	120	<0.1	110	110	120	93	27	104
Nickel	mg/kg	<0.1	1	21	5.2	6.5	4.9	5.7	5.2	5.4	3.9	4.9	3.9	5.3	5.6	6.3	6.8	7.2	6.1	6.2	6.8	5.64	0.95	6.05
Lead	mg/kg	<0.1	1	50	7.4	5.5	4.3	5.7	4.5	4.7	3.2	4.4	3.4	5.1	5.2	5.2	6.3	5.8	5.9	5.6	5.8	5.18	1.04	5.62
Zinc	mg/kg	<0.1	1	200	15	16	16	16	15	16	7.8	13	8	14	15	17	23	24	17	16	18	15.7	4.1	17.4
Polyaromatic Hydrocarbons																								
Naphthalene	µg/kg	<5	5	-	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	-	-	-
1-Methylnaphthalene	µg/kg	<5	5	-	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	-	-	-
2-Methylnaphthalene	µg/kg	<5	5	-	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	-	-	-
Acenaphthylene	µg/kg	<5	5	-	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	-	-	-
Acenaphthene	µg/kg	<5	5	-	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	-	-	-
Fluorene	µg/kg	<5	5	-	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	5	<5			
Normalised to 1% TOC																				3.85		2.6	0.3	2.7
Phenanthrene	µg/kg	<5	5		<5	<5	10	<5	<5	<5	<5	<5	<5	40	<10	<5	5	5	5	<5	8			
Normalised to 1% TOC				-			10.00							42.11			4.55	3.85	3.85		8.00	6.0	9.5	10.1
Anthracene	µg/kg	<5	5		<5	<5	<5	<5	<5	<5	<5	<5	<5	6	<5	<5	<5	<5	<5	<5	<5			
Normalised to 1% TOC				-										6.32								2.7	0.9	3.1
Fluoranthene	µg/kg	<5	5		6	8	20	<5	5	<5	<5	<5	<5	50	9	<5	8	6	20	<5	10			
Normalised to 1% TOC				-	6.45	8.00	20.00		5.68					52.63	10.23		7.27	4.62	15.38		10.00	9.3	12.3	14.5
Pyrene	µg/kg	<5	5		6	7	14	<5	5	<5	<5	<5	<5	44	9	<5	8	7	19	<5	11			
Normalised to 1% TOC				-	6.45	7.00	14.00		5.68					46.32	10.23		7.27	5.38	14.62		11.00	8.6	10.6	13.0
Benz(a)anthracene	µg/kg	<5			<5	<5	<5	<5	<5	<5	<5	<5	<5	20	<5	<5	7	<5	10	<5	5			
Normalised to 1% TOC				-										21.05			6.36		7.69		5.00	4.3	4.6	6.2
Chrysene	µg/kg	<5	5		<5	<5	<5	<5	<5	<5	<5	<5	<5	20	<5	<5	8	<5	10	<5	5			
Normalised to 1% TOC				-										21.05			7.27		7.69		5.00	4.3	4.6	6.3
Benzo(b)&(k)fluoranthene	µg/kg	<10	5		<10	<10	<10	<10	<10	<10	<10	<10	<10	30	<10	<10	20	<10	30	<10	10			
Normalised to 1% TOC				-										31.58			18.18		23.08		10.00	8.7	7.9	12.0
Benzo(a)pyrene	µg/kg	<5	5		5	<5	5	<5	<5	<5	<5	<5	<5	17	<5	<5	11	<5	12	<5	<5			
Normalised to 1% TOC				-	5.38		5.00							17.89			10.00		9.23			4.6	4.2	6.3
Indeno(1,2,3-cd)pyrene	µg/kg	<5	5		<5	<5	<5	<5	<5	<5	<5	<5	<5	10	<5	<5	10	5	10	<5	6			
Normalised to 1% TOC				-										10.53			9.09	3.85	7.69		6.00	4.0	2.7	5.1
Dibenz(a,h)anthracene	µg/kg	<5	5	-	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	-	-	-
Benzo(g,h,i)perylene	µg/kg	<5			5	<5	<5	<5	<5	<5	<5	<5	<5	10	<5	<5	8	<5	8	<5	<5			
Normalised to 1% TOC				-	5.38									10.53			7.27		6.15			3.6	2.3	4.6
Coronene	µg/kg	<10	5	-	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	-	-	-
Benzo(e)pyrene	µg/kg	<5	5		<5	<5	<5	<5	<5	<5	<5	<5	<5	12	<5	<5	8	<5	9	<5	<5			
Normalised to 1% TOC				-										12.63			7.27		6.92			3.6	2.8	4.8
Total PAHs (as above)	µg/kg	<100	100	10,000	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	130	<100	<100			
Normalised to 1% TOC																			100.00			52.9	12.1	58.1
Organotins																								
Monobutyl tin	µgSn/kg	<0.5	1	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	-	-
Dibutyl tin	µgSn/kg	<0.5	1		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.8	0.8	0.8	0.8	0.5	0.5	0.9	0.8			
Normalised to 1% TOC				-										0.84	0.91	0.67	0.73	0.38	0.38	0.69	0.80	0.45	0.26	0.56
Tributyl tin	µgSn/kg	<0.5	1	9	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.6	<0.5	<0.5	<0.5	<0.5	<0.5			
Normalised to 1% TOC																0.50						0.27	0.06	0.29

Legend for Table 6-22		
	■	Value exceeds NAGD Screening Level
	mg/kg	milligrams per kilogram
	µg/kg	microgram per kilogram
	µgSn/kg	microgram of tin per kilogram

Table 6-23 Results of SPOCAS Acid Sulphate Soils Tests – Hornibrook Terminal

Sample ID	Units	PQL	HP1a	HP1b	HP1c	HP5a	HP5b	HP5c	HP6a	HP6b	HP6c	HP6a-1	HP6a-2	HP8-1	HP8-2	HP9-1	HP9-2	HP10-1	HP10-2
Depth	m		0–0.5	0.5–1.0	1.0–2.0	0–0.5	0.5–1.0	1.0–2.0	0–0.5	0.5–1.0	1.0–2.0	0–0.5	0.5–1.0	0–0.5	0.5–1.0	0–0.5	0.5–1.0	0–0.5	0.5–1.0
QASSIT (1998) Action Criteria																			
Sulphur Trail	% S		0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Acid Trail	moles H+/t		18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18
pH Measurements																			
pH kcl	pH units		8.6	8.7	8.7	8.8	8.8	8.8	8.9	8.8	8.9	9.4	9.4	9.4	9.4	9.4	9.4	9.4	9.4
pH Ox	pH units		7.5	7.6	7.6	7.5	7.5	7.6	7.7	7.5	7.6	8	7.6	7.9	7.5	7.9	7.9	7.5	7.9
Titratable Acidity																			
TAA pH 6.5	moles H+/t	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
TPA pH 6.5	moles H+/t	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Percentage Sulphur																			
SKCl	%w/w S	<0.005	0.15	0.14	0.093	0.14	0.12	0.11	0.12	0.15	0.14	0.15	0.13	0.12	0.12	0.11	0.12	0.15	0.13
SP	%w/w	<0.005	0.62	0.78	0.73	0.67	0.7	0.61	0.56	0.74	0.61	0.63	0.72	0.57	0.73	0.7	0.61	0.68	0.72
SRAS	%w/w	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
SHCl	%w/w S	<0.005	0.14	0.14	0.1	0.14	0.12	0.11	0.099	0.14	0.11	0.13	0.12	0.12	0.13	0.12	0.12	0.14	0.12
Percentage Calcium																			
CaKCl	%w/w	<0.005	0.22	0.26	0.22	0.24	0.23	0.21	0.2	0.26	0.2	0.26	0.26	0.25	0.22	0.25	0.25	0.28	0.25
CaP	%w/w	<0.005	4.2	4.6	4.7	4.5	3.9	4.3	4.3	3.6	4.2	4.8	5	4.7	4.9	4.7	4.6	4.8	5.1
Percentage Magnesium																			
MgKCl	%w/w	<0.005	0.12	0.12	0.11	0.12	0.11	0.099	0.09	0.12	0.089	0.12	0.12	0.097	0.12	0.1	0.1	0.1	0.11
MgP	%w/w	<0.005	0.31	0.35	0.32	0.32	0.31	0.3	0.27	0.31	0.27	0.37	0.37	0.34	0.41	0.34	0.35	0.38	0.36
Titratable Sulphidic Acidity																			
s-TAA pH 6.5	%w/w S	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
s-TPA pH 6.5	%w/w S	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
TSA pH 6.5	moles H+/t	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
s-TSA pH 6.5	%w/w S	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Acid Neutralising Capacity																			
ANCE	% CaCO3	<0.05	12	14	13	12	11	12	13	9.4	12	12	13	12	13	13	12	12	13
a-ANCE	moles H+/t	<5	2350	2750	2500	2475	2100	2400	2550	1875	2300	2425	2500	2400	2500	2500	2350	2375	2500
s-ANCE	%w/w S	<0.05	3.8	4.4	4	4	3.4	3.8	4.1	3	3.7	3.9	4	3.8	4	4	3.8	3.8	4
Peroxide Oxidisable Sulphur																			
SPOS	%w/w	<0.005	**0.47**	**0.64**	**0.64**	**0.53**	**0.57**	**0.51**	**0.44**	**0.59**	**0.47**	**0.48**	**0.58**	**0.46**	**0.61**	**0.59**	**0.49**	**0.53**	**0.59**
a-SPOS	moles H+/t	<5	295	399	399	328	358	317	275	369	295	300	363	284	379	368	305	332	370
Net Acid Soluble Sulphur																			
SNAS	%w/w S	<0.005	<0.005	0.005	0.008	<0.005	<0.005	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.014	0.005	<0.005	<0.005	<0.005
a-SNAS	moles H+/t	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	6.3	<5	<5	<5	<5
s-SNAS	%w/w S	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01
Percentage Reacted Calcium																			
CaA	%w/w	<0.005	4	4.4	4.4	4.2	3.6	4.1	4.1	3.4	4	4.5	4.7	4.4	4.7	4.5	4.4	4.5	4.8
Percent Reacted Magnesium																			

Sample ID	Units	PQL	HP1a	HP1b	HP1c	HP5a	HP5b	HP5c	HP6a	HP6b	HP6c	HP6a-1	HP6a-2	HP8-1	HP8-2	HP9-1	HP9-2	HP10-1	HP10-2
MgA	%w/w	<0.005	0.19	0.23	0.21	0.21	0.2	0.2	0.18	0.19	0.18	0.25	0.25	0.24	0.29	0.24	0.25	0.27	0.25
Net Acidity																			
a-Net Acidity	moles H+/t	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Liming Rate																			
Liming rate	kg CaCO3/t	<0.75	<0.75	<0.75	<0.75	<0.75	<0.75	<0.75	<0.75	<0.75	<0.75	<0.75	<0.75	<0.75	<0.75	<0.75	<0.75	<0.75	<0.75

Note: Bold values indicate exceedance of QASSIT action criteria.

6.5.6.4 Physical Characteristics – Humbug Terminal

Not all sampling locations were able to achieve the required depth of dredging, with refusal occasionally occurring close to the desired dredge depth on kaolin clay. A graphical summary of the PSD results for the Humbug Terminal dredging area sediments is presented in **Figure 6-47** with summary statistics provided in **Table 6-24**. Sediments located within the Humbug Terminal dredging area are dominated by silt and clay fractions (73%).

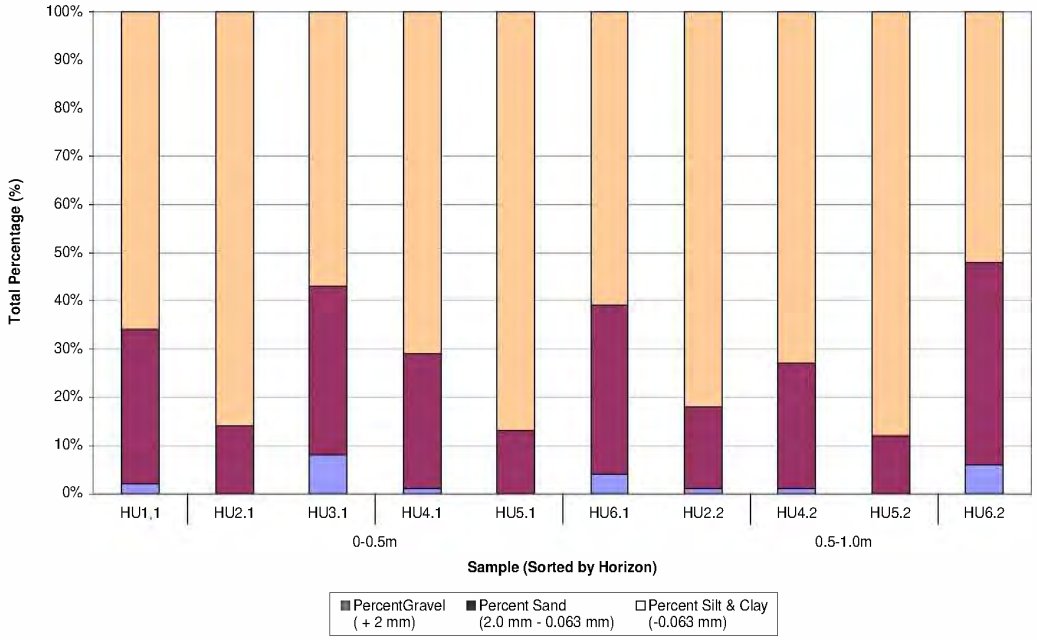


Figure 6-47 Particle Size Distribution within the Humbug Terminal Dredging Area

Table 6-24 Summary of Sediment Particle Size within the Humbug Terminal Dredging Area

Statistic	Gravel (>2mm)	Sand (0.060mm–2mm)	Silt & Clay (<0.060mm)
Number of samples	10	10	10
Mean (%)	2	25	73
Standard deviation (%)	3	11	13
Minimum (%)	0	12	52
Maximum (%)	8	42	88

6.5.6.5 Chemical Characteristics – Humbug Terminal

The chemical characteristics of the sediments from Humbug Terminal are presented in **Table 6-25** and summarised below:

Trace Metals – Total

- Mercury was below the detection level of 0.01mg/kg in three samples. Mercury was reported at the detection level in six samples. The concentration of mercury was above the detection level in one sample, HU5.2 at a concentration of 0.15mg/kg, which equals the NAGD screening level. The mean and 95%UCL of the mean for mercury were both below the NAGD screening level.

- Cadmium was detected across all sites except HU1. All detections, mean and 95%UCL of the mean were below the NAGD screening level.
- All other metals (Al, As, Cr, Cu, Fe, Mn, Ni, Pb and Zn) were detected across all sites. All detection levels, means and 95%UCLs of the mean were below respective NAGD screening criteria.

Polyaromatic Hydrocarbons (PAH)

- The concentration of naphthalene, 1-methylnaphthalene, 2-methylnaphthalene, acenaphthylene, acenaphthene, fluorene, anthracene, dibenz(a,h)anthracene and coronene was less than the LOR across all sites.
- All PAHs were below detection limits in the lower horizon samples from sites HU4 and HU6. Each of these sites only had one detection (fluoranthene and phenanthrene respectively) in the upper horizon.
- Phenanthrene, fluoranthene, pyrene, benz(a)anthracene, chrysene, benzo(b)&(k)fluoranthene, benzo(a)pyrene, indeno(1,2,3-cd)pyrene, benzo(g,h,i)perylene, benzo(e)pyrene were above detection limits across the majority of remaining sites.
- There are no NAGD screening levels for individual PAH species. Total PAHs were below the screening level at the mean and 95%UCL of the mean.

Organotins

- Monobutyltin and tributyltin were not detected at any site.
- Dibutyltin was detected in the upper horizon of HU2 and both the upper and lower horizons of HU5. There are no NAGD screening levels for dibutlytin.

Acid Sulphate Soils

The potential for the dredge material to be characterised as an acid sulphate soil was assessed using the SPOCAS suite of analyses. A summary of the results of acid sulphate soil analysis is provided below, and the laboratory results are provided in **Table 6-26**:

- Sediments pH ranged from 7.6 to 8.1, indicating no sulphur oxidation has yet taken place.
- TAA, which measures the soil's actual acidity prior to any oxidation taking place, was below the detection level for all samples, indicating no acid generation has yet taken place in the sediments.
- Potential sulphidic acidity (S_{POS}) indicated the oxidisable sulphur content was higher than the corresponding QASSIT action criteria across all locations tested. This indicates the material has the potential to generate sulphidic acidity;
- Retained acidity, net acid soluble sulphur (S_{NAS}), was below detection limits in all but one site (HU2.2). Low retained acidity is also indicated since all samples had a pH higher than 4.5, indicating no sulphur oxidation has yet taken place;
- Net acidity, which is used to predict the acid risk of a soil, was lower than detection limit across all sites;
- All sites have the ability to neutralise acidity with acid neutralising capacities above detection; and
- Low net acidity and the ability to neutralise some acid means the addition of lime to manage acid generation from the dredged material would not be required if the material was to be placed on land.

Table 6-25 Summary of Sediment Quality Analysis Results – Humbug Terminal

Sample	Units	LOR	PQL	NAGD Screening Level	HU1.1	HU2.1	HU2.2	HU3.1	HU4.1	HU4.2	HU5.1	HU5.2	HU6.1	HU6.2	Mean/ Geomean	Standard Deviation	95% UCL
Depth	m				0 - 0.5	0 - 0.5	0.5 - 1.0	0 - 0.5	0 - 0.5	0.5 - 1.0	0 - 0.5	0.5 - 1.0	0 - 0.5	0.5 - 1.0			
Date sampled					1/07/2009	1/07/2009	1/07/2009	1/07/2009	1/07/2009	1/07/2009	1/07/2009	1/07/2009	1/07/2009	1/07/2009			
Moisture Content	%	< 0.1			40.4	47.3	39.9	36.7	50.2	49.5	53.0	48.7	49.4	45.0	46.0	5.3	-
Total Organic Carbon	%	<0.02			0.88	0.97	0.66	0.8	1.2	0.9	1.4	1.1	1.1	1.1	1.0	0.2	-
Metals																	
Aluminium	mg/kg	<0.1	200		21594	17132	14464	22310	15252	15225	18001	18958	16617	15016	17460	2761	19060
Arsenic	mg/kg	<0.4	1	20	8.7	9.2	8.6	8.9	8.9	8.4	9.6	9.1	7.9	8.3	8.76	0.49	9.04
Cadmium	mg/kg	<0.1	0.1	1.5	<0.1	0.12	0.12	0.11	0.19	0.13	0.12	0.11	0.11	0.12	0.126	0.025	0.141
Chromium	mg/kg	<0.1	1	80	25	26	20	41	23	22	29	29	26	23	25.9	5.9	29.8
Copper	mg/kg	<0.1	1	65	3	4.4	2.4	3.3	3.5	2.9	5.1	4.9	4	3.1	3.7	0.9	4.2
Iron	mg/kg	<0.18	100		20000	22000	18000	22000	22000	21000	24000	23000	24000	25000	22100	2079	23305
Mercury	mg/kg	<0.01	0.01	0.15	<0.01	0.01	<0.01	0.01	0.01	0.01	0.01	0.15	0.01	<0.01	0.030	0.053	0.069
Manganese	mg/kg	<0.1	10		85	100	80	84	110	87	120	120	120	120	102.6	17.3	112.6
Nickel	mg/kg	<0.1	1	21	4.4	6.4	4.1	4.6	5.7	5	7.4	7.2	6.6	5.8	5.72	1.17	6.40
Lead	mg/kg	<0.12	1	50	4.9	5.4	4.8	5.6	5.1	4.9	6.3	6.4	5	4.5	5.3	0.6	5.7
Zinc	mg/kg	<0.1	1	200	13	18	9.4	13	18	11	19	21	16	14	15.2	3.8	17.4
Polyaromatic Hydrocarbons																	
Naphthalene	µg/kg	<5	5		<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	0	<5
1-Methylnaphthalene	µg/kg	<5	5		<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	0	<5
2-Methylnaphthalene	µg/kg	<5	5		<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	0	<5
Acenaphthylene	µg/kg	<5	5		<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	0	<5
Acenaphthene	µg/kg	<5	5		<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	0	<5
Fluorene	µg/kg	<5	5		<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	0	<5
Phenanthrene	µg/kg	<5	5		7	9	7	10	<5	<5	10	7	5	<5			
Normalised to 1%TOC					7.95	9.28	10.61	12.50			7.14	6.36	4.55		6.59	3.57	8.66
Anthracene	µg/kg	<5	5		<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	0	<5
Fluoranthene	µg/kg	<5	5		10	10	6	20	5	<5	20	10	<5	<5			
Normalised to 1%TOC					11.36	10.31	9.09	25.00	4.17		14.3	9.1			9.1	7.0	13.1
Pyrene	µg/kg	<5	5		10	13	5	17	<5	<5	17	10	<5	<5			
Normalised to 1%TOC					11.36	13.40	7.58	21.25			12.1	9.1			8.5	6.3	12.1
Benz(a)anthracene	µg/kg	<5	5		6	6	<5	7	<5	<5	10	5	<5	<5			
Normalised to 1%TOC					6.82	6.19		8.75			7.1	4.5			4.6	2.4	6.0
Chrysene	µg/kg	<5	5		6	7	<5	8	<5	<5	10	6	<5	<5			
Normalised to 1%TOC					6.82	7.22		10.00			7.1	5.5			4.9	2.8	6.5
Benzo(b)&(k)fluoranthene	µg/kg	<10	5		10	10	<10	10	<10	<10	20	10	<10	<10			
Normalised to 1%TOC					11.36	10.31		12.50			14.3	9.1			8.3	3.7	10.4
Benzo(a)pyrene	µg/kg	<5	5		5	5	<5	5	<5	<5	9	5	<5	<5			
Normalised to 1%TOC					5.68	5.15		6.25			6.4	4.5			4.1	1.7	5.1
Indeno(1,2,3-cd)pyrene	µg/kg	<5	5		8	8	<5	7	<5	<5	10	7	<5	<5			
Normalised to 1%TOC					9.09	8.25		8.75			7.1	6.4			5.2	3.0	6.9
Dibenz(a,h)anthracene	µg/kg	<5	5		<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	0	<5
Benzo(g,h,i)perylene	µg/kg	<5	5		5	5	<5	<5	<5	<5	7	<5	<5	<5			
Normalised to 1%TOC					5.68	5.15					5.0				3.3	1.4	4.1
Coronene	µg/kg	<10	5		<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	0	<10
Benzo(e)pyrene	µg/kg	<5	5		5	5	<5	<5	<5	<5	7	<5	<5	<5			
Normalised to 1%TOC					5.68	5.15					5.0				3.3	1.4	4.1
Total PAHs (as above)	µg/kg	<100	100	10,000	<100	<100	<100	<100	<100	<100	120	<100	<100	<100			
Normalised to 1%TOC											85.71				54	11	60
Organotins																	
Monobutyl tin	µgSn/kg	<0.5	1		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.05	0	<0.05
Dibutyl tin	µgSn/kg	<0.5	1		<0.5	0.5	<0.5	<0.5	<0.5	<0.5	0.7	0.6	<0.5	<0.5			
Normalised to 1%TOC						0.52					0.50	0.55			0.33	0.13	0.41
Tributyl tin	µgSn/kg	<0.5	1	9	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.05	0	<0.05

Legend for Table 6-25	■	Value exceeds NAGD Screening Level
	mg/kg	milligrams per kilogram
	µg/kg	microgram per kilogram
	µgSn/kg	microgram of tin per kilogram

Table 6-26 Results of SPOCAS Acid Sulphate Soils Tests – Humbug Terminal

Sample ID	Units	PQL	HU1.1	HU2.1	HU2.2	HU3.1	HU4.1	HU4.2	HU5.1	HU5.2	HU6.1	HU6.2
Depth	m		0–0.5	0–0.5	0.5–1.0	0–0.5	0–0.5	0.5–1.0	0–0.5	0.5–1.0	0–0.5	0.5–1.0
QASSIT (1998) Action Criteria												
Sulphur Trail	% S		0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Acid Trail	moles H+/t		18	18	18	18	18	18	18	18	18	18
pH Measurements												
pH kcl	pH units		9.5	9.4	9.5	9.5	9.3	9.4	9.3	9.4	9.3	9.3
pH Ox	pH units		7.8	7.7	8.1	8	7.8	7.9	7.7	7.7	8	7.6
Titratable Acidity												
TAA pH 6.5	moles H+/t	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
TPA pH 6.5	moles H+/t	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Percentage Sulphur												
SKCl	%w/w S	<0.005	0.1	0.12	0.098	0.1	0.1	0.12	0.12	0.12	0.13	0.11
SP	%w/w	<0.005	0.62	0.84	0.57	0.57	0.82	0.68	0.84	0.92	0.73	0.72
SRAS	%w/w	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
SHCl	%w/w S	<0.005	0.096	0.11	0.1	0.093	0.1	0.1	0.11	0.11	0.12	0.11
Percentage Calcium												
CaKCl	%w/w	<0.005	0.2	0.24	0.21	0.23	0.23	0.24	0.24	0.22	0.27	0.26
CaP	%w/w	<0.005	3.5	4.9	3.3	3.7	4.4	4	5	5.1	4.8	4.9
Percentage Magnesium												
MgKCl	%w/w	<0.005	0.075	0.11	0.077	0.08	0.11	0.1	0.13	0.13	0.12	0.1
MgP	%w/w	<0.005	0.23	0.39	0.23	0.25	0.34	0.32	0.38	0.4	0.34	0.33
Titratable Sulphidic Acidity												
s-TAA pH 6.5	%w/w S	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
s-TPA pH 6.5	%w/w S	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
TSA pH 6.5	moles H+/t	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
s-TSA pH 6.5	%w/w S	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Acid Neutralising Capacity												
ANCE	% CaCO3	<0.05	8.6	12	7.6	9	11	8.8	13	13	13	12
a-ANCE	moles H+/t	<5	1725	2325	1525	1800	2125	1750	2500	2500	2500	2425
s-ANCE	%w/w S	<0.05	2.8	3.7	2.4	2.9	3.4	2.8	4	4	4	3.9
Peroxide Oxidisable Sulphur												
SPOS	%w/w	<0.005	**0.52**	**0.71**	**0.47**	**0.47**	**0.71**	**0.56**	**0.72**	**0.79**	**0.59**	**0.6**
a-SPOS	moles H+/t	<5	322	446	294	293	444	350	448	496	370	375

Sample ID	Units	PQL	HU1.1	HU2.1	HU2.2	HU3.1	HU4.1	HU4.2	HU5.1	HU5.2	HU6.1	HU6.2
Net Acid Soluble Sulphur												
SNAS	%w/w S	<0.005	<0.005	<0.005	0.006	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
a-SNAS	moles H+/t	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
s-SNAS	%w/w S	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Percentage Reacted Calcium												
CaA	%w/w	<0.005	3.3	4.7	3.1	3.5	4.2	3.8	4.8	4.9	4.5	4.7
Percent Reacted Magnesium												
MgA	%w/w	<0.005	0.16	0.28	0.16	0.17	0.23	0.21	0.25	0.27	0.22	0.22
Net Acidity												
a-Net Acidity	moles H+/t	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Liming Rate												
Liming rate	kg CaCO3/t	<0.75	<0.75	<0.75	<0.75	<0.75	<0.75	<0.75	<0.75	<0.75	<0.75	<0.75

Note: Bold values indicate exceedance of QASSIT action criteria.

6.5.6.6 Physical Characteristics – Hey River Terminal

During sampling, refusal frequently occurred between 0.1 and 0.8m sediment depth on kaolin clay. Targeted dredging depths were not reached at all locations. Due to the shallow depth of penetration, sediments were submitted as single horizons for each site. A graphical summary of the PSD results for the Hey River Terminal dredging area sediments is presented in **Figure 6-48** while summary statistics are provided in **Table 6-27**. Gravel was the dominant particle size (41%), followed by sand (35%), and silt and clay (24%).

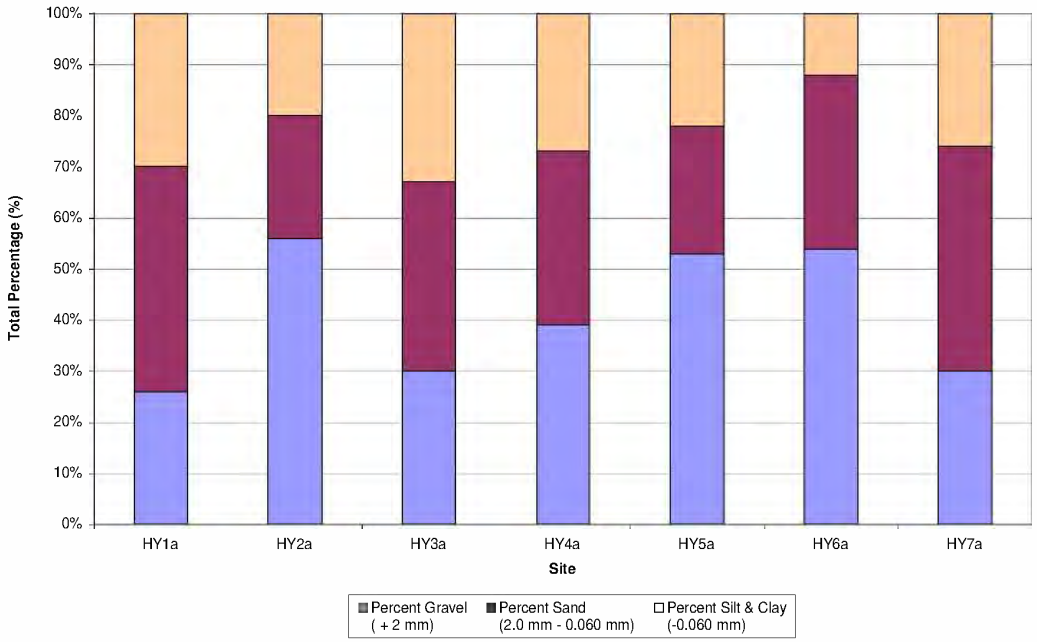


Figure 6-48 Particle Size Distribution within the Hey River Terminal Dredging Area

Table 6-27 Summary of Sediment Particle Size within the Hey River Terminal Dredging Area

Statistic	Gravel (>2mm)	Sand (0.060mm–2mm)	Silt & Clay (<0.060mm)
Number of samples	7	7	7
Mean (%)	41	35	24
Standard deviation (%)	13	8	7
Minimum (%)	26	24	12
Maximum (%)	56	44	33

6.5.6.7 Chemical Characteristics – Hey River Terminal

The chemical characteristics of the sediments at the Hey River Terminal are presented in **Table 6-29** and summarised below:

Trace Metals - Total

- Mercury was below detection limits across all sites.

- Cadmium was below detection limits at three (HY1, HY2 and HY5) of the seven sites. Detection at the remaining sites was below the NAGD screening limits.
- Arsenic was detected across all sites. Three (HY4, HY6 and HY7) of the seven sites had detections above the NAGD screening level. The mean (20.7mg/kg) and 95%UCL of the mean (25.8mg/kg) for arsenic were above the NAGD screening level of 20mg/kg. Although there is an absence of potential anthropogenic arsenic sources in the region, further core samples were taken on 23 September 2009 at the three sites (HY4, HY6 and HY7) with highest arsenic concentrations. These were tested for total arsenic, concentrations in elutriate water, and bioavailable arsenic using dilute acid extraction (refer **Section 6.5.4.1** for methods).
- Elutriate arsenic concentrations were all reported above the low reliability ANZECC/ARMCANZ (2000) water quality guideline values for arsenic (III) and arsenic (V) (refer **Table 6-28**) (no guideline for arsenic in marine waters is provided in the toxicant table of ANZECC/ARMCANZ (2000); however "low reliability" values are provided in supporting rationale and background information). A dilution factor of four would be required to achieve the lower of the guideline values (2.3µg/L) and would be readily achieved upon release from the barge hopper.
- Dilute acid extraction results identify that arsenic in the Hey River Terminal sediments has low bioavailability, with DAE concentrations being only about 11% of total concentrations. The mean and 95%UCL of the mean are well below the NAGD screening level (refer **Table 6-28**).
- All other metals (Cr, Cu, Fe, Mn, Ni, Pb, and Zn) were detected across all sites in concentrations below respective NAGD screening levels. All 95%UCLs of the mean for these elements were also below respective NAGD screening levels.

Table 6-28 Summary of Arsenic Total, Elutriate and Dilute Acid Extraction Results

Analysis	Units	LOR	NAGD PQL	NAGD Screening Level	ANZECC/ ARMCANZ Water Quality Guideline	HY7	HY6	HY4	Arithmetic Mean	Standard Deviation	95%UCL	95th Percentile (and dilution factor required to meet WQ Guideline)
Total arsenic	mg/kg	<0.4	0.5	20		11	26	27	21.3	8.96	36.4	-
Elutriate arsenic	µg/L	<5	-	-	2.3 & 4.5*	7.9	5.3	7.5	6.9	1.42	-	7.87 (4)
DAE Arsenic	mg/kg	<0.4	0.5	20		1.6	2.5	2.5	2.2	0.52	3.1	-

Legend

PQL	Practical Quantitation Limit
DAE	Dilute acid exctraction using 1M HCl
-	No guidelines levels set in NAGD for given parameter, or no analysis undertaken for a given sample
	Value exceeds NAGD Screening Level
	Value exceeds ANZECC/ARMCANZ(2000) guideline
*	ANZECC/ARMCANZ (2000) low reliability trigger values for As (III) and As (V) in marine waters.
mg/kg	Milligrams per kilograms
µg/L	Micrograms per litre

Polyaromatic Hydrocarbons *(PAH)*

- The concentration of all polyaromatic hydrocarbons in sediment samples was less than the LOR across all sites.

Organotins

- The concentration of all organotins in sediment samples was less than the LOR across all sites.

Table 6-29 Summary of Sediment Quality Analysis Results – Hey River Terminal

Analyte	Units	LOR	NAGD PQL	NAGD Screening Level	HY1a	HY2a	HY3a	HY4a	HY5a	HY6a	HY7a	Mean/ Geomean	Standard Deviation	95%UCL
Depth	m				0 - 0.7	0 - 0.1	0 - 0.5	0 - 0.8	0 - 0.2	0 - 0.6	0 - 0.5			
Date sampled					19/11/2008	19/11/2008	19/11/2008	19/11/2008	19/11/2008	19/11/2008	19/11/2008			
Moisture Content	%	< 0.1	0.1		34.2	35.5	39.4	39	38.1	29.2	37.3	36.1	3.6	-
Total Organic Carbon	%	<0.02	0.1		0.99	1.5	1	0.77	1.3	0.94	0.57	1.01	0.3	-
Metals														
Arsenic	mg/kg	<0.4	1	20	16	12	19	27	17	32	22	20.7	6.9	25.8
Cadmium	mg/kg	<0.1	0.1	1.5	<0.1	<0.1	0.11	0.17	<0.1	0.18	0.13	0.11	0.06	0.15
Chromium	mg/kg	<0.1	1	80	41	30	46	43	38	50	36	40.6	6.6	45.4
Copper	mg/kg	<0.1	1	65	2.3	3.3	2.4	2.3	2.3	1.7	2	2.3	0.5	2.7
Iron	mg/kg	<0.1	100	-	38000	31000	39000	47000	39000	65000	45000	43429	10830	51383
Mercury	mg/kg	<0.01	0.01	0.15	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0	<0.01
Manganese	mg/kg	<0.1	10	-	110	140	110	120	160	170	110	131	25	150
Nickel	mg/kg	<0.1	1	21	4.6	4.8	4.6	4.4	3.7	3	3.8	4.13	0.65	4.61
Lead	mg/kg	<0.1	1	50	6.3	5.5	6.5	7.3	6.4	11	6.7	6.94	1.80	8.42
Zinc	mg/kg	<0.1	1	200	8.7	10	8.5	7.9	8.1	6.4	7.1	8.10	1.16	8.95
Polyaromatic Hydrocarbons														
Naphthalene	µg/kg	<5	5	-	<5	<5	<5	<5	<5	<5	<5	<5	0	<5
1-Methylnaphthalene	µg/kg	<5	5	-	<5	<5	<5	<5	<5	<5	<5	<5	0	<5
2-Methylnaphthalene	µg/kg	<5	5	-	<5	<5	<5	<5	<5	<5	<5	<5	0	<5
Acenaphthylene	µg/kg	<5	5	-	<5	<5	<5	<5	<5	<5	<5	<5	0	<5
Acenaphthene	µg/kg	<5	5	-	<5	<5	<5	<5	<5	<5	<5	<5	0	<5
Fluorene	µg/kg	<5	5	-	<5	<5	<5	<5	<5	<5	<5	<5	0	<5
Phenanthrene	µg/kg	<5	5	-	<5	<5	<5	<5	<5	<5	<5	<5	0	<5
Anthracene	µg/kg	<5	5	-	<5	<5	<5	<5	<5	<5	<5	<5	0	<5
Fluoranthene	µg/kg	<5	5	-	<5	<5	<5	<5	<5	<5	<5	<5	0	<5
Pyrene	µg/kg	<5	5	-	<5	<5	<5	<5	<5	<5	<5	<5	0	<5
Benz(a)anthracene	µg/kg	<5	5	-	<5	<5	<5	<5	<5	<5	<5	<5	0	<5
Chrysene	µg/kg	<5	5	-	<5	<5	<5	<5	<5	<5	<5	<5	0	<5
Benzo(b)&(k)fluoranthene	µg/kg	<10	5	-	<10	<10	<10	<10	<10	<10	<10	<10	0	<10
Benzo(a)pyrene	µg/kg	<5	5	-	<5	<5	<5	<5	<5	<5	<5	<5	0	<5
Indeno(1,2,3-cd)pyrene	µg/kg	<5	5	-	<5	<5	<5	<5	<5	<5	<5	<5	0	<5
Dibenz(a,h)anthracene	µg/kg	<5	5	-	<5	<5	<5	<5	<5	<5	<5	<5	0	<5
Benzo(g,h,i)perylene	µg/kg	<5	5	-	<5	<5	<5	<5	<5	<5	<5	<5	0	<5
Coronene	µg/kg	<10	5	-	<10	<10	<10	<10	<10	<10	<10	<10	0	<10
Benzo(e)pyrene	µg/kg	<5	5	-	<5	<5	<5	<5	<5	<5	<5	<5	0	<5
Total PAHs (as above)	µg/kg	<100	100	10,000	<100	<100	<100	<100	<100	<100	<100	<100	0	<100
Organotins														
Monobutyl tin	µgSn/kg	<0.5	1	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0	<0.5
Dibutyl tin	µgSn/kg	<0.5	1	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0	<0.5
Tributyl tin	µgSn/kg	<0.5	1	9	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0	<0.5

Legend for Table 6-29		
		Value exceeds NAGD Screening Level
	mg/kg	milligrams per kilogram
	µg/kg	microgram per kilogram
	µgSn/kg	microgram of tin per kilogram

Acid Sulphate Soils

The potential for the dredge material to be characterised as an acid sulphate soil was assessed using the SPOCAS suite of analyses. A summary of the results of acid sulphate soil analysis is provided below, and the laboratory results are provided in **Table 6-31**.

- Sediments pH ranged from 7.5 to 7.9, indicating no sulphur oxidation has yet taken place.
- TAA, which measures the soils actual acidity prior to any oxidation taking place, was below the detection level for all samples, indicating no acid generation has yet taken place in the sediments.
- Potential sulphidic acidity (S_{POS}) indicated the oxidisable sulphur content was higher than the corresponding QASSIT action criteria across all locations tested. This indicates the material has the potential to generate sulphidic acidity.
- Retained acidity, net acid soluble sulphur (S_{NAS}), was below detection limits in all but two sites (HY2 and HY3). Low retained acidity is also indicated since all samples had a pH higher than 4.5 indicating that no sulphur oxidation has yet taken place.
- Net acidity, which is used to predict the acid risk of a soil, was lower than detection limit across all sites.
- All sites have the ability to neutralise acidity with acid neutralising capacities above detection.
- Low net acidity and the ability to neutralise some acid means the addition of lime to manage acid generation from the dredged material would not be required if the material was to be placed on land.

6.5.6.8 Suitability of Dredged Material for Sea Dumping – Hornibrook, Humbug and Hey River Sediments

Chemical analyses of sediments to be dredged from the Hornibrook Terminal area demonstrate that potential contaminants, if present, are all below respective NAGD screening level criteria for individual samples, the mean and 95%UCL of the mean. Based on this assessment it is considered that dredge material from the Hornibrook Terminal area is suitable for unconfined ocean disposal at the Albatross Bay spoil ground.

At the Humbug Terminal area, no contaminants in sediments exceeded NAGD screening levels for any samples; however one sample contained mercury at the screening level. Despite this, the mean and 95%UCL of the mean for all contaminants was below respective NAGD screening levels. Based on this assessment it is considered that dredge material from the Humbug Terminal area is suitable for unconfined ocean disposal at the Albatross Bay spoil ground.

Analyses of sediment samples collected from the Hey River Terminal area demonstrate that concentrations for all but one contaminant were below respective NAGD screening levels. Arsenic is the exception, with three of the seven sites exceeding the NAGD screening level of 20mg/kg. The mean and the 95%UCL of the mean were also above the NAGD screening levels. Further testing of sediments identified the arsenic had low bioavailability, with DAE concentrations well below the NAGD screening level and elutriate concentrations requiring only minimal dilution to achieve ANZECC/ARMCANZ (2000) low reliability water quality guidelines. Accordingly, the sediments to be dredged from the Hey River Terminal area are considered suitable for unconfined ocean disposal at the Albatross Bay spoil ground.

For each of the three dredge areas, sediments have the ability to generate acidity; however it was evident this had not yet taken place. All sediments also had sufficient acid neutralising capacity to neutralise any acid generated. Consequently, the addition of lime to manage acid generation would not be required for any sediments if they were to be placed on land.

Table 6-30 Results of SPOCAS Acid Sulphate Soils Tests – Hey River Terminal

Sample ID	Units	PQL	HY1a	HY2a	HY3a	HY4a	HY5a	HY7a
Depth	m		0–0.7	0–0.1	0–0.5	0–0.8	0–0.2	0–0.5
QASSIT (1998) Action Criteria								
Sulphur Trail	% S		0.03	0.03	0.03	0.03	0.03	0.03
Acid Trail	moles H+/t		18	18	18	18	18	18
pH Measurements								
pH kcl	pH units		8.9	8.9	9	9	8.9	9.1
pH Ox	pH units		7.5	7.7	7.7	7.9	7.7	7.7
Titratable Acidity								
TAA pH 6.5	moles H+/t	<5	<5	<5	<5	<5	<5	<5
TPA pH 6.5	moles H+/t	<5	<5	<5	<5	<5	<5	<5
Percentage Sulphur								
SKCl	%w/w S	<0.005	0.14	0.2	0.14	0.16	0.15	0.1
SP	%w/w	<0.005	0.65	0.43	0.61	0.47	0.34	0.24
SRAS	%w/w	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
SHCl	%w/w S	<0.005	0.12	0.22	0.16	0.16	0.21	0.095
Percentage Calcium								
CaKCl	%w/w	<0.005	0.24	0.31	0.26	0.26	0.28	0.19
CaP	%w/w	<0.005	3.5	6.4	4.5	2.7	5.2	1.6
Percentage Magnesium								
MgKCl	%w/w	<0.005	0.11	0.19	0.13	0.12	0.16	0.083
MgP	%w/w	<0.005	0.26	0.33	0.28	0.23	0.26	0.16
Titratable Sulphidic Acidity								
s-TAA pH 6.5	%w/w S	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
s-TPA pH 6.5	%w/w S	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
TSA pH 6.5	moles H+/t	<5	<5	<5	<5	<5	<5	<5
s-TSA pH 6.5	%w/w S	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Acid Neutralising Capacity								
ANCE	% CaCO3	<0.05	19	25	25	14	25	4.6
a-ANCE	moles H+/t	<5	3850	5000	5000	2800	5000	925
s-ANCE	%w/w S	<0.05	6.2	8	8	4.5	8	1.5
Peroxide Oxidisable Sulphur								
SPOS	%w/w	<0.005	**0.51**	**0.22**	**0.46**	**0.31**	**0.19**	**0.14**
a-SPOS	moles H+/t	<5	320	140	289	191	117	87
Net Acid Soluble Sulphur								
SNAS	%w/w S	<0.005	<0.005	0.02	0.014	<0.005	0.065	<0.005
a-SNAS	moles H+/t	<5	<5	9.5	6.3	<5	31	<5
s-SNAS	%w/w S	<0.01	<0.01	0.015	0.01	<0.01	0.049	<0.01
Percentage Reacted Calcium								
CaA	%w/w	<0.005	3.3	6.1	4.3	2.4	4.9	1.4
Percent Reacted Magnesium								
MgA	%w/w	<0.005	0.15	0.14	0.15	0.11	0.098	0.073
Net Acidity								
a-Net Acidity	moles H+/t	<10	<10	<10	<10	<10	<10	<10
Liming Rate								

Sample ID	Units	PQL	HY1a	HY2a	HY3a	HY4a	HY5a	HY7a
Liming rate	kg CaCO3/t	<0.75	<0.75	<0.75	<0.75	<0.75	<0.75	<0.75

Note: Bold values indicate exceedance of QASSIT action criteria.

6.5.7 Albatross Bay Spoil Ground Sediment Characterisation

The material is proposed to be disposed of in the existing Port of Weipa spoil ground in Albatross Bay. The disposal ground is located approximately 5km northwest of the seaward end of the South Channel.

The spoil ground is defined by a 2,000m radius, centred on the following coordinates:

S12° 39′ 34.7″ E141° 39′ 24.1″ (WGS84)

The location of the Albatross Bay spoil ground in relation to the Project area and the proposed new spoil ground is shown in **Figure 2-9**. The relevant AusMap is Au301.

The approved Albatross Bay spoil ground was commissioned in 1998 and since that time has received capital and maintenance dredging material from operations within the Port of Weipa. **Table 6-31** shows the volumes disposed in the spoil ground between 2002 and 2008. The spoil ground received over 3,000,000m^3 of capital dredging material from the entrance channel in 2006–2007. Before any material is placed at the Albatross Bay spoil ground, the spoil must be proven to be suitable for placement at sea using the NAGD assessment framework.

Table 6-31 History of Disposal at the Albatross Bay Spoil Ground (2002-2008)

Year of Dredging	Type of Dredging	Volume of In-situ Materials (m^3)
2002	Maintenance	976,585
2003	Maintenance	463,513
2004	Maintenance	621,650
2005	Maintenance	803,098
2006	Capital and Maintenance	2,976,868
2007	Maintenance	796,848
2008	Maintenance	779,599

Source: SKM (2009b)

The existing Albatross Bay spoil ground is south of the boundary of the proposed Fish Habitat Area (refer **Section 1.9.16**).

6.5.7.1 Chemical Characteristics

Chemical characteristics of the Albatross Bay spoil ground sediments is not available from published sources; however it is an active spoil ground and would receive only sediments that have been identified as suitable and approved for sea dumping.

The most recent chemical characterisation of materials to be placed at the Albatross Bay spoil ground was undertaken by SKM (2009b) on behalf of NQBP. This survey physically and chemically characterised material from 68 locations from seven dredge areas from within the Port of Weipa. Three reference locations were also analysed. The dredge areas, estimated annual dredge volumes and number of sampling locations area provided in **Table 6-32**.

Table 6-32 Port of Weipa 2008 Maintenance Dredging Sediment Characterisation

Dredge Area	Estimated Annual Dredge Volume (m^3)	Number of Sampling Locations
South Channel	1,000,000	21
Evans Landing Wharf	8,000	6
Humbug Wharf	8,000	6
Lorim Point Wharf	31,000	10
Approach Channel	23,000	9
Departure Channel	31,000	10
Tug berth	10,000	6
Reference Site	Not applicable	3

Samples were collected and analysed for:

- metals (As, Cd, Cr, Cu, Hg, Ni, Pb, Zn);
- polynuclear aromatic hydrocarbons (PAHs);
    - Individual species;
    - Sum of low molecular weight;
    - Sum of high molecular weight; and
    - Total PAHs.
- organotins (MBT, DBT and TBT); and
- total organic carbon for the purposes of normalising organic contaminants.

Sample results were compared to the screening levels identified in the NODGDM (Commonwealth of Australia 2002), which is the guideline document superseded by the NAGD in 2009. Under the NAGD, screening levels for TBT and total PAHs increased.

The South Channel, Approach Channel, Departure Channel and Tug Berth sample results were below all NODGDM screening levels. Samples that were above the NODGDM criteria in the remaining dredge areas were as follows.

- Lorim Point: two samples of TBT, with one of these well above the maximum level. This was likely due to the presence of a flake of antifouling paint in the sample. Only one of these samples would have exceeded the NAGD screening levels.
- Evans Landing: Two samples had PAH concentrations that exceeded screening and maximum concentrations across a range of species.
- Humbug Wharf: Nickel exceeded the screening level in one sample.

The 95%UCL of the mean calculated for Lorim Point, Evans Landing and Humbug Wharf identified the following exceedances of the NODGDM screening levels.

- Lorim Point: TBT was above the maximum level. This is due to the influence of the single result that likely had a flake of antifouling paint in the sample.
- Evans Landing: PAH species, sum of low molecular weight PAHs , sum of high molecular weight PAHs and total PAHs were all above the NODGDM screening levels. However these levels would be complaint with the current NAGD criteria.
- Humbug Wharf: Nickel was below the NODGDM.

In accordance with the NODGDM and NAGD sediment assessment framework, further testing was conducted in these areas.

Elutriate and direct toxicity testing was undertaken on Lorim Point sediments to assess the potential impacts of TBT on water quality during placement a sea and toxicity to benthic organisms following placement. Elutriate analysis results were below the ANZECC/ARMCANZ (2000) guideline value for TBT of 0.06ng Sn/L. Ecotoxicity assessment on whole sediments and porewaters from Lorim Point and Evans Landing identified that samples from both areas showed no observable toxicity.

On the basis of the results obtained, the maintenance dredging material to be sourced from the South Channel, Evans Landing, Humbug Wharf, Lorim Point, the Tug Berth and the Approach and Departure Channels were recommended as being suitable for unconfined placement at the Albatross Bay spoil ground.

Further chemical characterisation of sediments from the Albatross Bay spoil ground was not completed as part of this study on the basis that:

- The volumes to be placed by the Project are small in comparison to the annual loads being deposited by routine maintenance dredging at the Port of Weipa; and
- The physical and chemical characteristics of the spoil may change due to further routine maintenance dredging at the Port of Weipa prior to dredging at the ferry/barge terminal locations in the Hey and Embley Rivers.

6.5.7.2 Physical Characteristics

As part of infauna sediment assessments for the present study (refer **Section 6.6.8**), nine sediment samples (DG1-DG9) were collected within the Albatross Bay spoil ground using a van Veen sediment grab and analysed for particle size distribution (PSD). A graphical summary of the PSD results is presented in **Figure 6-49** while summary statistics are provided in **Table 6.33**.

Surface sediments are dominated by silt and clay (62%) and sand fractions (37%). Gravel comprises only about 1% of the sediments.

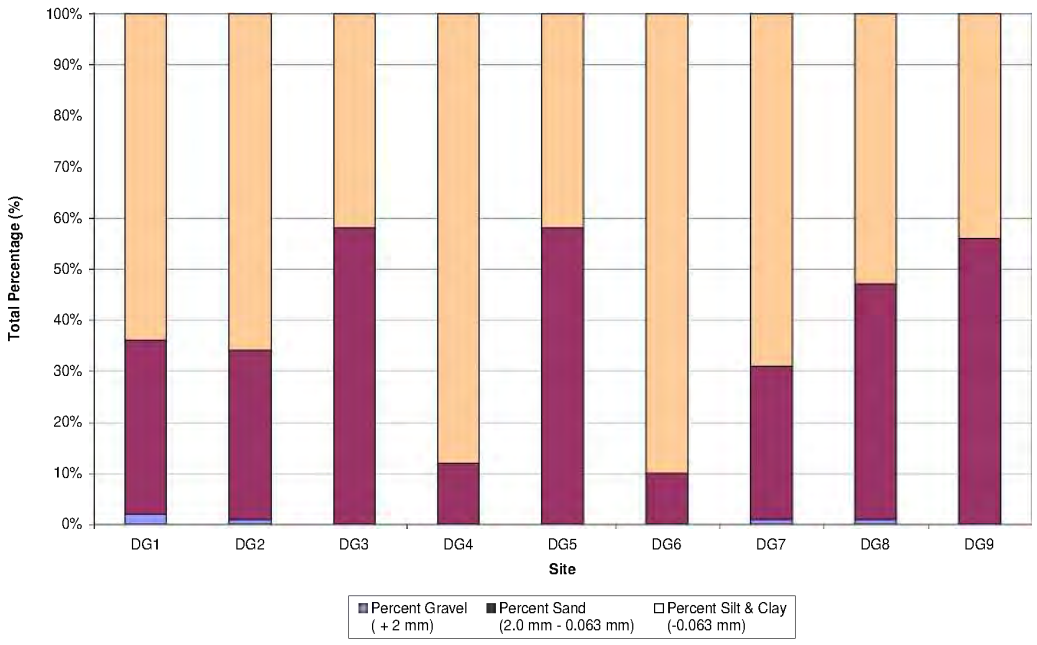


Figure 6-49 Particle Size Distribution Results for the Albatross Bay Spoil Ground

Table 6-33 Summary of Sediment Particle Size at the Albatross Bay Spoil Ground

Statistic	Gravel (>2mm)	Sand (0.063mm–2mm)	Silt & Clay (<0.063mm)
Number of samples	9	9	9
Mean (%)	1	37	62
Standard deviation	0.7	18	18
Minimum (%)	0	10	42
Maximum (%)	2	58	90

6.6 Marine Fauna

6.6.1 Listed Threatened and Migratory Species

This section identifies the threatened species and migratory marine species that are Matters of National Environmental Significance (MNES) under the *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth) (EPBC Act) that occur or potentially occur in the Project area. A search using the EPBC Act "Protected matters search tool" was conducted over three areas to define the Project area bound by coordinates listed in **Table 6-34** with a 5km buffer.

Table 6-34 EPBC Act "Protected Matters Search Tool" Coordinates

	Latitude			Longitude		
Location point	degrees	minutes	seconds	degrees	minutes	seconds
A1	–12	41	4.5	141	34	34
A2	–12	41	4.5	141	54	55
A3	–13	21	43	141	54	55
A4	–13	21	43	141	34	34
B1	–12	34	6.5	141	39	40
B2	–12	39	37.3	141	44	57.7
B3	–12	44	49	141	39	18.7
B4	–12	39	40.3	141	33	58.1
C1	–12	49	21	141	29	8
C2	–12	54	48.9	141	34	23.6
C3	–13	00	13.68	141	28	36.4
C4	–12	54	48.9	141	23	20.9

EPBC Act = *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth)

The status of threatened and migratory species is shown in **Table 6-35** along with the likelihood of occurrence in the Project area. Marine species protected under the *Nature Conservation Act 1992* (Queensland) (NC Act) are included. The conservation status of relevant marine species under The *IUCN Red List of Threatened Species* (IUCN 2008) is also presented.

Marine species of conservation significance are described in **Section 6.6.2 to Section 6.6.6** below and potential impacts are described in **Section 6.9.4**.

Table 6-35 Threatened and Migratory Marine Species Status

Species name	IUCN Red List	EPBC Act	NC Act	Preferred habitat in the Weipa/ Cape York region	Likelihood of Occurrence within the Project Area and Areas of Proposed Disturbance within the Project Area
Estuarine Crocodile (*Crocodylus porosus*)	Lower risk	Migratory species	Vulnerable	Estuarine and inshore waters	**Project Area** ***Known to Occur*** Tracks of this species were recorded during field work within the study area and verified by Traditional Owners. Nesting was observed near Norman Creek. **Proposed Port Site** ***Known to Occur:*** This species has been recorded in marine environments within the Project area. **Proposed Spoil Ground** ***Possible:*** This species has been recorded within marine environments within the Project area, although not as far out to sea as the proposed spoil ground. However this species is known to occasionally traverse some distance into the marine environment, so it is possible that this species may occur in this area on occasion. **Albatross Bay Spoil Ground** ***Possible:*** This species has been recorded within marine environments within the Project area, although not as far out to sea as the Albatross Bay spoil ground. However this species is known to occasionally traverse some distance into the marine environment, so it is possible that this species may occur in this area on occasion. **Ferry/Barge Terminals – Hey and Embley Rivers** ***Known to Occur:*** This species has been recorded in estuarine environments within the Project area. The ferry/barge terminal sites are within estuarine and sometimes mangrove environments. Estuarine and mangrove habitats of which the ferry/ barge terminal areas are the main habitat for this species. The species is likely to use the habitat within the ferry/barge terminal areas for foraging and shelter. **Dam C on a Freshwater Tributary of Norman Creek and Upstream of Dam C** ***Known to Occur:*** This species has been recorded in freshwater environments within the Project area. Foraging and nesting habitats for this species have been recorded within the footprint of Dam C.

Species name	IUCN Red List	EPBC Act	NC Act	Preferred habitat in the Weipa/ Cape York region	Likelihood of Occurrence within the Project Area and Areas of Proposed Disturbance within the Project Area
Indo-Pacific Humpback Dolphin (*Sousa chinensis*)	Data deficient	Migratory species	Near threatened	Inshore coastal waters to a depth of approximately 20 metres.	**Project Area** ***Known to Occur:*** Incidental sightings of this species were recorded during field studies. **Proposed Port Site** ***Known to Occur:*** Incidental sightings of this species were recorded within the proposed port footprint during field studies. **Proposed Spoil Ground** ***Possible:*** This species usually inhabits shallow coastal waters less than 20m deep and are often associated with tidal riverine and estuarine systems, enclosed bays and coastal lagoons (Corkeron *et al.* 1997; Hale *et al.* 1998; Jefferson 2000; Parra 2006). While the proposed spoil ground does not represent preferred habitat, it is possible they are transient in the area. **Albatross Bay Spoil Ground** ***Possible:*** For the same reasons as the proposed spoil ground, while preferred habitat isn't present, it is possible they are transient in the area. **Ferry/Barge Terminals – Hey and Embley Rivers** ***Likely:*** As this species is often associated with tidal riverine and estuarine systems, it is likely that this species may occur in the vicinity of the ferry/barge terminals.
Bottlenose Dolphins (*Tursiops aduncus* and *Tursiops truncatus*)	Data deficient	—	—	Inshore and nearshore coastal waters to a depth of approximately 50 metres.	**Project Area** ***Known to Occur:*** Incidental sightings of this species were recorded during field studies. **Proposed Port Site** ***Known to Occur:*** Incidental sightings of this species were recorded within the proposed port footprint during field studies. **Proposed Spoil Ground** ***Likely:*** Although this species distribution does not normally include the vicinity of the Project area, the offshore species of this dolphin is likely to occur within the proposed spoil ground as the site as the depth of waters at the proposed spoil ground is within the preferred rang of this species. **Albatross Bay Spoil Ground** ***Likely:*** For the same reasons as the proposed spoil ground, it is likely that the offshore species of this dolphin is would occur at the Albatross Bay spoil ground. **Ferry/Barge Terminals – Hey and Embley Rivers** ***Likely:*** Inshore species likely to occur in estuarine areas as part of inshore habitat.

Species name	IUCN Red List	EPBC Act	NC Act	Preferred habitat in the Weipa/ Cape York region	Likelihood of Occurrence within the Project Area and Areas of Proposed Disturbance within the Project Area
Australian Snubfin Dolphin (*Orcaella heinsohni*) (Note: Previously the Australian Snubfin Dolphin was identified as the widely distributed Irrawaddy Dolphin (*Orcaella brevirostris*) (Beasley et al. 2005))	Data deficient	Migratory species	Near threatened	Inshore coastal waters to a depth of approximately 20 metres.	**Project Area** ***Known to Occur:*** Incidental sightings of this species were recorded during field studies. **Proposed Port Site** ***Known to Occur:*** Incidental sightings of this species were recorded in the vicinity of the proposed port footprint during field studies. **Proposed Spoil Ground** ***Possible:*** This species usually inhabits shallow coastal waters less than 20m deep and are often associated with tidal riverine and estuarine systems, enclosed bays and coastal lagoons (Corkeron *et al.* 1997; Hale *et al.* 1998; Jefferson 2000; Parra 2006). The proposed spoil ground is in deeper water than this and therefore it is unlikely to represent preferred habitat for this species. However, it is possible they may be transient in the area. **Albatross Bay Spoil Ground** ***Possible:*** For the same reasons as the proposed spoil ground while preferred habitat isn't present, it is possible they are transient in the area. **Ferry/Barge Terminals – Hey and Embley Rivers** ***Likely:*** As this species is often associated with tidal riverine and estuarine systems, it is likely that this species may occur in the vicinity of the ferry/barge terminals.
Bryde's Whale (*Balaenoptera edeni*)	—	Migratory species	—	Pelagic environment including principally continental shelf waters but also extending into coastal and inshore waters	**Project Area** ***Possible:*** While the Project area does not contain preferred habitat, the recording of the species from tropical inshore waters suggests it is possible the species may occur sporadically in the Project area. **Proposed Port Site** ***Possible:*** While the proposed port site does not contain preferred habitat, the recording of the species from tropical inshore waters suggests it is possible the species may occur sporadically in the vicinity of the proposed port footprint. **Proposed Spoil Ground** ***Possible:*** This species may possibly occur within the proposed spoil ground footprint for the same reasons that it possibly occurs in the vicinity of the proposed port site. **Albatross Bay Spoil Ground** ***Possible:*** This species may occur within the Albatross Bay spoil ground footprint for the same reasons that it possibly occurs in the vicinity of the proposed port site. **Ferry/Barge Terminals – Hey and Embley Rivers** ***Unlikely:*** Although this species occurs in shallow water, it generally is found in coastal areas rather than estuaries. It is therefore unlikely to occur within the Embley and Hey River estuaries, including in the vicinity of the barge/ferry terminal footprints.

Species name	IUCN Red List	EPBC Act	NC Act	Preferred habitat in the Weipa/ Cape York region	Likelihood of Occurrence within the Project Area and Areas of Proposed Disturbance within the Project Area
Humpback Whale (*Megaptera novaeangliae*)	—	Vulnerable Migratory species	Vulnerable	Pelagic environment, including but not limited to coastal waters. No feeding areas are located in the Gulf of Carpentaria and the Gulf of Carpentaria is not along the migratory path.	***Unlikely:*** No feeding areas are located in the Project area and it is not along the migratory path of the species.
Killer Whale (*Orcinus orca*)	—	Migratory species	—	Pelagic environment primarily limited to the continental shelf.	***Unlikely:*** The species prefers offshore waters and as such is unlikely to occur in the Project area.
Blue Whale (*Balaenoptera musculus*)	—	Endangered Migratory species	—	Pelagic environment near the edge of the continental shelf. They are unlikely to occur in the Gulf of Carpentaria, preferring the cooler waters of southern Australia.	***Unlikely:*** The species principally occurs near the edge of the continental shelf in cooler waters and not in inshore areas of the Project area.
Dugong (*Dugong dugon*)	Vulnerable	Migratory species	Vulnerable	The species prefers shallow seagrass beds dominated by pioneering species of species such as *Halophila* spp.	**Project Area** ***Known to Occur:*** Dugong is known to occur in the area associated with seagrass beds. Traditional Owners report that the species migrates through Boyd Bay. The species is highly migratory and will traverse coastal waters between seagrass beds. **Proposed Port Site** ***Known to Occur:*** Traditional Owners report that the species migrates through Boyd Bay which also indicates migration past the proposed port site. **Proposed Spoil Ground** ***Possible:*** This species may migrate through this area between feeding grounds, however it is more likely that the species would migrate through shallower waters than where the footprint of the proposed spoil ground occurs. **Albatross Bay Spoil Ground** ***Possible:*** This species may possibly occur within the Albatross Bay spoil ground footprint for the same reasons that it possibly occurs in the vicinity of the proposed spoil ground footprint. **Ferry/Barge Terminals – Hey and Embley Rivers** ***Known to Occur:*** The Dugong is known to occur in the area associated with seagrass beds. The seagrass beds in the Embley and Hey Rivers potentially constitute feeding habitat for Dugong; however, no Dugong were incidentally observed associating with these seagrass beds during marine field surveys for this Project.

Species name	IUCN Red List	EPBC Act	NC Act	Preferred habitat in the Weipa/ Cape York region	Likelihood of Occurrence within the Project Area and Areas of Proposed Disturbance within the Project Area
Green Sawfish (*Pristis zijsron*)	Critically endangered	Vulnerable	—	Occurs in estuaries, river mouths, embayments and along sandy and muddy beaches.	**Project Area** ***Likely:*** The species has been recorded from Albatross Bay and the Project area contains suitable habitat for the species. **Proposed Port Site** ***Likely:*** The species has been recorded from Albatross Bay and the proposed port footprint contains suitable habitat for the species. **Proposed Spoil Ground** ***Unlikely:*** This species prefers shallower waters. The proposed spoil ground is in waters that are deeper than what this species would usually prefer. **Albatross Bay Spoil Ground** ***Unlikely:*** For the same reasons as the proposed spoil ground, it is unlikely that this species would occur at the Albatross Bay spoil ground. **Dam C on a Freshwater Tributary of Norman Creek and Upstream of Dam C** ***Unlikely:*** This species is not found within freshwater environments. Dam C would be located on a freshwater reach of Norman Creek. Therefore this species is unlikely to occur within the footprint of the proposed Dam C or upstream of this dam. **Ferry/Barge Terminals – Hey and Embley Rivers** ***Likely:*** Records from Albatross Bay adjoining the mouth of the Embley River make occurrence of this species within the estuarine sections of the Hey and Embley Rivers likely. The extent of Project related disturbance of these areas would be minimal in relation to the total estuarine environment available within these rivers. Disturbance would consist of the clearance of 400m^2 of mangroves (0.008% of the associated vegetation community within the Project area) and 2.1ha of riverbed. The dredging in these areas would only be to a depth of -2m LAT.

Species name	IUCN Red List	EPBC Act	NC Act	Preferred habitat in the Weipa/ Cape York region	Likelihood of Occurrence within the Project Area and Areas of Proposed Disturbance within the Project Area
Narrow Sawfish (*Anoxypristis cuspidata*)	Critically endangered	—	—	Occurs in estuaries, river mouths, embayments and along sandy and muddy beaches.	**Project Area** ***Likely:*** The species has been recorded from Albatross Bay and the Project area contains suitable habitat for the species. **Proposed Port Site** ***Likely:*** The species has been recorded from Albatross Bay and the proposed port footprint contains suitable habitat for the species. **Proposed Spoil Ground** ***Unlikely:*** This species prefers shallower waters. The proposed spoil ground is in waters that are deeper than what this species would usually prefer. **Albatross Bay Spoil Ground** ***Unlikely:*** For the same reasons as the proposed spoil ground, it is unlikely that this species would occur at the Albatross Bay spoil ground. **Dam C on a Freshwater Tributary of Norman Creek and Upstream of Dam C** ***Unlikely:*** This species does not occur in freshwater; therefore it is unlikely to traverse as far as the footprint of Dam C, which is on a freshwater tributary of Norman Creek. **Ferry/Barge Terminals – Hey and Embley Rivers** ***Possible:*** This species is known to inhabit the floor of estuaries. The ferry/barge terminal footprints are within estuarine environments, therefore it is possible that this species may occur in these areas.

Species name	IUCN Red List	EPBC Act	NC Act	Preferred habitat in the Weipa/ Cape York region	Likelihood of Occurrence within the Project Area and Areas of Proposed Disturbance within the Project Area
Dwarf Sawfish (*Pristis clavata*)	Critically endangered	Vulnerable	—	Occurs in estuaries, river mouths, embayments and along sandy and muddy beaches.	**Project Area** ***Likely:*** The species is likely to occur within Albatross Bay and the Project area contains suitable habitat for the species. **Proposed Port Site** ***Likely:*** The species has been recorded from Albatross Bay and the proposed port footprint contains suitable habitat for the species. **Proposed Spoil Ground** ***Unlikely:*** This species prefers shallower waters. The proposed spoil ground is in waters that are deeper than what this species would usually prefer. **Albatross Bay Spoil Ground** ***Unlikely:*** For the same reasons as the proposed spoil ground, it is unlikely that this species would occur at the Albatross Bay spoil ground. **Dam C on a Freshwater Tributary of Norman Creek and Upstream of Dam C** ***Unlikely:*** This species is not found and does not breed within freshwater environments. Dam C would be located in a freshwater reach of Norman Creek. Therefore this species is unlikely to occur within the proposed footprint of Dam C or upstream of the dam. **Ferry/Barge Terminals – Hey and Embley Rivers** ***Likely:*** Suitable habitat for this species is present in near coastal areas and the estuary of the Embley River. Disturbance in the Embley River associated with the Project would be limited to a small amount of dredging activities related to the construction and maintenance of the Hornibrook Ferry Terminal. This species may also utilise as a resting place either side of high tide, the 400m^2 of mangrove forest that would be cleared for the construction of the Hey River ferry/barge terminal. The area of mangroves that would be cleared only represents 0.008% of this mangrove community within the Project area. Therefore there would be sufficient remaining mangrove habitat in the surrounding area which the species would be able to utilise for resting.
Whale Shark (*Rhincodon typus*)	Vulnerable	Vulnerable	—	Pelagic environment near the edge of the continental shelf. The Gulf of Carpentaria does not represent preferred habitat.	***Unlikely:*** This species is unlikely to occur in the study area. The species prefers oceanic environments. The Project area does not provide the preferred habitat.

Species name	IUCN Red List	EPBC Act	NC Act	Preferred habitat in the Weipa/ Cape York region	Likelihood of Occurrence within the Project Area and Areas of Proposed Disturbance within the Project Area
Green Turtle (*Chelonia mydas*)	Endangered	Vulnerable Migratory species	Vulnerable	Coastal waters, in particular seagrass beds. The Wellesley Island area in the south-western corner of the Gulf of Carpentaria is a significant nesting site.	**Project Area** ***Likely:*** The species is likely to forage in the Project area. Surveys have found no nests in the Project area. No large rookeries are present in the region. **Proposed Port Site** ***Likely:*** This species is known to forage in shallow coastal areas, which would include the proposed port site footprint. Surveys have found no nests within the footprint of the proposed port site. **Proposed Spoil Ground** ***Possible*** This species prefers to forage in shallow coastal areas or within seagrass beds. The proposed spoil ground would be too deep to provide preferred foraging habitat for this species and it contains no seagrass beds. While the proposed proposes spoil ground does not represent preferred habitat, it is possible they are transient in the area. **Albatross Bay Spoil Ground** ***Possible:*** For the same reasons as the proposed spoil ground, it is unlikely that this species would frequently occur at the Albatross Bay spoil ground; however, it is possible that they transit the area. **Ferry/Barge Terminals – Hey and Embley Rivers** ***Likely:*** As this species is known to forage within shallow coastal areas and seagrass beds. Foraging habitat for this species is present in the estuaries.
Hawksbill Turtle (*Eretmochelys imbricata*)	Critically endangered	Vulnerable Migratory species	Vulnerable	Hawksbill Turtle nesting sites occur on islands adjacent to Arnhem Land and north-eastern Cape York. The main feeding habitat for the species tends to be tidal and sub-tidal reefs.	**Project Area** ***Known to Occur:*** Although difficulties in identifying nest activity of this species exist, low density nesting is recorded from a number of locations from False Pera Head to Boyd Bay. Reef habitat in the area is also likely to provide significant foraging habitat for the species. **Proposed Port Site** ***Likely:*** Near shore fringing reef communities occur within the vicinity of the proposed port area occur at Boyd Point, Pera Head and between Pera Head and Thud Point. This species may therefore traverse across the proposed port site to access preferred feeding habitat. This species is also known to nest on the beaches in the vicinity of the Project area. Therefore it may be assumed that the footprint of the proposed port site may also contain suitable nesting habitat for this species. **Proposed Spoil Ground** ***Possible:*** As Nine Mile Reef which includes suitable foraging habitat for this species is located approximately 6km south-south-west of the proposed spoil ground, this species may traverse the proposed spoil ground to access Nine Mine Reef for foraging. **Albatross Bay Spoil Ground** ***Possible:*** The Albatross Bay Spoil ground does not contain or is not close to any reef communities. It is therefore unlikely this species would frequently occur in this area; however they may transit the site. **Ferry/Barge Terminals – Hey and Embley Rivers** ***Unlikely:*** The ferry barge terminals would be located within an estuarine environment, which is not a preferred habitat of this species.

Species name	IUCN Red List	EPBC Act	NC Act	Preferred habitat in the Weipa/ Cape York region	Likelihood of Occurrence within the Project Area and Areas of Proposed Disturbance within the Project Area
Flatback Turtle (*Natator depressus*)	—	Vulnerable Migratory species	Vulnerable	Coastal waters including but not limited to shallow water habitats. Nesting is confined to Australia. The species forages in shallow inshore areas.	**Project Area** ***Known to Occur:*** The Flatback Turtle is likely to forage in the Project Area and nesting has been regularly recorded and is best described as medium density nesting. The area is not a major location for breeding aggregations of the species. **Proposed Port Site** ***Known to Occur:*** Nesting has been regularly recorded within and surrounding the proposed port site footprint and is best described as medium density nesting. The area is not a major location for breeding aggregations of the species. This species forages in shallow coastal habitats. The proposed footprint of the port would therefore be considered foraging habitat for this species. **Proposed Spoil Ground** ***Possible:*** As Nine Mile Reef which includes suitable foraging habitat for this species is located approximately 6km south-south-west of the proposed spoil ground, this species may traverse the proposed spoil ground to access Nine Mine Reef for foraging. **Albatross Bay Spoil Ground** ***Possible:*** The Albatross Bay Spoil ground does not contain or is not close to any reef communities and is not shallow in nature. It is therefore unlikely this species would occur in this area beyond transiting the site. **Ferry/Barge Terminals – Hey and Embley Rivers** ***Likely:*** This species forages in shallow coastal habitats. The proposed footprints of the ferry/barge terminals are within an estuarine environment which may be considered foraging habitat for this species.
Olive Ridley Turtle (*Lepidochelys olivacea*) (also known as the Pacific Ridley Turtle under the NC Act)	Vulnerable	Endangered Migratory species	Endangered	Coastal waters including but not limited to reefs. The species forages in benthic habitats over a range of depths from a few metres to hundreds of metres. Low density nesting has been historically recorded from a number of locations including the eastern Gulf of Carpentaria.	**Project Area** ***Known to Occur:*** Although there are uncertainties regarding whether nesting of Olive Ridley Turtles is still occurring in the western Cape York region, low density nesting has previously been recorded from a number of locations from False Pera Head to Boyd Bay. **Proposed Port Site** ***Known to Occur:*** Sporadic nesting has been recorded surrounding the proposed port site footprint. This species forages in shallow unvegetated coastal habitats. The proposed footprint of the port would therefore be considered foraging habitat for this species. **Proposed Spoil Ground** ***Possible:*** The proposed spoil ground is too deep to provide foraging habitat for this species; however it is possible that it sporadically transits this area. **Albatross Bay Spoil Ground** ***Possible:*** For the same reasons as the proposed spoil ground, this species is unlikely to frequently occur within the Albatross Bay spoil ground due o lack of preferred habitat; however it may transit the site. **Ferry/Barge Terminals – Hey and Embley Rivers** ***Likely:*** This species forages in shallow unvegetated coastal habitats. The parts of the proposed footprints of the ferry/barge terminals that are not vegetated may therefore provide foraging habitat for this species.

Species name	IUCN Red List	EPBC Act	NC Act	Preferred habitat in the Weipa/ Cape York region	Likelihood of Occurrence within the Project Area and Areas of Proposed Disturbance within the Project Area
Leatherback Turtle (*Dermochelys coriacea*)	Critically endangered	Endangered Migratory species	Endangered	Pelagic environment. The Albatross Bay area is identified as a potential foraging area for the species.	**Project Area** ***Likely:*** The species is likely to occur in the Project Area, using it for foraging. However, Leatherback turtles are rarely found in Queensland so any presence would be sporadic. No Leatherback Turtle nesting has been recorded in eastern Australia since 1996. **Proposed Port Site** ***Likely:*** The species is likely to occur sporadically in the vicinity of the proposed port site, using it for foraging. **Proposed Spoil Ground** ***Likely:*** The species is likely to occur sporadically in the vicinity of the proposed spoil ground, using it for foraging. **Albatross Bay Spoil Ground** ***Likely:*** The species is likely to occur sporadically in the vicinity of the Albatross Bay spoil ground, using it for foraging. **Ferry/Barge Terminals – Hey and Embley Rivers** ***Unlikely:*** This species prefers oceanic environments to estuarine environments, so it is unlikely to utilise the estuaries that contain the proposed footprints of the ferry/barge terminals as habitat.
Loggerhead Turtle (*Caretta caretta*)	Endangered	Endangered Migratory species	Endangered	Coastal waters including subtidal and intertidal coral and rocky reefs and seagrass meadows as well as soft-bottomed habitats.	**Project Area** ***Likely:*** The species is likely to be transient in the Project area and use it for foraging or resting. No rookeries are present in the Project Area. **Proposed Port Site** ***Likely:*** The species is likely to be transient in the vicinity of the proposed port and use it for foraging or resting. **Proposed Spoil Ground** ***Likely:*** This species is likely to occur within the proposed spoil ground for the same reasons that it is likely to occur in the vicinity of the proposed port. **Albatross Bay Spoil Ground** ***Likely:*** This species is likely to occur within the Albatross Bay spoil ground for the same reasons that it is likely to occur in the vicinity of the proposed port. **Ferry/Barge Terminals – Hey and Embley Rivers** ***Likely:*** This species is likely to occur in the vicinity of the ferry/barge terminals for the same reasons that it is likely to occur within the proposed port footprint.

EPBC Act = *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth)
NC Act = Queensland *Nature Conservation Act 1992* (Queensland)
IUCN = International Union for the Conservation of Nature
— = Species not listed

6.6.2 Whales and Dolphins (Cetaceans)

A number of dolphin species are known to occur in the Gulf of Carpentaria. These include the Indo-Pacific Humpback Dolphin (*Sousa chinensis*), inshore (*Tursiops aduncus*) and offshore (*Tursiops truncatus*) forms of the Bottlenose Dolphin, and the Australian Snubfin Dolphin (*Orcaella heinsohni*). One whale species, Bryde's Whale (*Balaenoptera edeni*) inhabits inshore tropical waters, so it may occur sporadically in the Project area.

There are no specific studies of the distribution and abundance of cetaceans in the Project area. Incidental observations while undertaking the habitat mapping at the proposed port site described in **Section 6.3.2** confirmed the presence of the Indo-Pacific Humpback Dolphin, at least one species of the Bottlenose Dolphin (most probably the inshore form) and the Australian Snubfin Dolphin.

Potential impacts on cetacean populations in the vicinity of the Project area, including potential impacts on these populations associated with the construction of the port, barge and ferry terminals (including dredging and spoil dumping operations) is discussed in **Section 6.9.2.4**.

Dolphins

The Indo-Pacific Humpback Dolphin and Australian Snubfin Dolphin are listed migratory species under the EPBC Act. They usually inhabit shallow coastal waters less than 20m deep and are often associated with tidal riverine and estuarine systems, enclosed bays and coastal lagoons (Corkeron *et al.* 1997; Hale *et al.* 1998; Jefferson 2000; Parra 2006). On the east coast of Australia, the inshore bottlenose dolphin inhabits estuaries and shallow offshore waters (<30m) (Hale *et al.* 1998, 2000).

The SPRAT database suggests that the regional population levels (e.g. Queensland) of the Indo-Pacific Humpback Dolphin are likely to be in the order of thousands rather than tens of thousands (Parra *et al.* 2002). Aerial survey in the western Gulf of Carpentaria (which includes the Project area) estimated a population of about 1000 Australian Snubfin Dolphins (Freeland & Bayliss 1989). However, the estimate has been questioned due to the known difficulty of identifying dolphin species in turbid waters from the air (Parra *et al.* 2002). Based on the low numbers of Australian Snubfin Dolphins sighted during aerial and boat based surveys of the east coast of Queensland (Parra *et al.* 2002; Parra 2006) the population at a regional level (Queensland) is likely to be in the thousands rather than tens of thousands (Parra 2006). It is therefore difficult to quantify exactly an actual population size of this species within the vicinity of the Project area, however based on the above information; the Indo-Pacific Dolphin population within the vicinity of the Project area is likely to be negligible.

Bottlenose dolphins are listed cetacean species under the EPBC Act but are not threatened or a migratory species (It is noted that the Arafura/Timor Sea sub-population of *Tursiops aduncus* is migratory, but their distribution does not include the Project area or Gulf of Carpentaria). The SPRAT database notes that the Bottlenose Dolphin total population size is not known, but it is likely to be common in offshore waters of south-eastern and southern Australia (V. Peddemors & R. Harcourt 2006, pers. comm.). The total population size of inshore Bottlenose Dolphin (*Tursiops aduncus*) is also not known. However, it is likely that this species is common in inshore and nearshore waters of eastern, western and northern Australia (Ross 2006). Local population estimates suggest that 102 individuals occur in Jervis Bay, 140 in Port Stephens (Möller *et al.* 2002), about 350 in Moreton Bay (Corkeron 1990), 900 in coastal waters off North Stradbroke Island (Chilvers & Corkeron 2003), and about 1800–2400 in Shark Bay, Western Australia (Preen *et al.* 1997). Although incidental sightings were recorded of this species during field studies, its distribution does not normally include the vicinity of the Project area, therefore any population within the vicinity of the Project area is likely to be transient and of a small size.

The DSEWPaC (2010) Species Profile and Threats Database (SPRAT Database) identifies the main threats to the Indo-Pacific Humpback Dolphin and Australian Snubfin Dolphin as habitat destruction and degradation, bycatch in gillnets and shark nets, overfishing of prey species, pollution and poisoning, and interaction with vessels. The main threats likely to affect Australian Bottlenose Dolphin populations include bycatch in gillnets, entanglements in debris, and overfishing. Elsewhere in Australia, the three dolphin species co-exist with coastal development including extensive port facilities such as the Port of Brisbane and Cleveland Bay (Townsville) (Hale *et al.* 1998; Parra 2006).

Bryde's Whale

There are two forms of Bryde's Whales: coastal and offshore. The coastal form of Bryde's whale appears to be limited to the 200m depth contour, moving along the coast in response to availability of suitable prey (Best *et al.* 1984). The SPRAT database states that it is likely that Australian inshore stocks of Bryde's Whales will be small, possibly of similar size to those off South Africa (estimated at 582 ±184 animals: Best *et al.* 1984), and therefore it is unlikely that significant numbers would occur in the vicinity of the Project area. There is no evidence of large-scale migrations of the inshore form of Bryde's Whales. The offshore form is found in deeper water (500 to 1000m). Bryde's Whale is considered to be a fairly opportunistic feeder, readily consuming whatever shoaling prey is available (Kato 2002; Martin 1990). The DSEWPaC (2010) SPRAT Database identifies the main threats to Bryde's Whales as ingestion of discarded plastic, pollution, disturbance (possibly from seismic and/or defence operations), collisions with large vessels, and entanglement in fishing gear. In addition, competition with commercial fisheries may also affect these animals. The following listed threatened and migratory species were recorded on the EPBC Act protected matters search as possibly occurring within the Project area; however, they are unlikely to be present due to a lack of suitable habitat: Humpback Whale, Killer Whale and Blue Whale.

Review of the Queensland Marine Wildlife Stranding and Mortality Database annual reports from 2002-2007 (most recent) indicates that no cetacean deaths were recorded in the Western Cape York region associated with boat strikes.

6.6.3 Dugong

In the Gulf of Carpentaria, most dugongs are found in the shallow waters around the Wellesley Islands in Queensland (485km from the project area) and from the Sir Edward Pellew Islands to Blue Mud Bay in the Northern Territory (Saalfeld and Marsh 2004). Aerial surveys of the Queensland coast of the Gulf in 1997 and the Northern Territory coast of the Gulf in 1985 and 1994 indicate that the total number of Dugongs in the Gulf of Carpentaria is in the range 20,000 to 30,000 (Seagrass Watch, 2005). In 1997, Saalfeld and Marsh (2004) estimated that the population of Dugong on the Queensland Gulf of Carpentaria Coast to be 4,266 +/-657, which represents approximately 14-21% of the estimated Gulf of Carpentaria population. Based on an estimated Australian population of 80,000 (Saalfeld and Marsh 2004), the Queensland Gulf of Carpentaria dugong population represents approximately 5% of the Australian population.

In a 1997 survey (Saalfeld and Marsh 2004), the following number of Dugongs were sighted within the vicinity of the Project area.

- two Dugongs within Albatross Bay;
- three Dugongs at sea adjacent to Albatross Bay;
- one Dugong near Aurukun; and
- one Dugong to the north of Jantz Point.

This represents a total of seven Dugongs sighted within the vicinity of the Project area, which represents approximately 0.2% of the Queensland Gulf of Carpentaria Coast population, between 0.023% and 0.035% of the Gulf of Carpentaria population and 0.009% of the Australian population.

Dugongs prefer to feed on seagrasses that are early or "pioneer" species, particularly species of the genera *Halophila* and *Halodule* (DEWHA 2010a). Field studies verify that seagrass beds do not occur at the proposed port site or the proposed new dredge disposal area. While no foraging areas for Dugong occur in the area of the port development, it is likely Dugong traverse it as they travel between seagrass resources. However, Dugongs were not observed at the proposed port location during the marine ecology surveys undertaken for the purposes of this EIS. The seagrass beds in the Embley and Hey Rivers potentially constitute feeding habitat for Dugong; however, no Dugong were observed associating with these seagrass beds during field studies. The long, strap-like seagrass *Enhalus acoroides*, which dominates the seagrass beds of the Embley and Hey Rivers, is not a preferred species in the Dugong diet.

Dugong mortality in the Gulf of Carpentaria may currently be caused by traditional hunting, incidental capture in commercial mesh nets, targeted capture by illegal foreign fishing vessels in Australian waters, and boat strikes from fast moving vessels. Populations would be vulnerable to a reduction in the area and quality of seagrass beds.

Potential impacts on any Dugong population in the vicinity of the Project area, including potential impacts on any dugong population associated with the construction of the port, barge and ferry terminals (including dredging and spoil dumping operations) is discussed in **Section 6.9.2.3**.

6.6.4 Sharks and Rays

The shark and ray fauna of Albatross Bay is diverse and abundant (Blaber *et al.* 1990): 23 shark species are recorded, 18 of these being whaler sharks (Family Carcharhinidae). The numerically dominant shark species in Albatross Bay is the spot-tail shark (*Carcharhinus sorrah*) and the blacktip shark (*Carcharhinus tilstoni*), comprising 83% of the shark and ray assemblage (Salini *et al.* 1992). Three species of sawfish are also recorded:

- Green Sawfish, *Prisitis zijsron*;
- Narrow Sawfish, *Anoxypristis cuspidata*; and
- Dwarf Sawfish, *Pristis clavata.*

While only the Green Sawfish and Dwarf Sawfish are listed threatened species (Vulnerable) under the EPBC Act, all are listed as critically endangered by the IUCN. The populations of sawfishes in the Gulf of Carpentaria are of global significance. The major threat to sawfish populations is incidental capture in fishing nets (refer also to **Section 8.10**).

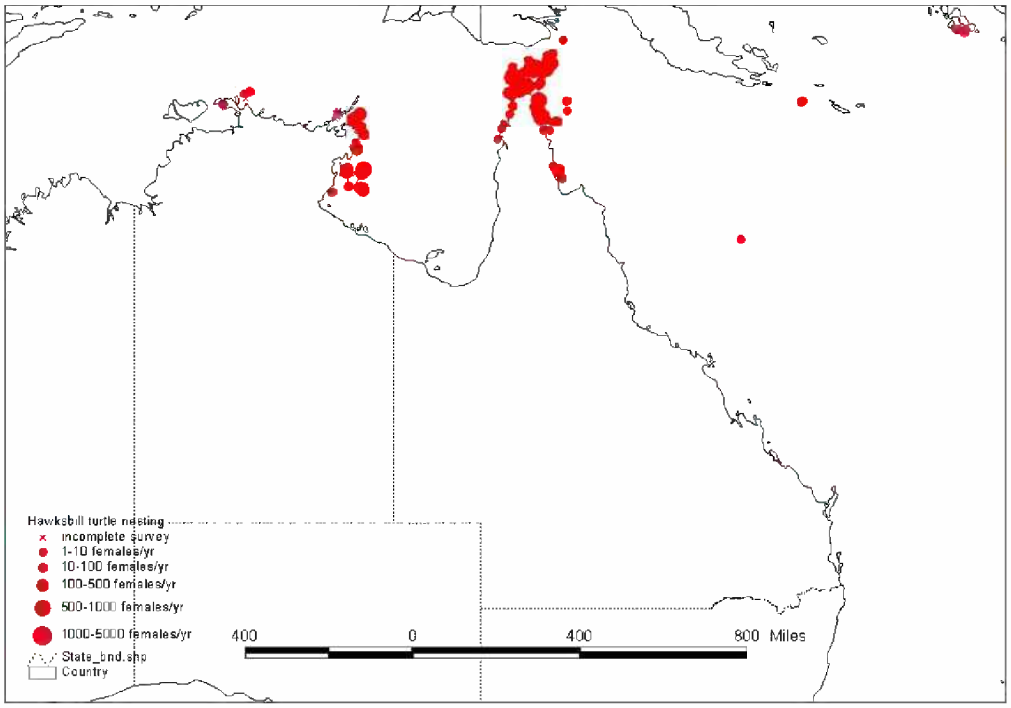
The preferred habitat of sawfishes is shallow inshore sedimentary habitats (less than 10m), although they have been recorded in the Gulf of Carpentaria from waters deeper than 20m. Sawfishes in the Gulf of Carpentaria breed through the wet season until the beginning of the dry period in May (Peverell 2005). A further 16 species of stingrays and shovelnose rays are also recorded from Albatross Bay, all with a wide geographic distribution.

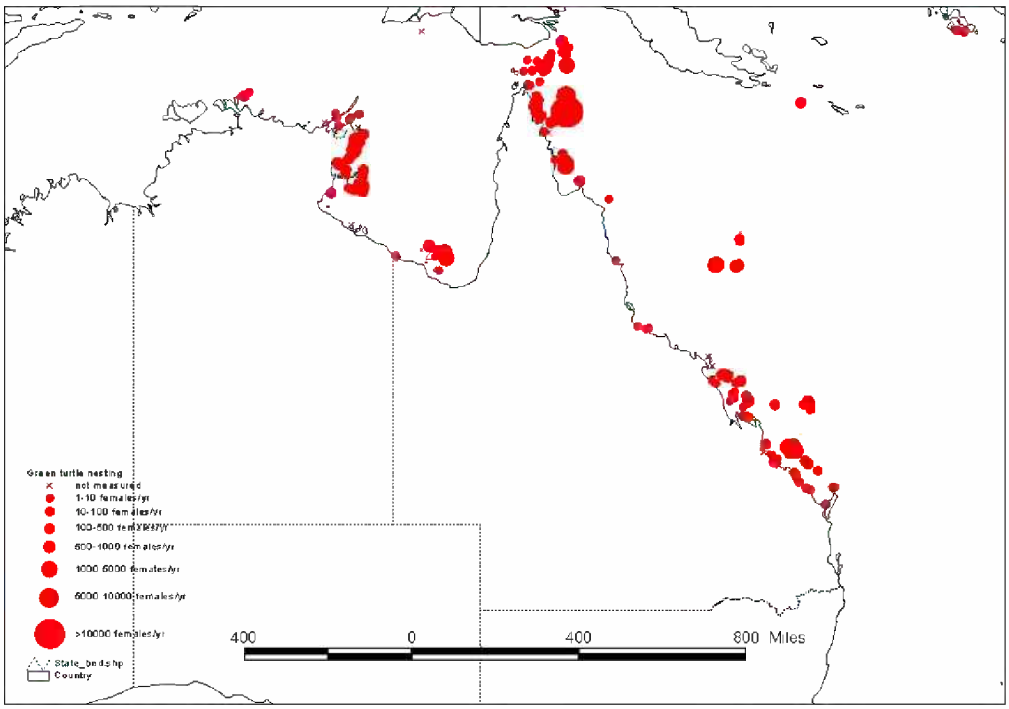
The Whale Shark was recorded on the EPBC Act protected matters search as possibly occurring within the Project area; however, this species is unlikely to be present due to a lack of suitable habitat.

6.6.5 Marine Turtles

Three species of marine turtles – the Flatback Turtle (*Natator depressus*), the Olive Ridley Turtle (*Lepidochelys olivacea*), and the Hawksbill Turtle (*Eretmochelys imbricata*) – are known to nest on the beaches in the vicinity of the Project area and feed in the surrounding waters. The Flatback Turtles nest all year round, peaking in May through to September. Uncertainty exists over the peak timing of nesting of the other species in the Project area.

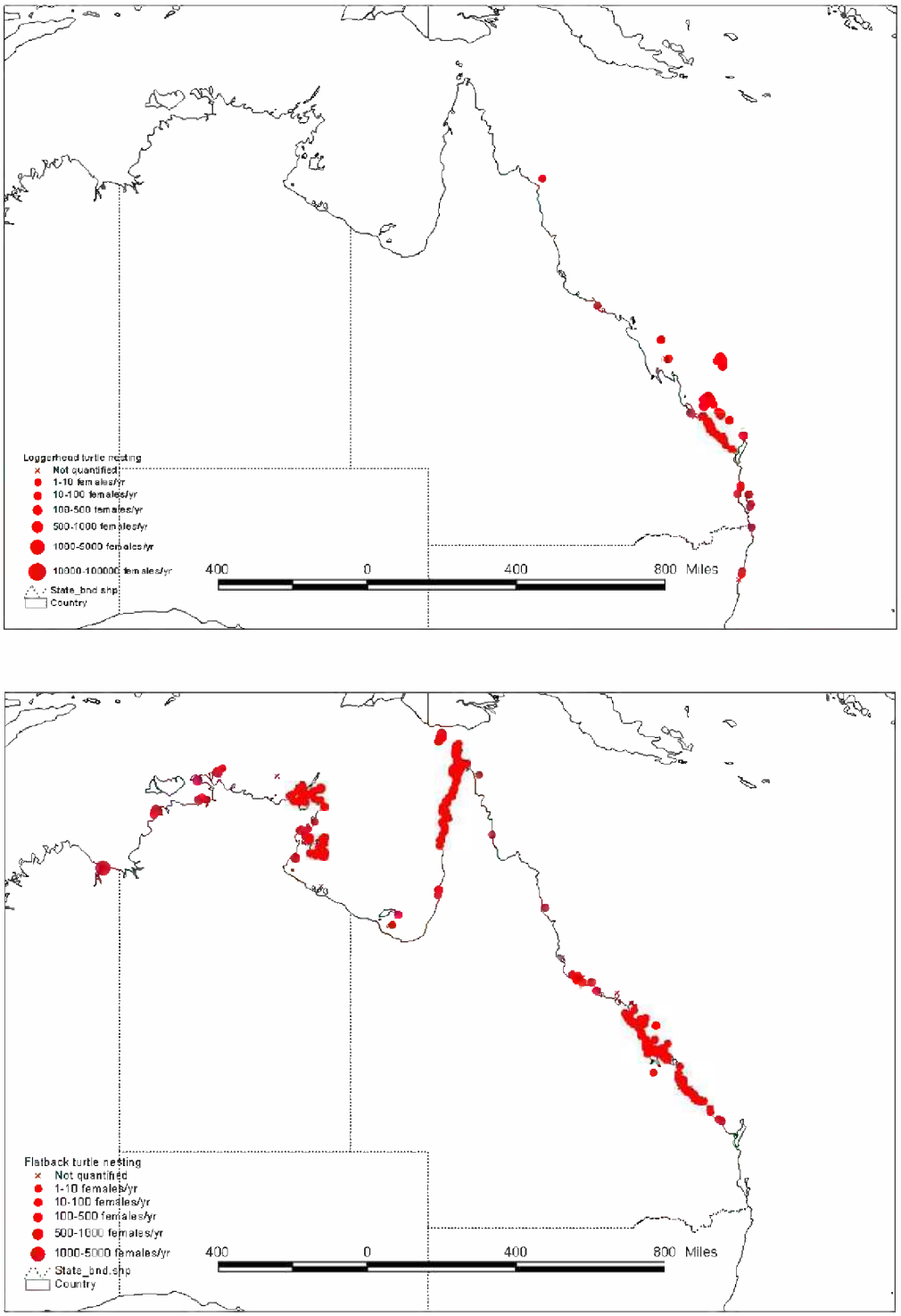
A further three marine turtle species – the Loggerhead Turtle (*Caretta caretta*), the Leatherback Turtle (*Dermochelys coariacea*) and the Green Turtle (*Chelonia mydas*) – also feed in the waters surrounding the proposed port but do not nest on the beaches. The Leatherback Turtle is generally recognised as principally utilising offshore pelagic areas for foraging. Coastal waters such as the proposed port site are not key habitat. The known nesting locations of these marine turtle species in northern and eastern Australia are shown in **Figure 6-50** to **Figure 6-52**. All are listed as threatened species under the EPBC Act. The foraging characteristics of all six turtle species are summarised in **Table 6-35**.





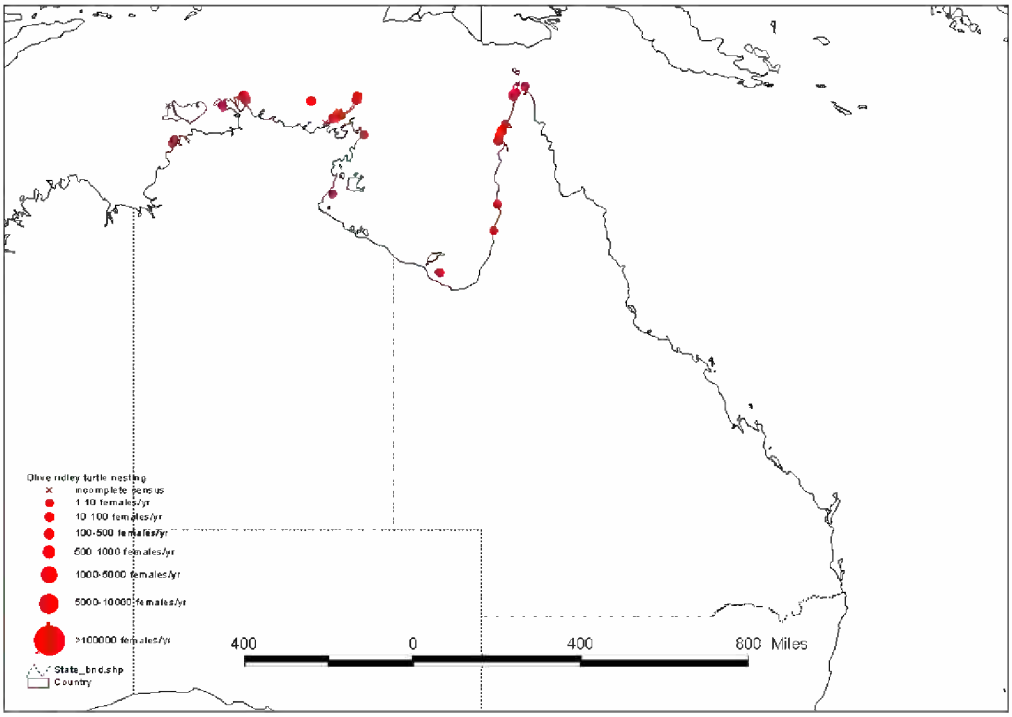
Source: Limpus and Miller 2008

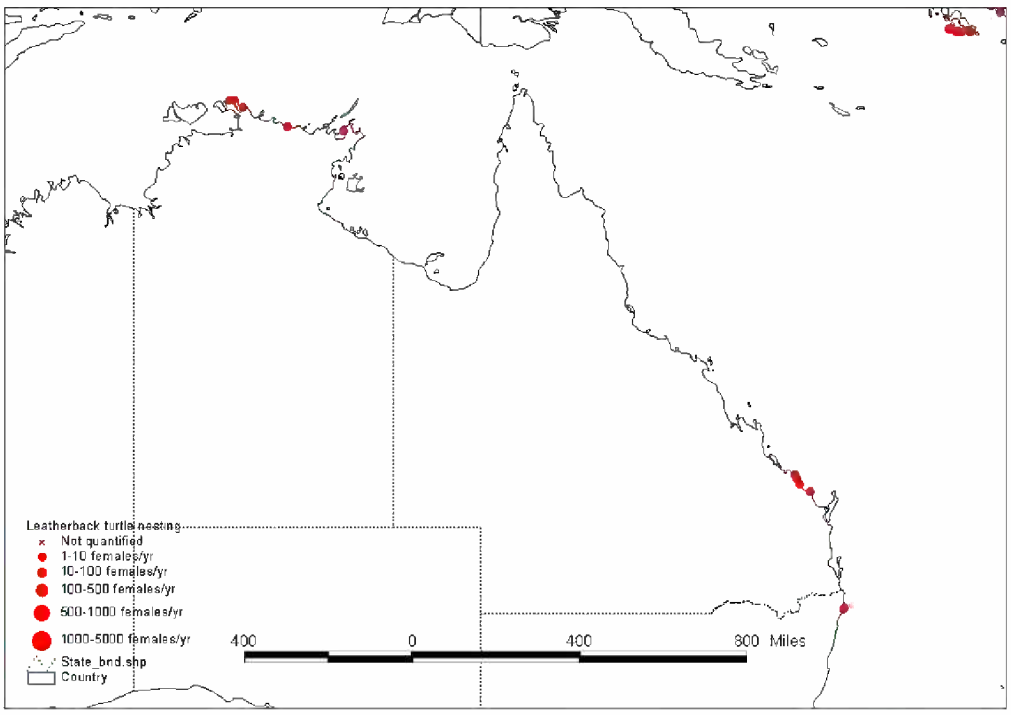
Figure 6-50 Nesting Locations for Hawksbill Turtles (top) and Green Turtles (bottom)



Source: Limpus and Miller 2008

Figure 6-51 Nesting Locations for Loggerhead Turtles (top) and Flatback Turtles (bottom)





Source: Limpus and Miller 2008

Figure 6-52 Nesting Locations for Olive Ridley Turtles (top) and Leatherback Turtles (bottom)

Table 6-36 Sea Turtle Foraging Characteristics

Turtle Species	Foraging Habitats	Preferred Food Items	Reference
Green Turtle (*Chelonia mydas*)	Shallow coastal area, in particular seagrass beds	Seagrass and seaweeds, although juveniles are also carnivorous	Brand-Gardner et al. (1999)
Hawksbill Turtle (*Eretmochelys imbricata*)	Rocky reef and coral reef habitats	Algae, seagrass and sponges	Limpus (2009a)
Flatback Turtle (*Natator depressus*)	Shallow coastal environments including rocky reef and sedimentary habitats	A wide variety of soft-bodied animals including soft corals, sea pens, sea cucumbers, jellyfish and other large plankton	Limpus (2007)
Loggerhead Turtle (*Caretta caretta*)	A wide range of intertidal and subtidal habitats including coral and rocky reefs, seagrass meadows, and unvegetated sand or mud areas	Although their diet is diverse, typical items include bivalve and gastropod molluscs and crabs	Limpus (2008a)
Olive Ridley Turtle (*Lepidochelys olivacea*)	Principally shallow unvegetated coastal environments	Principally feeds on gastropod molluscs and crabs	Limpus (2008b)
Leatherback Turtle (*Dermochelys coriacea*)	Oceanic environments from the sea surface to the seabed	Principally feeds on colonial ascidians such as *Pyrosoma* spp., jellyfish such as *Catostylus* spp. and other soft-bodied invertebrates	Limpus (2009b)

The methodology for the turtle nesting activity survey was developed based on advice from Dr. Colin Limpus (Chief Scientist, Freshwater and Marine Sciences, Queensland Department of Environment and Resource Management). Daylight field surveys were undertaken on foot from 22 to 24 April 2008 to identify marine turtle tracks and nests between Norman Creek to approximately 5km north of Boyd Point, encompassing 27km of beach, including the proposed port site. Consent to conduct the survey was provided by Traditional Owners. The survey was led by Dr Daryl McPhee (Worley Parsons) assisted by Mr Les Player (RTA) and two Traditional Owners – Mr Henry Kelinda and Mr Norman Kerindun.

April was chosen as a survey month to complement previous studies and to focus on a period when Olive Ridley Turtles may be more likely to nest in the area. Previous studies of nesting activity in the area were undertaken in May to July (GHD 2007b) and August to September (Bell 2003). Surveys were undertaken between 7.00am and 12.00pm to maximise the visibility of nests from the previous night's nesting activity (Schroeder and Murphy 1999).

Previously, field investigations by Bell (2004) recorded 41 Flatback Turtle nests and two Olive Ridley/Hawksbill Turtle nests over a 4 day survey in August 2003 along 38km of beach from Boyd Point south to False Pera Head. During 2007 field investigations, GHD (2007b) recorded 15 nesting events during three separate daily survey periods between May and July 2007 along a 10km stretch of foreshore between Boyd Point and Pera Head, with most nesting activity occurring at Boyd Point. Again, the majority of nesting activity represented that of Flatback Turtles, with Olive Ridley or Hawksbill Turtles next identified. Methodologies for the 2003 and 2007 surveys are provided in the survey reports. In the 2003 survey nesting beaches were accessed by water or land and observations of nesting tracks were documented and an assessment of the impact of pig predation on individual nests was recorded. In the 2007 survey standard beach surveying methodology was used.

For the current study and the 2007 survey, nesting activity is described in **Table 6-37** and an example of a Flatback Turtle nesting track is shown in **Plate 6-9**. **Figure 6-53** identifies the marine turtle nesting locations recorded by GHD (2007b) and in the present study. Specific locations and details from the 2003 study have not bee provided as the report only summarises the total nesting activity for each species.

The proposed location of the port is not considered a high density turtle nesting beach. The nearest major rookery on Cape York is Crab Island (Limpus 2007). On Crab Island, Leis (2008) found an average of 30 nesting tracks per kilometre per day of beach surveyed during May 2008. This compares with Bell (2004) who found 0.3 turtle tracks per kilometre per day from False Pera Head to Boyd Bay and GHD (2007b) who found 0.6 tracks per kilometre per day in a similar area. The April 2008 survey of the proposed port area found 0.1 tracks per kilometre per

day. The proposed port area can be considered to have a low to medium density nesting population. .

Table 6-37 Sea Turtle Tracks and Associated Nests in the Survey Area, 2007 and April 2008

Survey Date	Coordinates (WGS 84)	Species	Nest and Track Descriptions
May 2007	S12°54'787" E141°37'978"	Green Turtle (*Chelonia mydas*)	Large body pit, single egg shell found at surface, evidence of predation of eggs.
May 2007	S12°54'693" E141°38'107"	Flatback Turtle (*Natator depressus*)	Body pit with several egg shell fragments found on sand surface, evidence of predation of eggs.
May 2007	S12°54'675" E141°38'124"	Unidentified	Large body pit, no evidence of egg predation.
May 2007	S12°54'632" E141°38'124"	Unidentified (body pit only, no tracks)	Body pit with several egg shell fragments found on sand surface, evidence of predation of eggs.
May 2007	S12°54'721" E141°38'135"	Unidentified (old track)	False crawl, no associated body pit or nest.
May 2007	S12°54'613" E141°38'110"	Unidentified (old track)	False crawl, no associated body pit or nest.
June 2007	S12°54'060" E141°40'000"	Unidentified (body pit only, no tracks)	Small body pit, shell fragments evidence of pig predation.
June 2007	S12°54'619" E141°38'128"	Unidentified (body pit only, no tracks)	Small body pit, shell fragments evidence of pig predation.
June 2007	S12°54'693" E141°38'107"	Unidentified (body pit only, no tracks)	Large body pit, several egg shell fragments found at surface, evidence of predation of eggs.
June 2007	S12°54'859" E141°37'910"	Unidentified (body pit only, no tracks)	Small body pit, shell fragments evidence of pig predation.
June 2007	S12°54'875" E141°37'852"	Flatback Turtle (*Natator depressus*)	Body pit/nest. No signs of feral pig predation.
July 2007	S12°54'598" E141°38'106"	Unidentified (body pit only, no tracks)	Small body pit, shell fragments evidence of pig predation.
July 2007	S12°54'662" E141°38'090"	Unidentified (body pit only, no tracks)	Small body pit, shell fragments evidence of pig predation.
July 2007	S12°54'836" E141°37'921"	Flatback Turtle (*Natator depressus*)	No evidence of egg predation.
July 2007	S12°54'875" E141°37'857"	Unidentified (body pit only, no tracks)	Small body pit, shell fragments evidence of pig predation.
July 2007	S12°55'095" E141°37'672"	Olive Ridley Turtle (*Lepidochelys olivacea*) or Hawksbill Turtle (*Eretmochelys imbricata*)	Small body pit and narrow alternating tracks. No signs of predation. Multiple nesting attempts.
July 2007	S12°55'209" E141°37'618"	Flatback Turtle (*Natator depressus*)	No signs of predation. Multiple nesting attempts.
April 2008	S12°55'777" E141°37'299"	Flatback Turtle (*Natator depressus*)	Very fresh tracks and nest (probably only a few hours old). No sign of disturbance or predation. Nest shallow. Track and nest shown in **Plate 6-9**.
April 2008	S12°56'513" E141°36'795"	Flatback Turtle (*Natator depressus*)	Paired gait of flippers. Nest adjacent to cliff edge. Evidence of predation by feral pigs.
April 2008	S12°55'897" E141°36'514"	Flatback Turtle (*Natator depressus*)	Reasonably old track. Paired gait of flippers. Nesting against fallen timber. Predation of nest by pigs/dogs. Quad bike tracks leading to and from nest.
April 2008	S12°56'913" E141°36'500"	Flatback Turtle (*Natator depressus*)	Old track. Straight drag pattern down the centre of the track. Paired gait of flippers. Nesting against cliff and under fallen timber. Predation of nest by pigs/dogs.
April 2008	S12°56'957" E141°36'461"	Flatback Turtle *(Natator depressus*)	Old track but with sufficient morphology to identify it as a flatback. Predation of nest by pigs.

Survey Date	Coordinates (WGS 84)	Species	Nest and Track Descriptions
April 2008	S12°56'990" E141°36'455"	Unidentified	Old track without clear morphology. Predation of nest.
April 2008	S12°59'230" E141°35'320"	Flatback Turtle (*Natator depressus*)	Paired gait of flippers with a wide plastron imprint. Nest adjacent to cliff edge. No tail drag lines down the centre of the track. No evidence of predation.
April 2008	S12°59'608" E141°35'111"	Hawksbill Turtle (*Eretmochelys imbricata*)	Fresh track most probably from previous night. Tracks are in very coarse sand, meandering and in part over rock. Several attempts made to nest on the side of a vegetated dune. No evidence of predation, but feral pig tracks abundant in the general area (Thud Point).
April 2008	S12°54'704" E141°38'047"	Flatback Turtle (*Natator depressus*)	False crawl with no associated nest.
April 2008	S12°54'635" E141°38'133"	Unidentified	Old nest with no signs of tracks but fragments of egg shell present.

2007 Survey Data from GHD, 2007b

Plate 6-9 Flatback Turtle Nest (left) and Turtle Tracks between Boyd Point and Pera Head

Available information identifies that scattered nesting of Flatback Turtles occurs along most beaches of western Cape York, including the proposed Project site. There are no concentrated high density rookeries such as those that occur on islands of the Torres Strait such as Crab Island and Deliverance Island; however, the beaches of western Cape York represents an area of low to medium density nesting activity for this species. Nesting of the Olive Ridley and Hawksbill Turtles in the vicinity of the Project site and throughout the western Cape York beaches is identified as low density. There are uncertainties regarding whether nesting of Olive Ridley Turtles is still occurring in the western Cape York region.

Incidental observations while undertaking boat-based marine ecology field work identified that, within the area surveyed, marine turtles (predominantly Flatback Turtles) were frequently observed surfacing. The qualitative observations did not reveal any apparent preference for one part of the study area over the other. No quantitative assessment of the relative importance of the area as sub-tidal feeding habitat for marine turtles was undertaken.

Marine turtles are long-lived and late maturing with maturity reached at between 30 and 50 years of age (Miller 1996). Female marine turtles emerge from the water, generally at night, and move up the shoreline to select a nesting location. Most females do not nest in consecutive years (Miller 1996). However, a female marine turtle may lay several clutches of eggs per year (Limpus *et al.* 1984). Nesting marine turtles generally demonstrate fidelity to a nesting beach and return to nest on their natal beach with a high degree of precision (Limpus *et al.* 1984). The process by which turtles select nesting sites along a beach has not been clarified (Miller 1996); however, the light regime is considered to have a significant impact on the emergence of female marine turtles from the ocean. Marine turtles may also emerge from the water and

return without attempting to excavate a nest or lay eggs – a phenomenon known as a "false crawl". Nesting generally occurs between the high water mark and the foredune; however, nests may also be laid below the high tide mark (Whiting *et al.* 2007). If inundation of nests is significant, the nest becomes unviable.

The sex ratio of turtle hatchlings is dependent on the temperature of incubation, which is a function of sand colour. Nests in darker sand incubate at higher temperatures and produce more females (Hays *et al.* 2001). For Flatback Turtles, the most numerically important nesting location, Crab Island, produces mostly male offspring while the scattered nesting in darker coloured beaches on western Cape York, such as those in the area of the proposed development, produce predominantly female offspring (Dr Colin Limpus, pers. comm.).

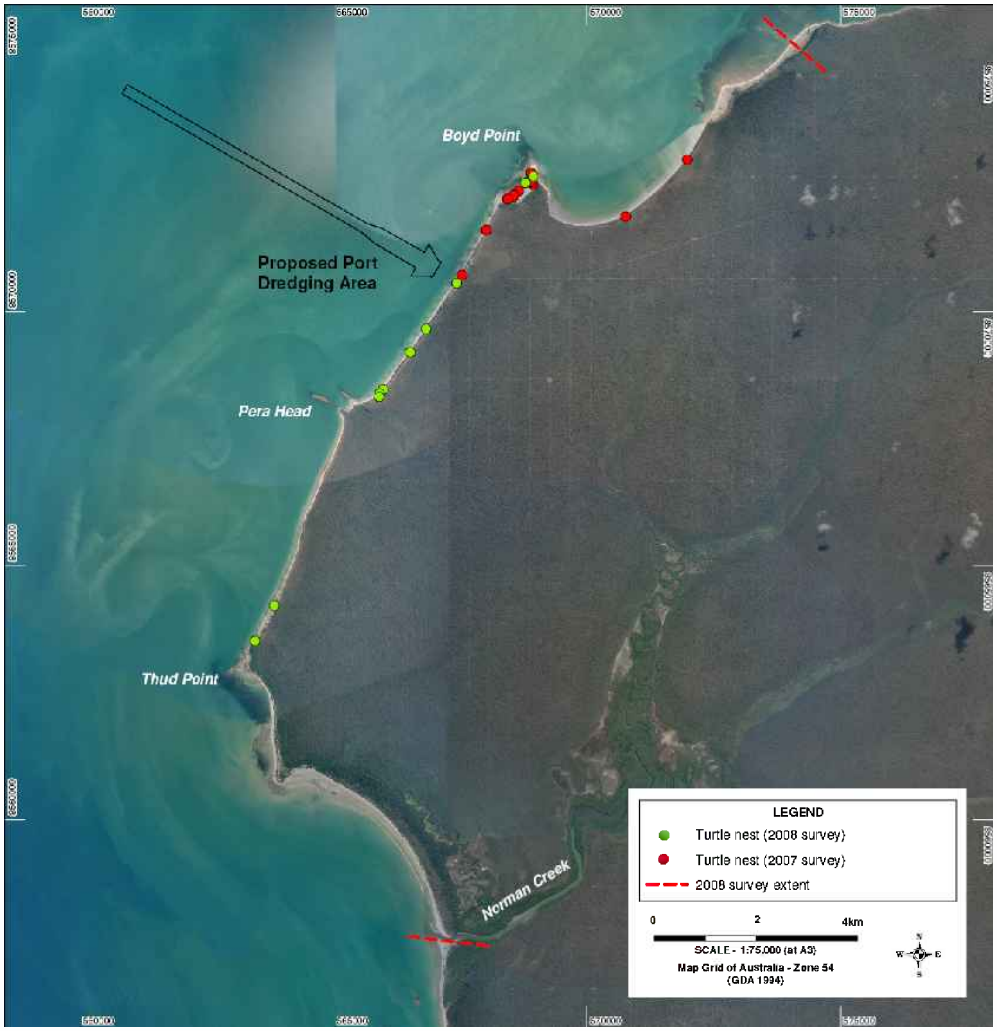


Figure 6-53 Location of Turtle Nesting Activity May – July 2007 and April 2008

Once hatched, lighting cues are identified as critical for hatchlings to move from the beach to the ocean – a behaviour known as sea-finding. In simple terms, where there are no anthropogenic light sources, hatchlings move away from the dark silhouetted shoreline towards the brighter ocean horizon. Brightness in this context, however, is a term that encompasses wavelength and intensity (Witherington and Martin 1996). The uniformity of the light regime can also act as a cue, whereby hatchlings may orientate away from a horizon that has patterns of light and shadow representing shoreline vegetation or structures. In practical terms, the

turtles would see these patterns and orientate away from the shore and head towards the more uniform light environment of the ocean horizon (Godfrey and Barreto 1995; Witherington and Martin 1996).

Altered above-water, night-time light regime can have an effect on hatchlings' attempts to find water. Lights at a nesting beach can result in turtle hatchlings heading inland rather than into the ocean, with subsequent mortality. Lights adjacent to nesting beaches can result in hatchlings entering the ocean safely, only to re-emerge closer to the light source. At Hummock Hill Island (central Queensland), lighting from the Boyne Island smelter, which is approximately 18km north of the nesting beach, was observed to disorientate nesting turtles (Hodge *et al.* 2006). This lighting source is extremely bright and lacks any measures to mitigate impacts on marine turtles. A modified lighting regime may elicit an impact, with illumination of salt spray adjacent to a nesting beach being sufficient to alter sea-finding behaviour (Dr Colin Limpus pers. comm.). Offshore lighting may result in hatchlings aggregating under the light, effectively becoming a focus for predatory fish. Flashing lights (e.g. navigation beacons) are not recorded as inducing alteration to sea-finding behaviour.

Currently, there are two major anthropogenic threats to nesting marine turtles along the beaches of western Cape York – predation by feral pigs and entanglement in discarded fishing nets (ghost nets). The former is currently considered the most significant. Feral pigs are a well-acknowledged environmental problem in Australia. They are identified as a key threatening process under the EPBC Act and a Threat Abatement Plan (TAP) is currently in place to protect marine turtles in Australia. The impact from feral pigs on turtle nesting is a significant reason for listing feral pigs as a key threat.

Field surveys identified significant destruction of turtle nests by feral pigs, at and adjacent to the area of the proposed port development. Feral pig activity within the field survey area was particularly prevalent in areas with direct access to the beach from adjacent bushland. Where cliffs extended to the water edge, feral pig activity was considerably less, or absent. The two areas where feral pig activity was most prevalent were Boyd Point and Thud Point. Extensive feral pig activity, including turtle nest excavation, was observed just above the high tide mark at Boyd Point. Although exact estimates were not possible, approximately 50 to 60 nests appeared to be disturbed on approximately 500m of beach north of Boyd Point (refer **Plate 6-10**). This count includes nests with visible track marks, and those without track marks (time of nesting is unknown).

Ghost nets are discarded or lost nets that float in the ocean until they wash up on beaches (refer **Plate 6-11**). These nests can entangle and kill marine turtles in the open ocean and/or in inshore areas. According to the Carpentaria Ghost Nets Program, which is an Indigenous community and Commonwealth Government partnership in northern Australia, most ghost nets in the Gulf of Carpentaria originate from south-east Asian countries, in particular, Taiwan, Indonesia and Korea.

Plate 6-10 Example of Feral Pig Digging North of Boyd Point (background)

Plate 6-11 Juvenile Olive Ridley Turtle Carcass in a Ghost Net near Pera Head

6.6.6 Sea Snakes

The Gulf of Carpentaria contains a diverse and abundant sea snake assemblage of at least 17 species. In the Weipa area, the numerically dominant sea snake species is *Lapemis hardwicki,* which comprises approximately 90% of the sea snake population (Redfield *et al*. 1978).

Other species recorded in the Weipa area include: *Acalyptophis peronii*; *Aipysurus duboisii*; *Aipysurus laevis*; *Astrotia stokesii*; *Enhydrina schistose*; *Hydrophis elegans*; and *Hydrophis ornatus*.

All these species have been recorded from multiple locations elsewhere in the Gulf of Carpentaria (Redfield *et al*. 1978). There are no specific studies that have examined the sea

snake fauna specifically at the sites of the proposed development. The main impact on sea snake populations in the Gulf of Carpentaria is incidental capture in the Northern Prawn Fishery.

6.6.7 Bony Fish and Nektobenthic Marine Invertebrates

Albatross Bay is recognised as extending in a straight line from Jantz Point southwards to Pera Head. Information from Albatross Bay is also relevant to areas directly adjacent. The fish assemblages of Albatross Bay have been well studied and much of this work has focussed in or directly adjacent to the Embley River estuary (e.g. Blaber *et al.* 1989, 1990a). 344 fish species have been recorded in Albatross Bay (Baker and Sheppard 2006).

No fish species listed under the EPBC Act or the NC Act have been recorded in Albatross Bay. Different fish assemblages occur in the various habitats sampled. The fish biomass estimates obtained by Blaber *et al.* (1989) for open water channels, sandy beach habitats and mangroves creeks were found to be similar to previously-published estimates from tropical estuarine areas. In contrast, the fish biomass of seagrass habitat was lower than that estimated for other tropical estuaries. The fish assemblages of Albatross Bay estuarine and shallow coastal waters are summarised in **Appendix 6-A**.

Along the foreshore, just south of the Embley River estuary, the dominant species caught by gill netting were Queenfish, Milkfish and Blue Salmon (Blaber *et al.* 1995). Overall, Blaber *et al.* (1995) found that fish catch rates along the Weipa foreshore were less than in the adjacent estuary and offshore waters. Nonetheless, Blaber *et al.* (1995) identified the area as a transition zone between estuarine and offshore waters for some species. In offshore waters, the dominant families of fish were those that occurred at similar depths and distance from the coastline throughout the eastern and south-eastern region of the Gulf of Carpentaria (e.g. Family Leiognathidae, Ponyfishes).

Although not well studied, the reef habitats in Albatross Bay support a diverse assemblage of demersal and pelagic species. Demersal species include members of the Families Serranidae (e.g. Coral Trout, *Plectropomus leopardus*), Lutjanidae (e.g. Fingermark, *Lutjanus johnii* and Red Emperor, *Lutjanus sebae*) and Labridae (e.g. tuskfish, *Choerodon* spp.). Pelagic species include mackerel (e.g. Spanish Mackerel, *Scomberomorus commerson*i) and various tunas.

Three species of sygnathids (pipefish and seahorses) that are listed marine species under the EPBC Act (section 248) – *Hippichthys heptagonus* (Big Belly Seahorse), *Hippocampus kuda* (Spotted Seahorse) and *Hippocampus whitei* (White's Seahorse) – are confirmed to occur in Albatross Bay (Blaber *et al.* 1990). As the distribution and abundance of sygnathids are poorly known, it is highly likely that other species of sygnathids also occur in Albatross Bay.

Albatross Bay is known to be an important nursery area for the juvenile tiger and banana prawns that are the principal target species in the Northern Prawn Fishery area. Banana prawns migrate from estuarine areas into the Gulf of Carpentaria for spawning from September to November and March to May. At low tide, juvenile and sub-adult prawns are most abundant in small tidal creeks and gutters that drain from mangrove forests (Vance *et al.* 1998; Kenyon *et al.* 2004).

The Brown Tiger Prawn (*Penaeus esculentus*) and the Grooved Tiger Prawn (*Penaeus semisulcatus*) are abundant in the Gulf of Carpentaria. Brown Tiger Prawns spawn throughout the year, with peak spawning occurring from August to September (Kenyon *et al.* 2004). Grooved Tiger Prawns' spawning peaks between August and October, with a minor peak in the months of January and February. Juvenile tiger prawns are generally associated with vegetated habitats (particularly large seagrass beds) in the vicinity of estuaries (Haywood *et al.* 1995; Rothilsberg *et al.* 1996). Other prawn species that occur in abundance in Albatross Bay are Endeavour Prawns (*Metapenaeus endeavouri* and *Metapenaeus ensis*) and Eastern King Prawns (*Penaeus plebejus*).

The cephalopod (squid and cuttlefish) assemblage in the Gulf of Carpentaria is diverse and abundant, with at least 21 species. The numerically dominant species of squid and cuttlefish recorded are *Photololigo chinensis* and *Photololigo edulis*, and *Sepia elliptica* and *Sepia pharaonis* respectively (Dunning *et al.* 1994). There are no specific studies that have examined the squid and cuttlefish assemblage at the sites of the proposed marine infrastructure.

Mud crabs are common in the creeks and rivers of Albatross Bay.

6.6.8 Macrobenthic Infauna

Long and Poiner (1994) examined the macrobenthic infaunal assemblage in sub-tidal areas of the Gulf of Carpentaria. Species assemblages consisted primarily of overlapping species distributions rather than highly-structured, discrete communities with well-defined groups that are characteristic of the community. Polychaete worms were identified as the numerically dominant group of animals, followed by crustaceans and bivalve molluscs. The benthic infauna assemblage has been impacted for many years by prawn trawl operations.

The structure of macrobenthic assemblages was surveyed at six locations within three sites: the proposed new disposal ground, the proposed port area and the existing disposal ground in Albatross Bay using a benthic grab to collect four replicate samples and sieving them using a 1mm mesh sieve. Remaining infauna material was preserved and identified to lowest practical taxonomic level (typically Family morphospecies level, whereby each apparently different taxonomic "species" of a family is a different "morphospecies"). The taxa richness and abundance of the assemblage, and the five numerically dominant taxa at each of the survey sites, was assessed (**Table 6-38** and **Table 6-39** respectively).

Of the three sites, it is noteworthy that the existing spoil ground in Albatross Bay had an exceptionally high abundance of the small bivalve *Gouldia* sp., which comprised approximately 90% of the total abundance (refer **Table 6-39**). The high abundance of *Gouldia* sp. at the existing disposal site is most likely a direct response of the species rapidly colonising the area after dredge spoil deposition. Although available information is limited, a similar response by populations of this genus was recorded in the United States in response to dredge disturbance and spoil deposition (Iversen and Beardsley 1974).

The majority of taxa surveyed at the three sites were previously recorded by Long and Poiner (1994).

Table 6-38 Taxa Richness and Abundance of Macrobenthic Infauna at the Three Survey Sites

Site	Taxa Richness	Abundance
New Disposal Ground (6 locations)	148	851
Port Area (6 locations)	111	504
Disposal Ground in Albatross Bay (6 locations)	97	4562

Table 6-39 Five Dominant Macrobenthic Infaunal Taxa at the Three Survey Sites

Rank of abundance	New Disposal Ground	Port Area	Disposal Ground in Albatross Bay
1	Polychaete worm – *Eunice vittata sp?*	Polychaete worm – F. Chaetopteridae	Bivalve mollusc – *Gouldia* sp.
2	Polychaete worm – F. Maldanidae	Peanut worm – *Aspidosiphon* sp.	Bivalve mollusc – *Nuculana* sp.
3	Polychaete worm – F. Capitellidae	Polychaete worm – *Eunice vittata sp?*	Bivalve mollusc – *Yoldia* sp.
4	Anemone – F. Zooanthidae	Polychaete worm – F. Maldanidae	Polychaete worm – F. Maldanidae
5	Tusk shell – F. Laevidentaliidae	Amphipod crustacean – *Apseudes* sp.	Bivalve mollusc – *Yoldia narthecia sp?*

6.6.9 Introduced Marine Species

In Australia, there are existing protocols in place to minimise the risk of marine pest incursions and to ensure the early detection of an incursion if one occurs. Pests may be introduced by ships' ballast water or hull fouling. There is a National System for the Prevention and Management of Marine Pest Incursions, which includes three major components: prevention,

emergency response, and ongoing control and management of existing pests. Since 2001, requirements have been in place for the management of internationally-sourced ballast water that apply to all ships arriving from overseas. The Australian Ballast Water Management Requirements (DAFF 2008) details the controls to minimise the risk of introducing harmful aquatic organisms into the environment. These requirements are implemented through the *Quarantine Act 1908* and are administered by the Seaports Program within the Australian Quarantine Inspection Service (AQIS). No ballast water may be discharged from internationally trading vessels in Australian waters without express written permission from AQIS as discussed in further detail in **Section 13.3.8**.

All vessels owned and contracted by RTA would manage ballast water through a Ballast Water Management Plan which would comply with Australian mandatory requirements and the International Convention for the Control and Management of Ships Ballast Water and Sediments (IMO 2004). There would be no hull cleaning at the proposed port; however, pests may still be present on ships hulls. Monitoring would be undertaken to provide a means of early detection of introduced pests (refer **Section 6.9.4.6** and **Section 13.3.8**).

Extensive surveying for marine pest species has been undertaken at the Port of Weipa and no invasive marine pest incursions have been recorded (Hoedt *et al.* 2001; PCQ 2007; PCQ 2009). While no invasive species have been found, at least two introduced species were identified in the 1999 baseline survey (Hoedt *et al.* 2001). The detailed baseline survey of the Port of Weipa has been supplemented since 2006 by inspection every three months of larval monitoring devices installed in the port and targeted surveys by DEEDI of high-risk areas in the port. This monitoring was instigated following the discovery of the high-risk species Asian green mussel (*Perna viridis*) on a non-trading vessel that had been in the Port of Weipa. No Asian green mussels or other non-indigenous species have been detected since the monitoring began in 2006 (PCQ 2009).

6.7 Marine Fisheries Resources

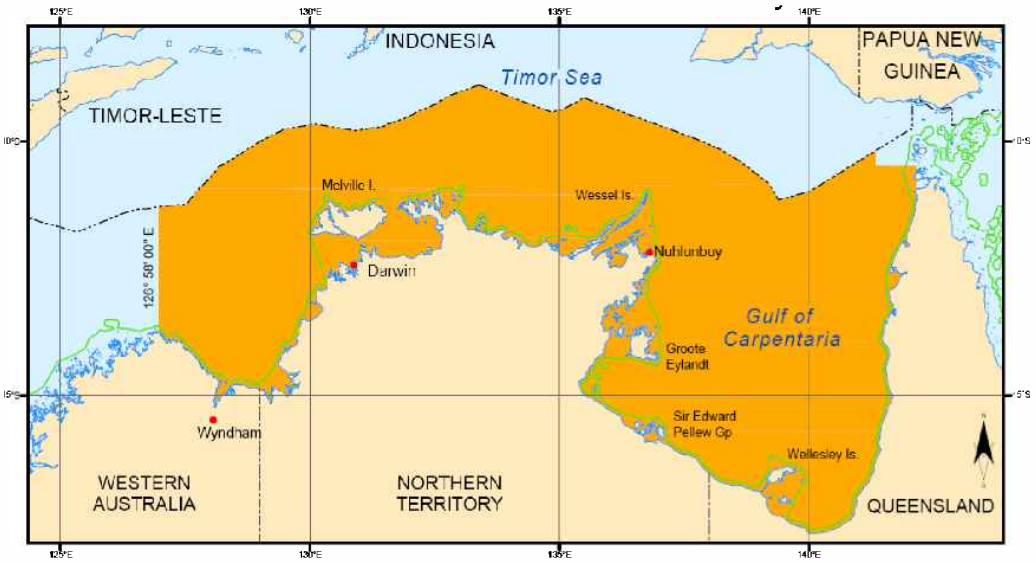
The Gulf of Carpentaria hosts commercial fisheries that are managed by the Queensland Government, Commonwealth Government, and jointly through the Queensland Fisheries Joint Authority (QFJA). The Queensland Government manages the commercial mesh net fisheries and crab fisheries through DEEDI. The Commonwealth Government manages the Northern Prawn Fishery (NPF) through the Australian Fisheries Management Authority. The line fishery is managed through the QFJA. There is also a Developmental Finfish Trawl Fishery managed through the QFJA. The recreational and charter fisheries are managed by DEEDI.

Catch information for the fisheries managed by the State and the QFJA is recorded by operators in compulsory logbooks that are submitted to DEEDI. The catch data for the fishery is recorded at a very broad spatial scale of "30 minute grids". The area of the proposed development is within reporting grid "AB8". For monitoring and assessment purposes, the NPF is divided into 15 large statistical areas, with the Weipa statistical area being relevant for the proposed development.

Recreational fishing catches are monitored through a biennial phone survey and diary program. These surveys collect information at the spatial level of the ABS statistical division (based on where an angler resides), and can only provide very broadscale information. Weipa falls within the Far Northern Statistical Division, which stretches from the Herbert River just north of Townsville, through the Torres Strait, to the Edward River on the mid-western coast of Cape York. As such, this information cannot be relied upon to provide relevant information at the appropriate spatial scale.

6.7.1 Northern Prawn Fishery

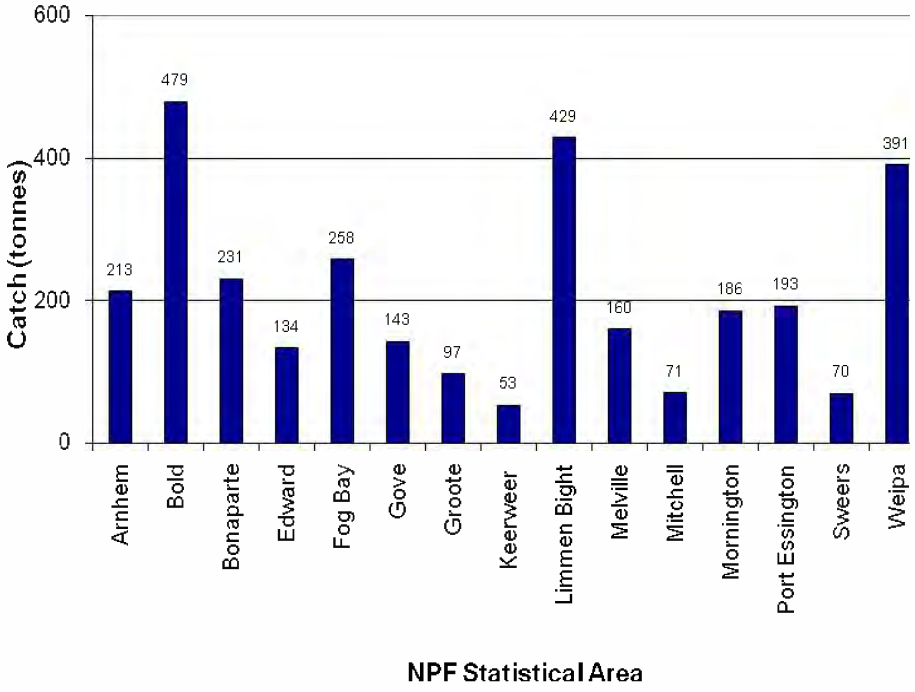
The NPF is Australia's most valuable commercial fishery, with an annual value of production averaging $95 million (1999–2007). In 2007 there were 52 operators accessing the fishery. The prawn fishing area extends across the northern part of Australia from Cape Londonderry (Western Australia) east to Cape York (refer **Figure 6-54**). In practice, fishing is focussed on a number of "hotspots", although the relative importance of these hotspots varies between years in response to climatic factors, in particular rainfall.



Source: Raudzens 2007

Figure 6-54 Permitted Fishing Area of the Northern Prawn Fishery

The main species caught in the NPF are tiger prawns and banana prawns, targeted at different times and generally in different locations. For catch and effort reporting purposes the NPF is divided into 15 statistical areas. The proposed port development area is within the Weipa statistical area, which extends from approximately Port Musgrave southwards to Thud Point. Tiger prawn fishing takes place in the western Gulf of Carpentaria from August to November, with little catch recorded in the Weipa statistical area or in the eastern Gulf of Carpentaria in general. The banana prawn season extends from April to June, with the Weipa statistical area being a significant area of production (refer **Figure 6-55**). Banana prawns are targeted in waters less than 20m deep. Areas adjacent to the proposed port site between Pera Head and Boyd Point and the potential spoil ground location are important areas within the Weipa statistical area for catching banana prawns (refer **Figure 6-56**). These species spawn offshore and give rise to larvae that migrate into 'nursery' grounds, usually seagrass beds or mangrove areas, in shallow coastal areas where they feed and grow. After three months in these nursery grounds, juveniles migrate offshore into the fishing grounds where they feed and grow for at least another three months before attaining commercial size. Peak times of migration of larvae onshore and juveniles offshore are from August to April. The potential impacts on prawn nursery grounds within the Project area are discussed in **Section 6.9.6.1**.



Source: Raudzens 2007

Figure 6-55 Total Catch of Banana Prawns for Each Area of the Northern Prawn Fishery, 2006

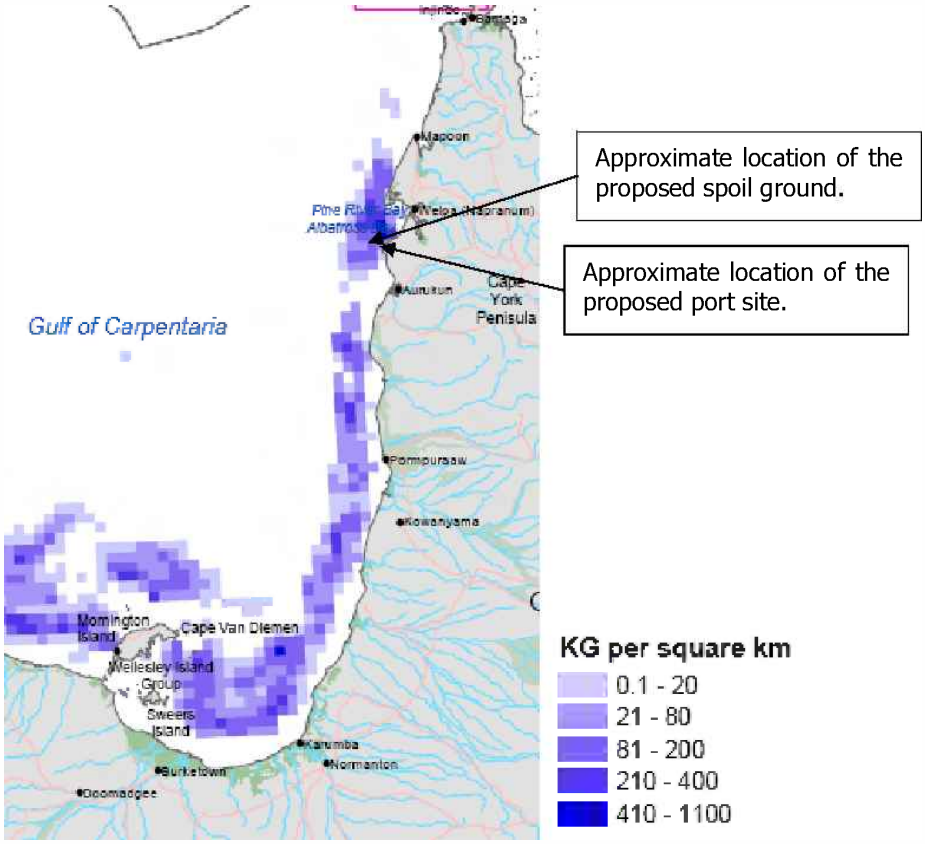


Figure 6-56 Prawn Catch – Eastern Gulf of Carpentaria Region of the Northern Prawn Fishery

6.7.2 Gulf of Carpentaria Commercial Fisheries

The Gulf of Carpentaria Inshore Finfish Fishery is a commercial mesh net fishery managed by the Queensland Government that extends from the Queensland – Northern Territory border to Slade Point on the north-west coast of Cape York Peninsula. It has an inshore component (0–7 nautical miles), targeting species such as barramundi and threadfins (*Polynemus* spp.), and an offshore component (7–25 nautical miles), targeting various shark species and grey mackerel (*Scomberomorus semifasciatus*). In 2006, 87 licensed fishers harvested 1,782 tonnes of fish with a landed gross value of production of $12.8 million. The rivers flowing into Albatross Bay are closed to the fishery, although the foreshores and sub-tidal areas can be accessed. Norman Creek can be accessed by the fishery, but the coarse spatial scale of the catch and effort data does not allow for determining the relative importance of this area for the fishery.

Production of the key target species in the inshore and offshore fishery components is reliant on intact and functioning inshore habitats such as mangroves and seagrass and the connectivity between habitats. There is a closed season between November and February to protect the spawning stock of key target species. On average, reporting grid AB8 contributes approximately 3% of the total annual catch of the Gulf of Carpentaria Inshore Finfish Fishery.

The Gulf of Carpentaria Commercial Line Fishery is managed by the Queensland Government and extends from the Queensland – Northern Territory border to Slade Point on the north-west coast of Cape York Peninsula. In 2006, 27 licensed fishers harvested 237 tonnes of fish with a landed gross value of production of $1.6 million. The main target species is Spanish mackerel, which constitutes 90% of the total catch. On average, reporting grid AB8 contributes approximately 12% of the total annual catch of the Gulf of Carpentaria Commercial Line Fishery. Commercial line fishermen recognise the reef areas in the vicinity of Pera Head, Boyd Point and Thud Point as key locations for Spanish mackerel (*Scomberomorus Commerson*) in the Weipa region. The peak season for Spanish mackerel in the Weipa region extends from August to November.

Unlike the commercial net and line fisheries discussed in the previous two sections, there is no specific fishery restricted to Gulf of Carpentaria waters for the taking of mud crab. Any licensed mud crab operator in Queensland can operate in Gulf of Carpentaria waters. At the regional level, there is a strong positive correlation between areas of mangrove forest and mud crab production. The creeks and rivers that drain into Albatross Bay are the most important mud crab harvesting areas in the Gulf of Carpentaria (Williams 2002). Mud crabbing generally focuses on areas directly adjacent to large mangrove stands, including small creeks draining such stands. The proposed port development and spoil ground is remote from these areas and therefore would not impact on mud crab populations or access to the mud crab fishery areas. Mud crabbing occurs in the Embley and Hey Rivers but the proposed barge and ferry terminal locations are not considered prime habitat for mud crabs.

Developmental fisheries are those that use new methods and/or target new and underutilised species. In the Gulf of Carpentaria there is a Developmental Finfish Trawl Fishery, extending north of 15 degrees south latitude to a distance of 25 nautical miles from the coastline. This fishery intersects the proposed Project area. The principal target species are crimson snapper (*Lutjanus erythropterus*), saddletailed snapper (*Lutjanus malabaricus*) and mangrove jack (*Lutjanus argentimaculatus*). In 2005, there were two vessels that captured 479 tonnes of fish with a landed gross value of production of $1.5 million.

6.7.3 Recreational Fishery

Recreational fishing is a popular pastime in the Project area and a range of species including barramundi, mangrove jack, fingermark, threadfins and mackerel are caught (Baker and Sheppard 2006). Common recreational fish species are identified in **Appendix 6A**. It is estimated that 9% of tourists who visit Weipa do so primarily to fish (GHD 2005). There is no information on the recreational catch and the distribution of fishing effort in the Project area.

Guided fishing supports recreational fishing tourism and attracts international tourists to Weipa. It is estimated there are eight guided fishing businesses in Weipa with a combined income of $396,000 (Fenton and Marshall 2001). Anecdotal information suggests the current income of the charter vessel fishery based in Weipa has increased substantially since 2001. The charter fishing businesses based at Weipa principally fish at the reefs in Albatross Bay, including nearby

Pera Head and Thud Point, the rivers and creeks that drain into it, and the sandflats that extend from the Embley River south to Norman Creek. Popular recreational reef fishing spots in relation to the Project marine facilities are shown in **Figure 6-57**.

6.8 Environmental Values

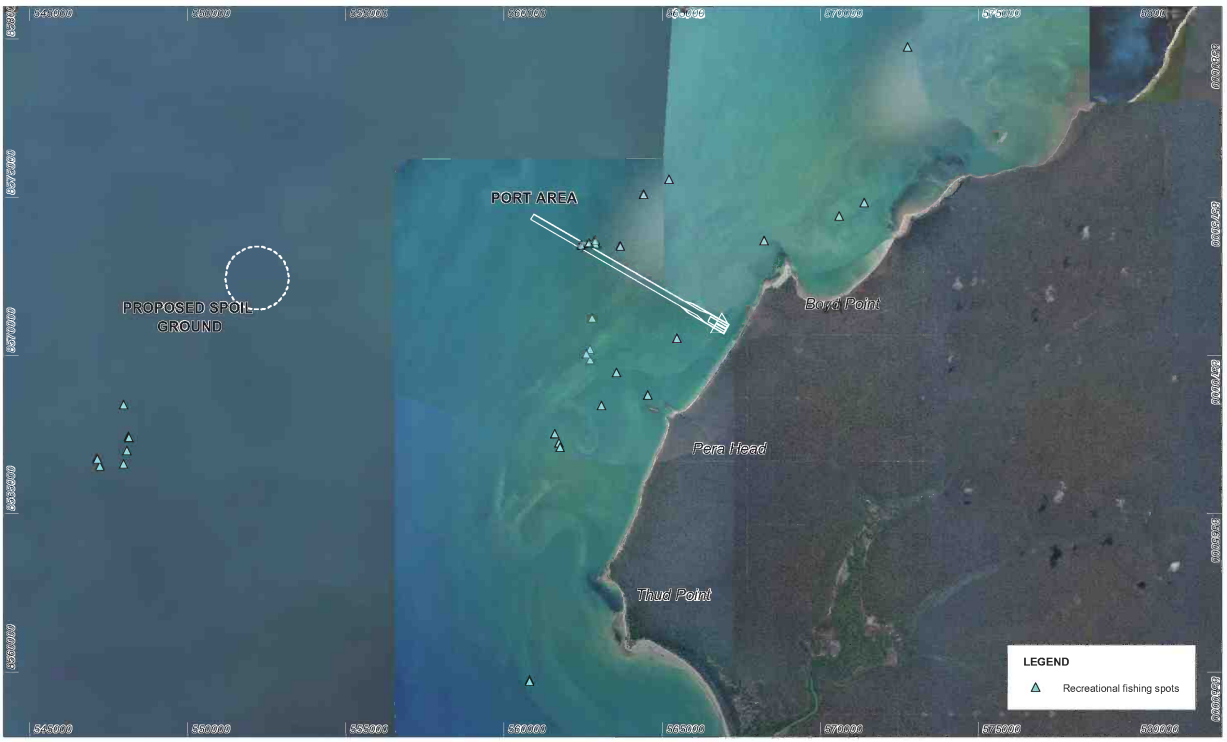
As identified in **Section 6.4.1**, no specific EVs or WQOs have been determined for the Western Cape York area. The marine ecosystem in the Project area is effectively unmodified and is considered of high ecological value under the EPP (Water). The EV to be protected is the biological integrity of the aquatic ecosystem. The Project area includes diverse habitat that supports species of conservation significance, and commercial and recreational fishing in water quality relatively unaffected by human impacts.

The EVs in the vicinity of the proposed port area are the diversity of habitats that support the local marine assemblages, and the use of the foreshore by nesting marine turtles. The area includes a diverse reef assemblage comprising soft and hard corals, algae, sponges and soft corals centred around Boyd Point, Pera Head, and reefs south to Thud Point. These reef assemblages occur adjacent to, but not at, the proposed port site. The importance of these reef systems (Boyd Point to Thud Point) in a regional context is considered to be high, as they support resources that are of conservation, cultural, commercial and recreational importance. Large soft sediment habitats provide habitat for macrobenthic infauna and fish species, including sawfishes, which are of conservation significance. Various fish species that support recreational, guided and commercial mesh net and line fishing occur in the reef areas and along the foreshore flats. Seagrasses are present in Boyd Bay to the north of the proposed port development and have historically been recorded in sparse isolated patches south of Thud Point.

The EVs of the proposed spoil ground include habitat for benthic infauna, fish and mobile invertebrate species that prefer sub-tidal soft sediment habitats. This type of habitat is widespread throughout the Gulf of Carpentaria. Banana prawns seasonally occur in the area and are targeted by the Northern Prawn Fishery.

The EVs of the barge/ferry terminal locations in the Embley and Hey Rivers include seagrass beds directly adjacent to the Hornibrook Terminal dredge area and isolated seagrass patches within and adjacent to the Humbug Terminal dredge area. Seagrass beds provide food and shelter for fish and invertebrates including those that support various commercial and recreational fisheries. The soft sediment estuarine area within the Embley and Hey Rivers also support macrobenthic infauna that contributes to fisheries production.

The Traditional Owners value the coastal environment for the protection of flora and fauna, for fishing and for recreation (refer **Section 16.2.2**).



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Aerial photography and vector data supplied by client.

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SCALE - 1:100,000 (at A3)

Map Grid of Australia - Zone 54
Geocentric Datum of Australia 1994

Rev	Date	Revision Description	DRN	CHK	ENG	APPD
A	26/07/2010	Issued for squad check	NA	MZ		

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FIGURE 6-57

Recreational fishing spots near port area and proposed spoil ground

Project No: 301001-01069	Figure: 01069-00-GM-EN-0020	Rev: A

Compiled by BRISBANE GEOMATICS SECTION

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6.9 Potential Impacts and Mitigation Measures – Marine

Potential impacts that may occur during the construction and operational phases of the Project are listed in **Table 6-40**.

Potential impacts and proposed management measures are discussed below in terms of: alterations to coastal processes, dredging, water quality, habitat, species, fisheries and pest species. A summary of mitigation strategies is presented in **Section 6.9.8**.

Table 6-40 Potential Impacts During Construction and Operation

Potential Impact	Port Area	New Disposal Ground	Embley River – Hornibrook & Humbug Terminals	Albatross Bay Spoil Ground	Hey River Terminal
Creation of a turbidity plume, and subsequent deposition and re-suspension of fine sediments	Construction and operation	Construction and operation	Construction and operation	Construction and operation	Construction and operation
Physical destruction to benthic habitats, including hard and soft coral communities, and fauna from dredging and construction of infrastructure	Construction and operation	Construction and operation	Construction and operation	Construction and operation	Construction and operation
Changes to coastal processes (erosion and deposition)	Construction and operation	—	—	—	—
Introduction of pollutants to marine waters and sediments	Construction and operation	Construction and operation	Construction and operation	—	Construction and operation
Underwater acoustic impacts from piling driving and vessel movement	Construction and operation	—	Construction and operation	—	Construction and operation
Disturbance from boating and shipping activities including exclusion from habitat	Construction and operation	—	Construction and operation	—	Construction and operation
Introduction of hard artificial substrata (e.g. piles) into the marine environment and shading effects from wharf structures	Operation	—	Operation	—	Operation
Altered light regime	Construction and operation	—	—	—	—
Boat strike	Construction and operation	—	Construction and operation	-	Construction and operation
Introduction of pest species	Operation	—	—	—	—

— = Limited potential for impacts

6.9.1 Altered Coastal Processes

The proposed open-piled wharf jetty and berth pockets have a low potential to impact the alongshore transport of sediment. There is a greater potential for impact to the longshore beach profile and cliffs due to the increased depth of the proposed berth and departure area allowing higher wave energy to reach shore during a storm. Any impacts would be limited to a reasonably short distance both sides of the wharf trestle structure. Potential impacts would be monitored and mitigation undertaken if cliff erosion is exacerbated.

Cross-shore transport of sediment occurs during storm events and alters the nearshore morphology by forming storm sand-bars. This is a natural beach response. Modelling indicates migration of the coarser sands as bed forms would not extend far enough offshore to pose infill issues with the proposed dredged berths. However, there may be a low potential for the finer beach sands to infill the proposed dredged berth area, although the effects of this process are limited due to the small volume of this fraction of sediment in the upper beach material. Furthermore, there is a reduction in transport potential of suspended cross-shore sediment with increasing water depth towards the berth pocket.

The influence of the proposed dredging inshore on the local tidal current pattern is determined by the following:

- berth and channel dimensions (length, width and side wall slope);
- angle between the main axis and direction of approaching current;
- strength of local current; and
- local bathymetry.

The existing peak spring tide current at the location of the proposed berth pockets, averaged over depth, is 0.33m/s. After dredging, this peak current speed would reduce to an average of 0.15m/s. Current speed would decrease over the extent of the berth but would increase again when the depth reverts to the normal profile.

The primary risk that reduced currents over the proposed dredged berth would increase silt within the proposed dredge area is addressed in discussion regarding maintenance dredging in **Section 6.9.2.11**.

6.9.2 Marine Water Quality Impacts

The potential marine impacts associated with dredging and operational activities are discussed below in terms of water quality. A review of the proposed development has identified the following key sources of possible marine water quality impacts:

- port area capital dredging and disposal plume generation at proposed new spoil ground;
- dredge spoil re-suspension at the proposed spoil ground;
- inshore sediment deposition;
- capital dredging at barge and ferry terminals;
- Albatross Bay spoil ground disposal plume generation;
- introduction of contaminants during operational ship loading; and
- maintenance dredging requirements and turbid plume generation.

The key potential impacts of dredging and spoil disposal on water quality are:

- possible mobilisation of contaminants into the water column;
- generation and migration of turbid plumes;
- reduction in benthic light regimes; and
- increased local sediment deposition.

Water quality at the proposed port, new spoil ground, and proposed ferry and barge facilities all exhibit significant natural fluctuations in suspended sediment and turbidity (refer **Section 6.4.4**). The extent of this natural variation buffers water quality impacts associated with dredging, disposal, construction and operation to some extent. Generally, these habitats may be described as being more resilient to short-term water quality changes.

Periodic alterations in chemical water quality are currently experienced during event-based elevations in ambient turbidity. As fine sediments are mobilised throughout the water column, nutrient and metal concentrations naturally increase. Seasonal alterations in chemical water quality are also experienced during the monsoon and cyclone periods.

Analysis of the sediments to be dredged from the proposed port area and the barge/ferry terminals have not identified any constituents present at levels of environmental concern that would persist in the water column during dredging or sea disposal at respective spoil grounds (refer **Section 6.5.4.3** and **Section 6.5.6**).

Proposed works within the Embley River and Hey River are likely to generate turbidity concentrations that fall within the natural turbidity range. The rivers and estuaries of Cape York are subject to high ranges in turbidities over both the dry and wet seasons. The method of dredging in the Embley and Hey Rivers is likely to be by bucket or grab dredgers, which generate relatively low levels of turbidity. This is because there is no significant return of waters via overflow such as would occur through suction dredging methods. The turbidity generated would be substantially lower than that generated during routine maintenance dredging

campaigns at the Port of Weipa using the TSHD Brisbane. These campaigns so far have not demonstrated a causal link with changes in seagrass density or meadow area in the estuary. As seagrass are the most sensitive receivers, this result is a good indicator of whether dredging activities are causing significant changes in turbidity levels. The short duration of dredging in each barge/ferry terminal area (1-2 weeks) would further limit potential for impacts. Potential impacts to water quality and coral health associated with dredging activities are discussed in detail in **Section 6.9.3.1.**

The migration and dispersion of turbid plumes during major capital dredging at the proposed port area and disposal at the proposed new spoil ground has been predicted through modelling due to the significant volume of material to be dredged.

6.9.2.1 Turbid Plume Generation Modelling

The Inner Gulf hydrodynamic Mike21 model coupled with the software's mud transport module (MT) has been used to predict the fate of dredge plumes and assist in determining the potential impacts for the port area capital dredging and disposal activity.

Plume modelling included the following methodology and assumptions:

- modelled concentrations are based on suspended sediments caused by dredging and represent expected increases above background;
- the entire nine-month period estimated for the dredging works is simulated;
- dredging commenced at the most seaward location for each cut, with the berth pockets dredged last;
- simulations are based on average tide and wind conditions;
- average wind conditions, derived from the long-term record at Weipa, are used for seasonal conditions (wet, dry and transitional seasons);
- dredging works are to commence in early May at the start of the dry season and continue until work is completed; and
- two dredge time series are used to represent the operations of the cutter suction dredge (CSD) and trailing suction hopper dredge (TSHD) (discussed further below).

The tidal conditions within the simulation cover the range of tidal states experienced under normal conditions in the Project area. Modelling of worst-case wind and tide scenarios (e.g. cyclonic events) was not undertaken as dredging would not be undertaken under such conditions due to safety risks.

To predict the behaviour of the plume resulting from dredging and spoil disposal activities, fine quadrangular elements were used to resolve the berth/departure area and departure channel. Detail of the mud transport module domain (Inner Gulf model) and hydrodynamic verification is provided in **Section 6.1.2**. Wind forcing is included and based on available records at the nearby Weipa Airport Gauge.

Based on recent PSD and settling tube test information, sediment particle size distribution and settling velocities have been established for the three sediment types representing the vertical sediment profile to be dredged and incorporated within the model (refer **Table 6-41**).

Table 6-41 Dredge Material Characteristics Used in Plume Modelling

Fraction	Material	Size (mm)	Particle Size Distribution (%)			Settling velocity (mm/s)
			Layer 1 (unconsolidated marine sediments and sandy clay)	Layer 2 (stiff sandy clay)	Layer 3/4 (siltstone)	
1	Clay	<0.002	44	11	13	0.03
2	Silt	0.06–0.002	35	50	10	1
3	Fine Sand	0.2 – 0.06	10	20	47	15

The spill rates from the dredging activities vary dependent on the sediment layer, as a result of the variable sediment composition and density of the layers (**Table 6-42**). Four layers have been identified for dredging. The adopted spill rate from the TSHD during overflow for the first dredge layer is 25kg/s and has been estimated by considering the results of loss estimation undertaken for recent dredging for the Port of Melbourne Channel Deepening Project, and the material structure/density variance in the sediment profile at the proposed SoE Project port. Dredging consultants for the Project identified that the losses found from the Port of Melbourne dredging are considered consistent with other findings in the dredging industry and applicable to the South of Embley Project port dredging study. The method of dredging and size of equipment is generally consistent with that which would be applied to the developing the proposed port. A reduced spill rate of 20kg/s adopted for the second dredge layer has been interpolated from these results, and again factors in the different physical properties of the material to be dredged. The spill rate adopted for the third and fourth dredge layers has been reduced to 10kg/s. Whilst this spill rate is not supported by actual measurements, it is based on the third and fourth dredge layers representing a hard siltstone, and being of differing physical properties to the clays above.

Table 6-42 Adopted Spill Rates (kg/s) for the Dredging Scenario

Activity	Dredge parameters		Spill Rates (kg/s)		
	Production Rate	Activity time per cycle	Layer 1 (unconsolidated marine sediments and sandy clay)	Layer 2 (stiff sandy clay)	Layer 3/4 (siltstone)
CSD redepositing via near bed diffuser	1,720 m^3/hr (berths and departure area) 1,420 m^3/hr (departure channel)	2hrs (over 3hr cycle) *	1	0.8	0.4
TSHD overflow	5,000 m^3/cycle	1hr40min (over 4hr10min cycle)	25	20	10
TSHD draghead and propeller disturbance	5,000 m^3/cycle	2hrs10min (over 4hr10min cycle)	4	3.2	1.6
TSHD disposal	n/a	15min (over 4hr10min cycle)	60	60	60

CSD = Cutter suction dredge; TSHD = Trailing suction hopper dredge (TSHD)
* Remaining time in cycle spent moving the dredge and repositioning the cutter

The adopted spill rates decrease with layer depth because material strength increases with depth resulting in more large clumps and less release of fine material during dredging. Given the physical differences in material within the vertical sediment profile, as documented by PSD and core inspections, these reductions in fine material release have been extended to apply to spill rates for the CSD, and TSHD drag head and propeller disturbance.

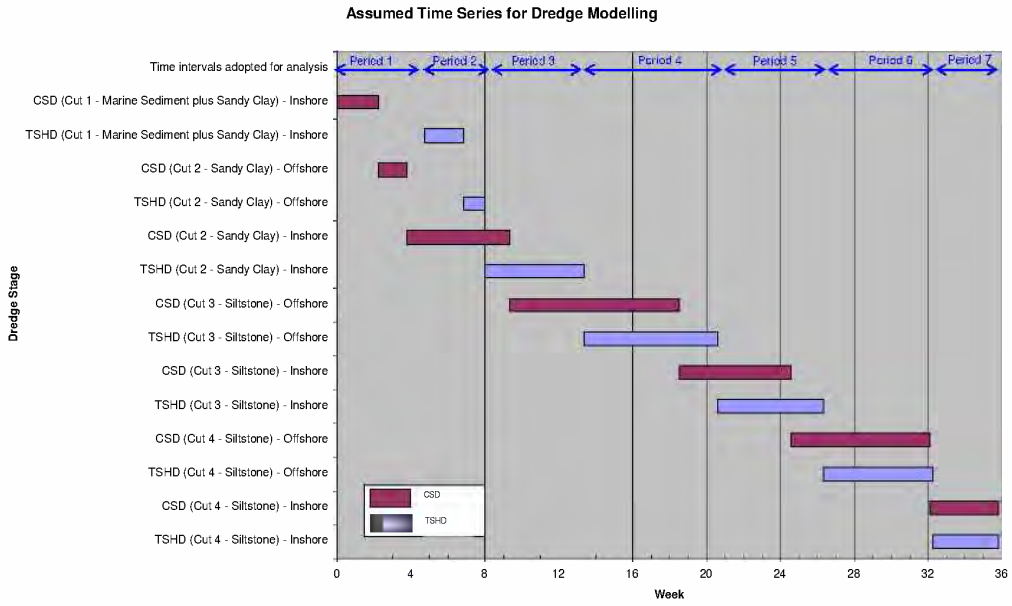
Resuspension is not included within the model predictions on the basis that there currently exists a layer of relatively fine unconsolidated material that covers a wide area of the nearshore area, and that is regularly suspended under natural conditions. Fines released from dredging will add to the unconsolidated material available for resuspension. However, the net change in material available for suspension is not considered significant.

The extent of geotechnical investigations are limited to the nearshore area surrounding the trestle and berth pockets. For areas to be dredged seaward of the extent of survey, the main assumption has been that the siltstone unit continues seaward at a similar level as identified by the nearshore boreholes (refer **Section 6.5.4.2**). This is a reasonable assumption based on the geology of the region (pers comm, Iain Turner, Coffey Geotechnics).

The dredge operation is simulated assuming the combined use of a CSD and TSHD. Approximately 6.5 million cubic metres of material is to be dredged within a 36-week period starting at the beginning of the dry season (early May) and continuing until work is completed (January). This 36-week dredging period does not allow for any delays such as for breakdowns

or maintenance, which would extend the duration of dredging but also interrupt suspended sediment plume generation. Based on *Boyd Point Facility for Cape-Size Vessels Review of Options for Dredging and Disposal of Dredged Materials* (SKM 2010) and in consultation with Pro Dredging & Marine Consultants, the adopted time series of the two dredges is shown in **Figure 6-58**. The dredging schedule has been divided into seven distinct periods. The TSHD has been assumed to commence dredging 33 days after the CSD in order for the two dredgers to complete the operation at approximately the same time.

A turbid plume would eventuate as material is released to the water column during the operation of the CSD and TSHD dredgers. The plume would be reasonably uniform over the local water depth due to the well-mixed tidal hydrodynamics and the predominantly fine silt and clay bed material. Clay and silt with a lower settling velocity may remain in the water column for long periods (days) and a low concentration plume may disperse for several kilometres in the direction of the tide.



Legend: CSD = Cutter suction dredge; TSHD = Trailing suction hopper dredge

Figure 6-58 Dredge Time Series Adopted for Mud Transport Model Runs

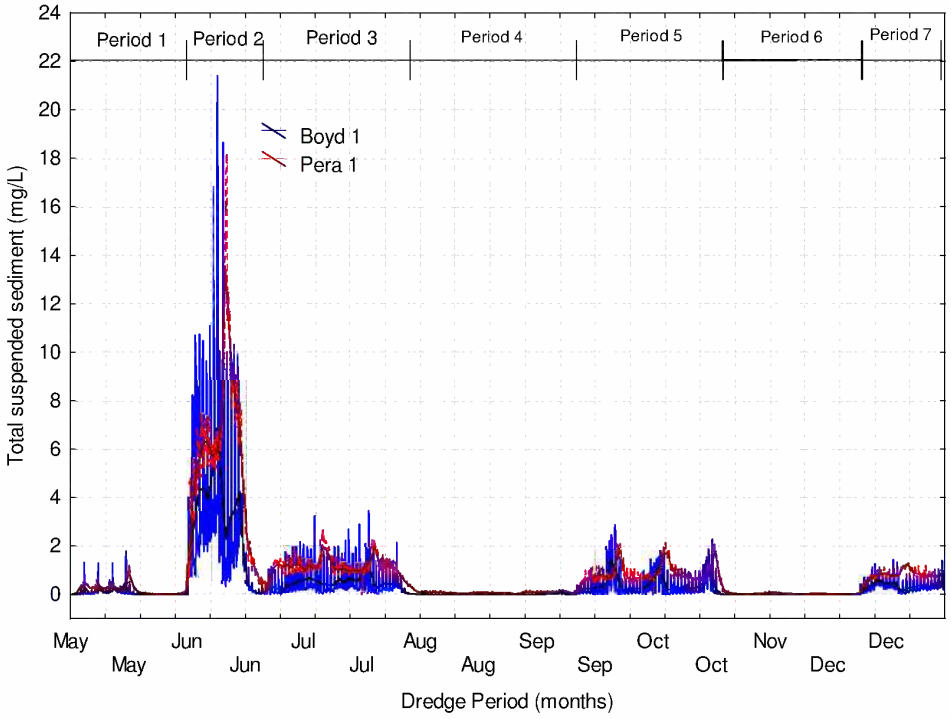
Plumes are advected by current strength and direction; therefore the individual flood and ebb tide phases influence their shape and trajectory, as do spring and neap tide phases. Model results of the dredge plume during approximately 36 weeks of continuous dredging were examined.

6.9.2.2 Port Area Capital Dredging Turbid Plume Generation

Model outputs identify that during flood tides the turbid plume generated by port area capital dredging extends parallel, along the coast from the dredge location to beyond Pera Head. During the flood tide phase, Boyd Point experiences relief from the increased TSS concentration. During the ebb tide the dredge plume extends along the coast extending from Pera Head to Boyd Point. In contrast to Boyd Point, Pera Head does not experience total relief from the increased TSS concentration. This is due to the net south-west tidal current direction causing suspended material to accumulate between the proposed port and Pera Head.

Modelled TSS time series data from Pera 1 (Pera Head) and Boyd 1 (Boyd Point) have been divided into the seven distinct dredging periods (refer **Table 6-43**) and are shown in **Figure 6-59**). Refer to **Figure 6-61** for locations. Periods of high TSS concentration generally coincide with the TSHD operating in the inshore area (i.e. in the berths and departure area). Period 1

represents an initial phase of inshore and offshore dredging of layer 1 using just a CSD, and as a result TSS concentrations remain relatively low throughout this period. The remaining six periods all include both CSD and TSHD operation with the spill rates varying depending on which layer is being dredged and the location of the dredges. Following dredge cut 1, the CSD makes a relatively minor contribution to the overall TSS concentrations. Period 2 represents dredging of layer 1 in the inshore area by the TSHD, while Period 3 represents dredging of layer 2 in the inshore area by the TSHD. Periods 4 and 5 represent dredging of layer 3 by the TSHD in the offshore and inshore areas respectively, while Periods 6 and 7 represent dredging of layer 4 by the TSHD in the offshore and inshore areas respectively.



Note: Bold lines represent rolling daily averages

Figure 6-59 Above Background TSS Concentration Time Series Extract at Pera 1 and Boyd 1

Table 6-43 Dredge Event Duration and Median Plume TSS Concentration Above Background at Pera 1

Plume Period	Dredge Event Duration (days)	Median Plume TSS (mg/L) above background – Pera 1
1	33	0.2
2	25	5.3
3	36	1.1
4	54	0.1
5	39	0.8
6	40	0
7	25	0.8

The median and 80th percentile of the TSS concentrations from the dredge plume dispersion model have been plotted spatially for Periods 2, 3 and 4 (**Figure 6-60 a, b and c respectively**) as representing inshore and offshore dredging for sediment layers 1, 2 and 3, respectively. Periods 5-7 are not shown to avoid duplication as their TSS concentrations are suitably represented by periods 3 and 4 (refer **Figure 6-59**). Dredge plumes may not cover the

entire dredge footprint as the different periods reflect different locations of dredging (inshore versus offshore) as described in **Section 6.9.2.1**. Summary statistics from key locations (refer **Figure 6-61**) for all seven periods are shown in **Table 6-44**. These locations include extract points from Pera Head, Boyd Point, Thud Point and the Boyd Bay beach area.

Modelling results indicate the Boyd Point reef area will experience greater respite from dredge plume migration than Pera Head and locations south (refer **Figure 6-59** and **Figure 6-60a-c**). Under ambient conditions, Boyd Point and Pera Head reef areas demonstrate a high variation in turbidity, driven primarily by local wind and associated wave events. Pera Head data loggers deployed during 2007–2008 recorded turbidity event periods of 9 and 24 days duration at median event concentrations of 248 and 127mg/L respectively (refer **Figure 6-33** in **Section 6.4.4**). Data captured from Boyd Point (GHD 2008) reported ambient events of 23 and 25 days duration, recording median event TSS concentrations of 163 and 184 mg/L respectively (refer **Figure 6-34** in **Section 6.4.4**). Respite between these events for both locations was approximately 13 days.

Median plume concentrations from all periods remain below event based ambient ranges reported from reef habitats (refer **Table 6-44**). Summary of plume duration and concentrations above background (ambient median TSS = 15mg/L) at Pera 1 is provided within **Table 6-43**. Modelling results indicate Thud Point locations south of Pera Head will experience similar patterns of TSS increases as predicted for Pera Head and Boyd Point during the seven periods but with a significant reduction in scale (refer **Figure 6-62**).

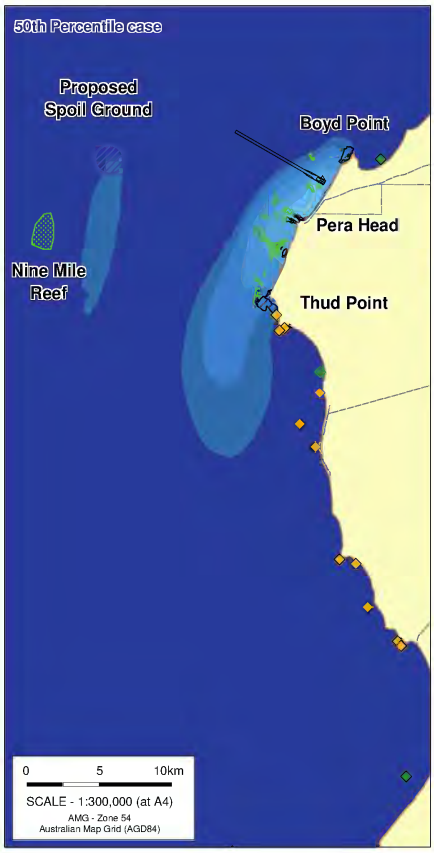
The durations of TSS plume concentrations at or above 5, 10 and 15mg/L above background (ambient median TSS = 15mg/L) have been extracted from the model for plume Periods 2 and 3 (refer **Figure 6-63a-c** respectively**)**. This is a duration-based plot based on percentage occurrence of concentrations for Periods 2 and 3. The 5mg/L case extends to 1-2km north of Thud Point during Period 2, while during Period 3 it remains local to the dredge. The 10mg/L case during Period 2 extends from Pera Head to Boyd Point, while during Period 3 it is restricted to within the immediate location of the area to be dredged. Results show that concentrations in excess of 15mg/L are not predicted to occur beyond Pera Head or Boyd Point for any of the periods for over 5% of the time. It is only during Period 2 that TSS concentrations in excess of 15mg/L occur for more than 5% of the time, and these concentrations do not occur for more than 20% of the time. Period 4 TSS concentrations do not exceed 5mg/L, so an exceedance figure is not presented.

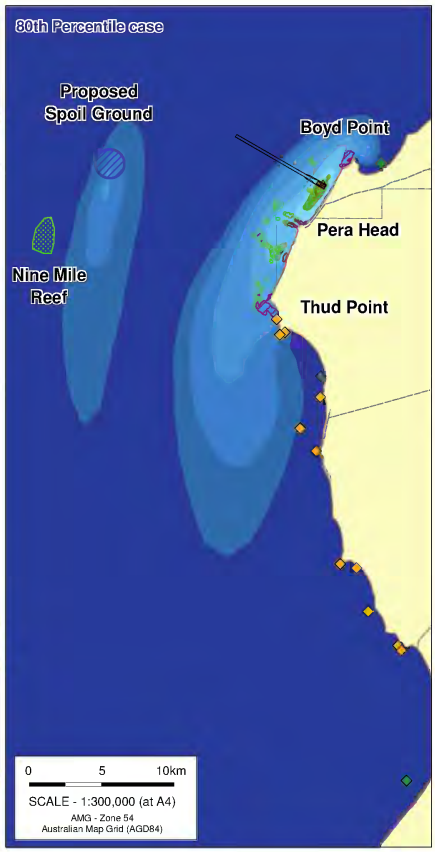
Given a predicted peak plume period of approximately 25 days (approximately the same as natural event durations of 30 days), only areas identified within **Figure 6-63** as having a duration exceedance approaching 100% may be described as approaching the currently understood limits of natural conditions. Given this comparison, plume duration effects at the 15mg/L concentration beyond that encountered during ambient events are not experienced throughout any of the dredge periods.

6.9.2.3 Proposed Spoil Ground Turbid Plume Generation

Modelling of turbid plumes at the proposed new spoil ground identified a median TSS concentration of less than 1mg/L above background and a maximum of 13mg/L above background (refer **Table 6-45**) over the dredging and disposal period of 36 weeks. These concentrations at the proposed new spoil ground are relatively low due to an increased dilution within the water column (i.e. depth averaged concentration), low duration (disposal approximately every four hours) and prevailing southerly currents providing dispersion.

The disposal plumes tend to disperse along a south-south-east trajectory due to tidal currents and are not predicted to impact Nine Mile Reef, which is located approximately 6km south-south-west of the spoil ground (refer **Figure 6-60a-c**). Modelling has predicted that a median TSS of less than 0.2mg/L and maximum of 1.2mg/L above background would occur over Nine Mile Reef (refer **Table 6-45**). These increases are negligible given background TSS characteristics at offshore areas, as represented by existing conditions at the proposed spoil ground where recorded TSS concentrations had a median of 33mg/L, mean of 135mg/L and maximum of 1056mg/L during the Project's in-situ logger program (refer to **Section 6.4.4.1**).





LEGEND

- Towns
- Unconfirmed reef locations
- Seagrass locations - indicative
- Roads and tracks
- Dredge area
- Proposed new spoil ground

Indicative Reef Classes

- Hard coral
- Soft coral or sponge

Median TSS above ambient mg/L

- 0.25 to 0.5
- 0.5 to 1
- 1 to 2
- 2 to 3
- 3 to 4
- 4 to 5
- 5 to 6
- 6 to 7
- 7 to 8
- 8 to 9
- 9 to 10
- 10 to 11
- 11 to 12
- 12 to 13
- 13 to 14
- 14 to 15
- 15 to 16

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Indicative Seagrass Locations
Queensland Seagrass Meadows 1984-1988 Department of Primary Industries and Fisheries 2002
Coastal Habitat Resources Information System http://chrisweb.dpi.qld.gov.au/CHRIS/
Pers. Comm. Michael Rasheed, 2010

Modeled dredge plume point data provided by WorleyParsons Newcastle office on 19/07/2010.

Rev	Date	Revision Description	ORIG	CHK	ENG	APPD
C	02/11/2010	Re-issued for information	JMM	DH		
B	27/07/2010	Re-issued for information	KM	NA		
A	27/07/2010	Issued for information	MM	NA		

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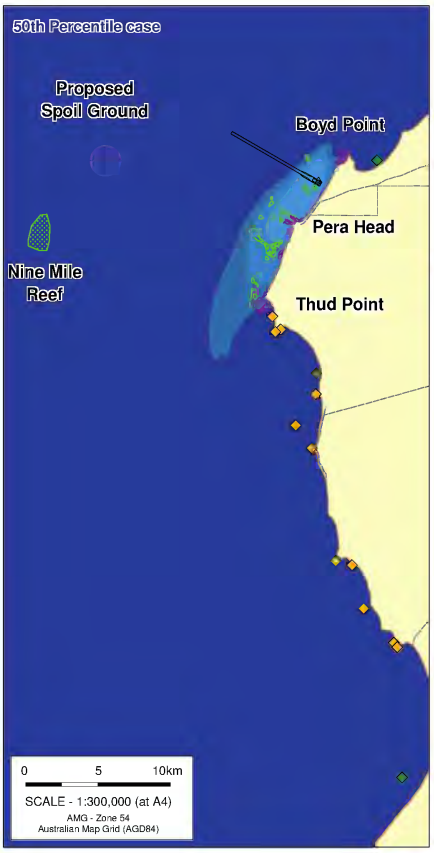
South of the Embley Project

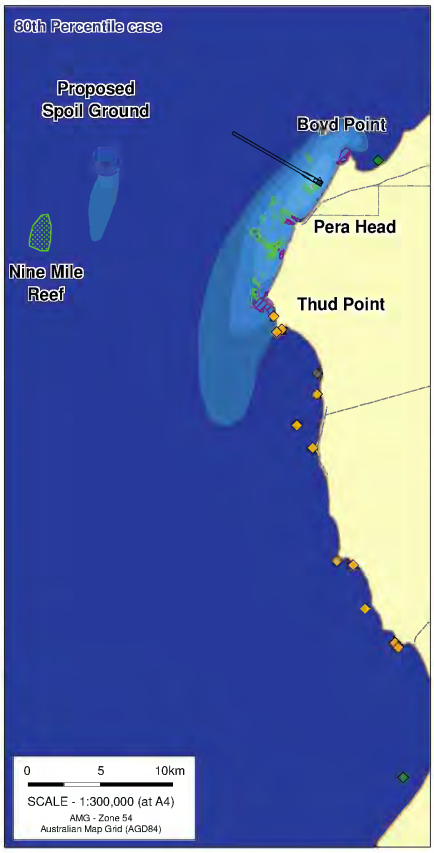
Figure 6-60a - Dredge plume dispersion model (median and 80th percentile cases) for port area dredging and disposal at proposed new spoil ground (Period 2)

Project No: 301001-01069	Figure: 01069-00-GM-EN-0010	Rev: C

Compiled by BRISBANE GEOMATICS

K:\RTA\301001-01069\GM\DAL\01069-00-GM-EN-0010-C(TSS_Period_2).wor





LEGEND

- Towns
- Unconfirmed reef locations
- Seagrass locations - indicative
- Roads and tracks
- Dredge area
- Proposed new spoil ground

Indicative Reef Classes

- Hard coral
- Soft coral or sponge

Median TSS above ambient mg/L

- 0.25 to 0.5
- 0.5 to 1
- 1 to 2
- 2 to 3
- 3 to 4
- 4 to 5
- 5 to 6
- 6 to 7
- 7 to 8
- 8 to 9
- 9 to 10
- 10 to 11
- 11 to 12
- 12 to 13
- 13 to 14
- 14 to 15
- 15 to 16

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Indicative Seagrass Locations
Queensland Seagrass Meadows 1984-1988 Department of Primary Industries and Fisheries 2002
Coastal Habitat Resources Information System http://chrisweb.dpi.qld.gov.au/CHRIS/
Pers. Comm. Michael Rasheed, 2010

Modeled dredge plume point data provided by WorleyParsons Newcastle office on 19/07/2010.

Rev	Date	Revision Description	ORIG	CHK	ENG	APPD
C	02/11/2010	Re-issued for information	JMM	DH		
B	28/07/2010	Re-issued for information	KM	NA		
A	27/07/2010	Issued for information	MM	NA		

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South of the Embley Project
Figure 6-60b - Dredge plume dispersion model (median and 80th percentile cases) for port area dredging and disposal at the proposed new spoil ground (Period 3)

Project No: 301001-01069	Figure: 01069-00-GM-EN-0011	Rev: C

Compiled by BRISBANE GEOMATICS

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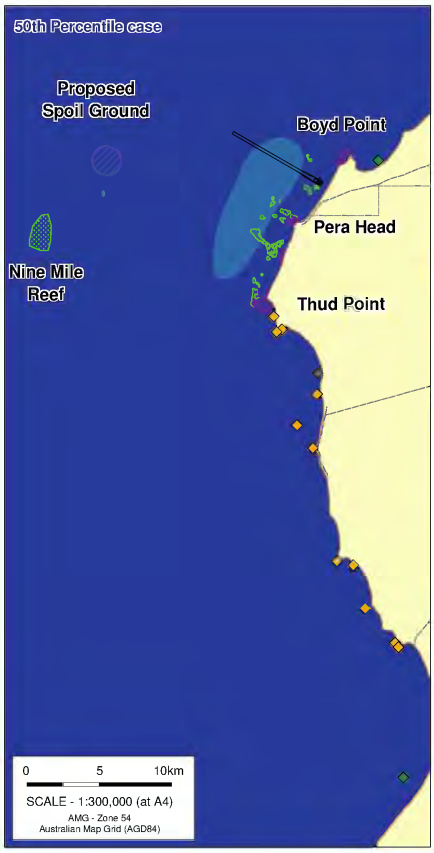

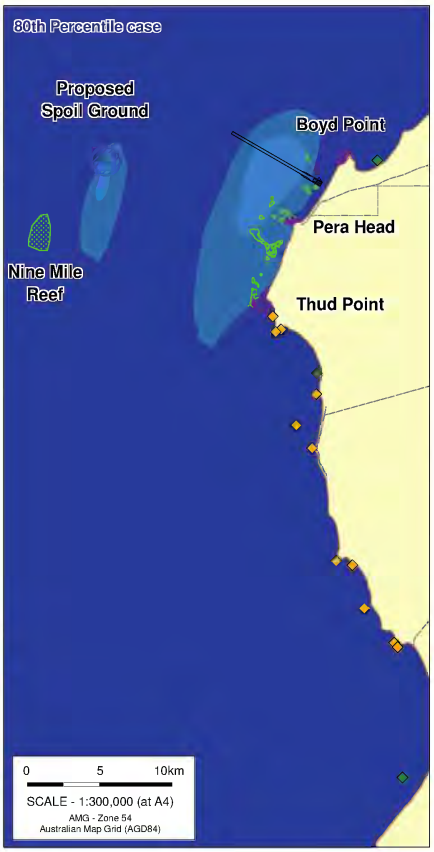

LEGEND

- Towns
- Unconfirmed reef locations
- Seagrass locations - indicative
- Roads and tracks
- Dredge area
- Proposed new spoil ground

Indicative Reef Classes

- Hard coral
- Soft coral or sponge

Median TSS above ambient mg/L

- 0.25 to 0.5
- 0.5 to 1
- 1 to 2
- 2 to 3
- 3 to 4
- 4 to 5
- 5 to 6
- 6 to 7
- 7 to 8
- 8 to 9
- 9 to 10
- 10 to 11
- 11 to 12
- 12 to 13
- 13 to 14
- 14 to 15
- 15 to 16

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Indicative Seagrass Locations
Queensland Seagrass Meadows 1984-1988 Department of Primary Industries and Fisheries 2002
Coastal Habitat Resources Information System http://chrisweb.dpi.qld.gov.au/CHRIS/
Pers. Comm. Michael Rasheed, 2010

Modeled dredge plume point data provided by WorleyParsons Newcastle office on 19/07/2010.

Rev	Date	Revision Description	ORIG	CHK	ENG	APPD
A	02/11/2010	Issued for information	JMM	DH		

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Figure 6-60c - Dredge plume dispersion model (median and 80th percentile cases) for port area dredging and disposal at the proposed new spoil ground (Period 4)

Project No: 301001-01069	Figure: 01069-00-GM-EN-0028	Rev: A

Compiled by BRISBANE GEOMATICS

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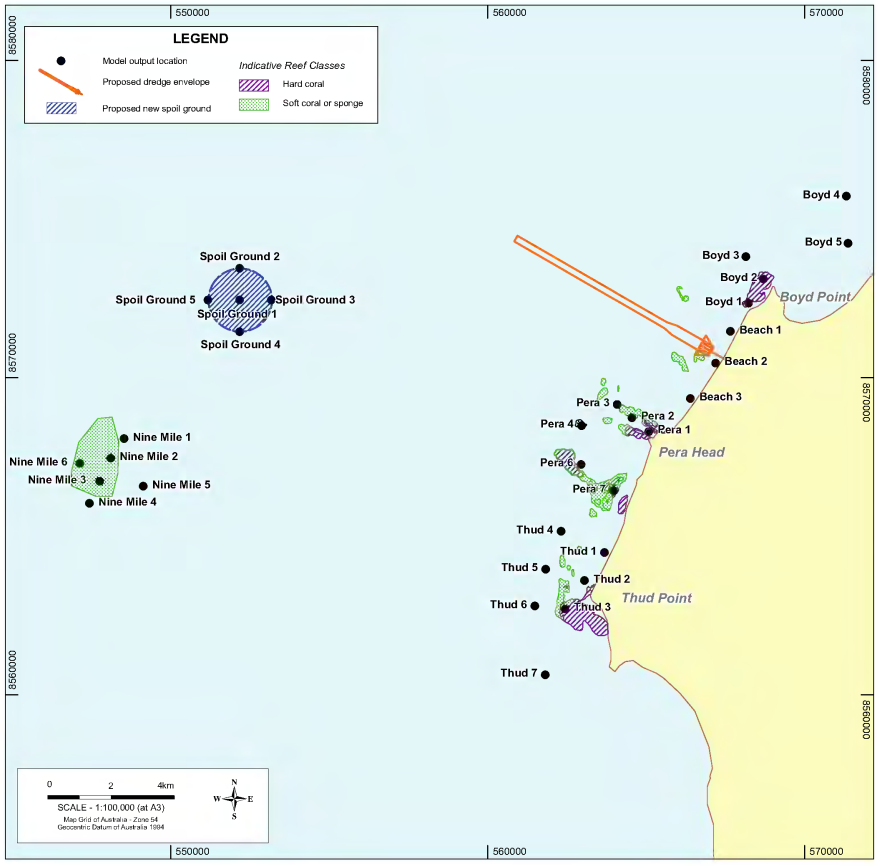

Note:
Model output locations are points selected from hydrodynamic model to provide data for characterisation of turbidity plumes for seven dredge periods. Statistics are provided in Table 6-44 and Table 6-45. Selected inshore locations also provide data to characterise sediment deposition rates in Table 6-46.

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Rev	Date	Revision Description	DRN	CHK	ENG	APPD
B	01/04/2011	Re-issued for review	DH	MM		
A	20/07/2010	Issued for squad check	KM	MZ		

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SOUTH OF THE EMBLEY PROJECT

Figure 6-61 Location of modelled time series extracts

Project No: 301001-01069	Figure: 01069-00-GM-DAL-0004	Rev: B

Compiled by BRISBANE GEOMATICS

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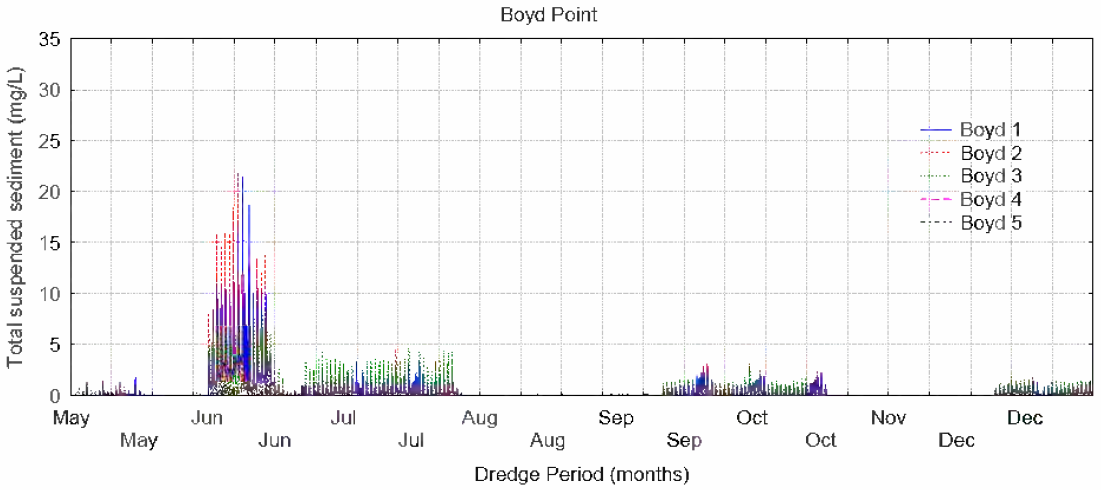
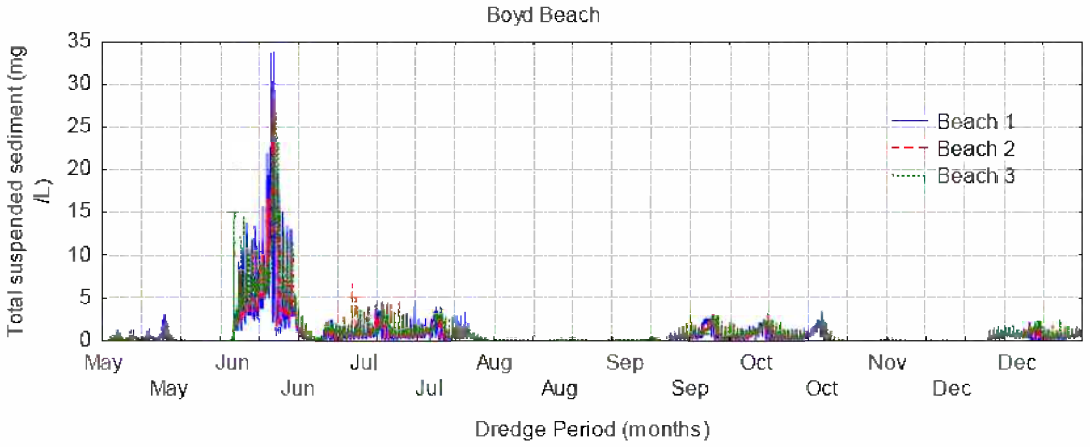
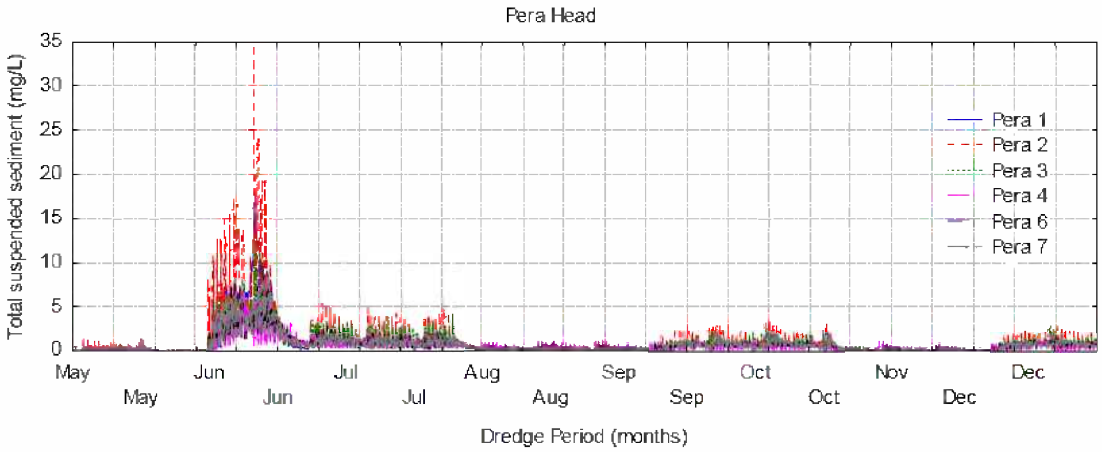
Table 6-44 Above Background TSS Summary Statistics for Plumes at Inshore Locations (refer Figure 6-61 for locations)

Location	Mean TSS (mg/L)							Median TSS (mg/L)							80th Percentile TSS (mg/L)							Maximum TSS (mg/L)						
Period	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Boyd Bay Beach																												
Beach 1	0.2	4.4	0.9	0.1	0.8	0	0.5	0	2.3	0.6	0	0.6	0	0.5	0.2	7.1	1.3	0.1	1.3	0	0.8	3	33.8	4.4	1.9	3.4	0.3	2.2
Beach 2	0.2	4.7	1.1	0.1	0.9	0	0.7	0	3.2	0.8	0	0.8	0	0.6	0.3	7.9	1.5	0.1	1.3	0	1	2.6	29.2	6.6	1.2	3.2	0.8	2.5
Beach 3	0.2	5.3	1.3	0.1	1	0	0.8	0.1	4.5	1.1	0	0.9	0	0.7	0.3	8.4	1.6	0.1	1.4	0	1.1	2.3	26.6	4.4	1.2	3.2	0.9	2.3
Boyd Point Reef																												
Boyd 1	0.1	2.6	0.5	0	0.5	0	0.4	0	1.5	0.3	0	0.2	0	0.3	0.1	3.9	0.9	0	0.8	0	0.6	1.8	21.4	3.5	2.1	2.9	0.1	1.4
Boyd 2	0	1.5	0.3	0	0.3	0	0.3	0	0.4	0.1	0	0	0	0.2	0	2.3	0.4	0	0.6	0	0.5	1.4	21.8	4.6	3.4	3.1	0.1	2
Boyd 3	0.1	1.4	0.7	0	0.4	0	0.3	0	0.3	0.1	0	0	0	0	0.1	3.3	1.5	0	0.8	0	0.8	0.9	9.5	4.7	4.3	2.9	0.1	1.6
Boyd 4	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	1.5	0.3	0.1	0.1	0	0.1
Boyd 5	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	2.2	0.2	0.1	0	0	0.3
Pera Head Reef																												
Pera 1	0.2	4.8	1.2	0.1	0.9	0.1	0.8	0.2	5.3	1.1	0.1	0.8	0	0.8	0.3	7.2	1.4	0.1	1.1	0.1	1	1.3	18.2	2.7	1.1	2.1	0.8	1.4
Pera 2	0.2	5.1	1.6	0.2	1.1	0.1	1	0.1	4.4	1.3	0.2	1	0.1	0.9	0.3	7.1	2.1	0.3	1.4	0.1	1.2	1.5	34.8	5.4	1.6	3.6	1.1	2.8
Pera 3	0.2	3.1	1.4	0.3	0.8	0.1	0.8	0.1	2.8	1.2	0.2	0.8	0.1	0.8	0.3	4.7	1.8	0.5	1	0.2	1	0.8	16.7	3.6	1.5	2.3	1	2.9
Pera 4	0.1	2	0.8	0.4	0.5	0.2	0.5	0.1	1.6	0.7	0.3	0.5	0.2	0.4	0.1	2.8	1	0.5	0.7	0.3	0.7	0.4	9.8	2.2	1.3	1.3	1.1	1.7
Pera 6	0.1	2.7	1	0.3	0.7	0.2	0.7	0.1	2.2	0.9	0.3	0.6	0.1	0.6	0.2	4.1	1.5	0.4	0.9	0.2	0.9	0.4	10.2	2.8	1.2	1.6	0.8	1.8
Pera 7	0.1	2.9	1	0.2	0.8	0.1	0.7	0.1	2.5	0.9	0.2	0.7	0.1	0.7	0.2	4.7	1.4	0.3	1.1	0.2	0.9	0.4	8.2	2.2	1.2	2.1	0.9	1.4
Reefs between Pera Head and Thud Point																												
Thud 1	0.1	2	0.7	0.2	0.5	0.1	0.5	0.1	1.7	0.6	0.2	0.4	0.1	0.5	0.2	3.4	1	0.3	0.7	0.1	0.7	0.3	6.8	1.6	0.9	1.4	0.8	1.2
Thud 2	0.1	1.6	0.6	0.2	0.4	0.1	0.4	0	1.1	0.5	0.1	0.3	0.1	0.4	0.1	2.7	0.9	0.3	0.7	0.1	0.6	0.3	6.6	1.6	0.9	1.2	0.8	1.1
Thud 3	0.1	1.2	0.4	0.2	0.3	0.1	0.3	0	0.7	0.3	0.1	0.2	0.1	0.3	0.1	2.2	0.8	0.2	0.6	0.1	0.6	0.3	5.6	1.4	0.9	1	0.8	1
Thud 4	0.1	1.8	0.7	0.3	0.5	0.2	0.5	0.1	1.5	0.6	0.2	0.5	0.1	0.4	0.1	2.7	1	0.4	0.7	0.2	0.7	0.4	7.2	2.1	0.9	1.5	0.8	1.4
Thud 5	0.1	1.3	0.5	0.2	0.4	0.1	0.4	0	1.1	0.5	0.2	0.3	0.1	0.4	0.1	2.1	0.7	0.4	0.5	0.2	0.5	0.3	5.7	1.5	0.9	0.9	0.7	1
Thud 6	0.1	1.1	0.4	0.2	0.3	0.1	0.3	0	0.9	0.4	0.1	0.3	0.1	0.3	0.1	1.8	0.6	0.3	0.5	0.2	0.4	0.3	4.9	1.1	0.8	0.8	0.6	0.8
Thud 7	0	0.8	0.3	0.1	0.2	0.1	0.2	0	0.6	0.2	0.1	0.1	0.1	0.2	0.1	1.3	0.5	0.2	0.4	0.1	0.4	0.2	3.4	0.9	0.7	0.8	0.6	0.7


Boyd Point
Total suspended sediment (mg/L)
0
5
10
15
20
25
30
35
Boyd 1
Boyd 2
Boyd 3
Boyd 4
Boyd 5
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Dredge Period (months)


Boyd Beach
Total suspended sediment (mg/L)
0
5
10
15
20
25
30
35
Beach 1
Beach 2
Beach 3
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Dredge Period (months)


Pera Head
Total suspended sediment (mg/L)
0
5
10
15
20
25
30
35
Pera 1
Pera 2
Pera 3
Pera 4
Pera 6
Pera 7
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Dredge Period (months)

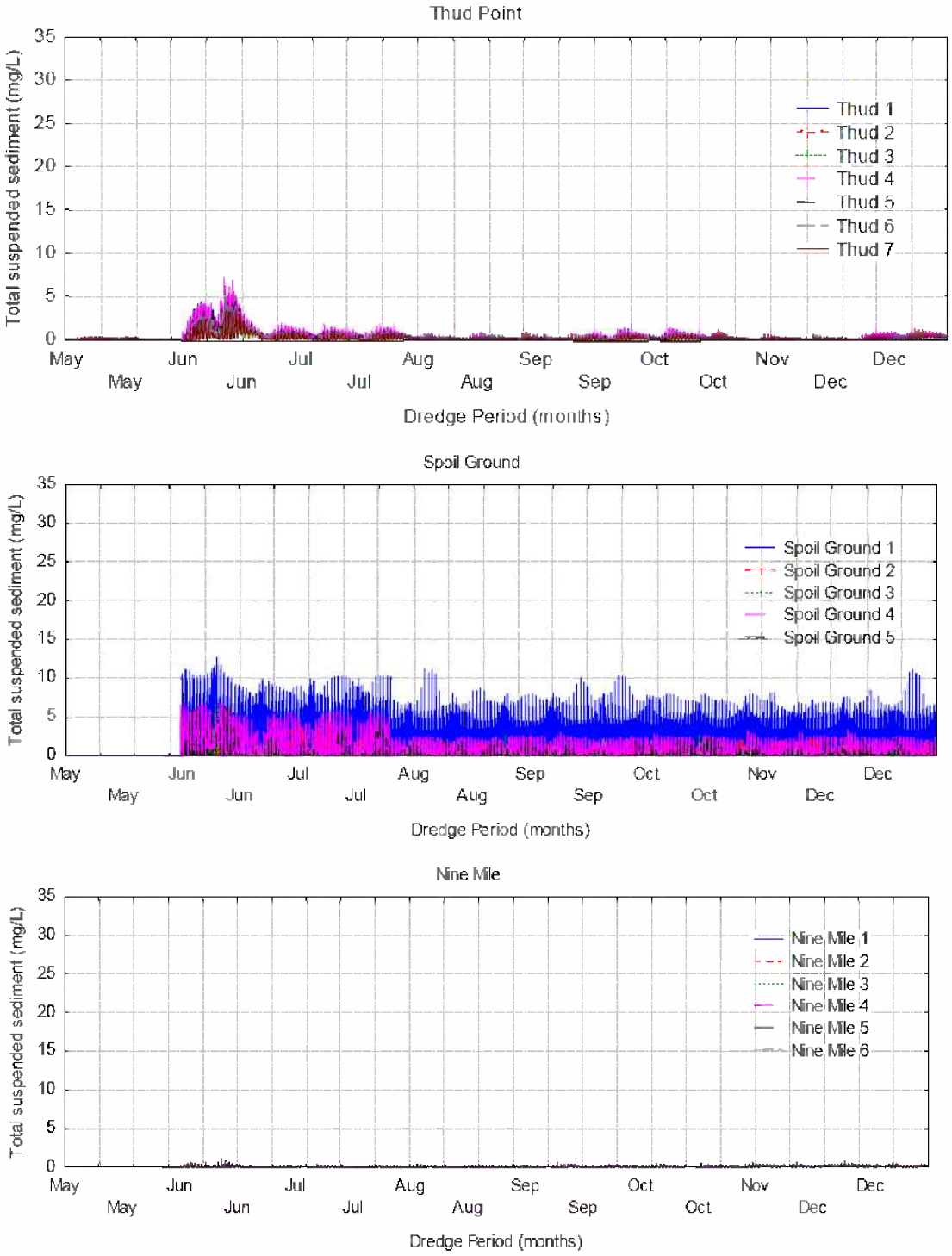


Figure 6-62 Time Series Extract from the Plume Model over the Nine-Month Dredge Period

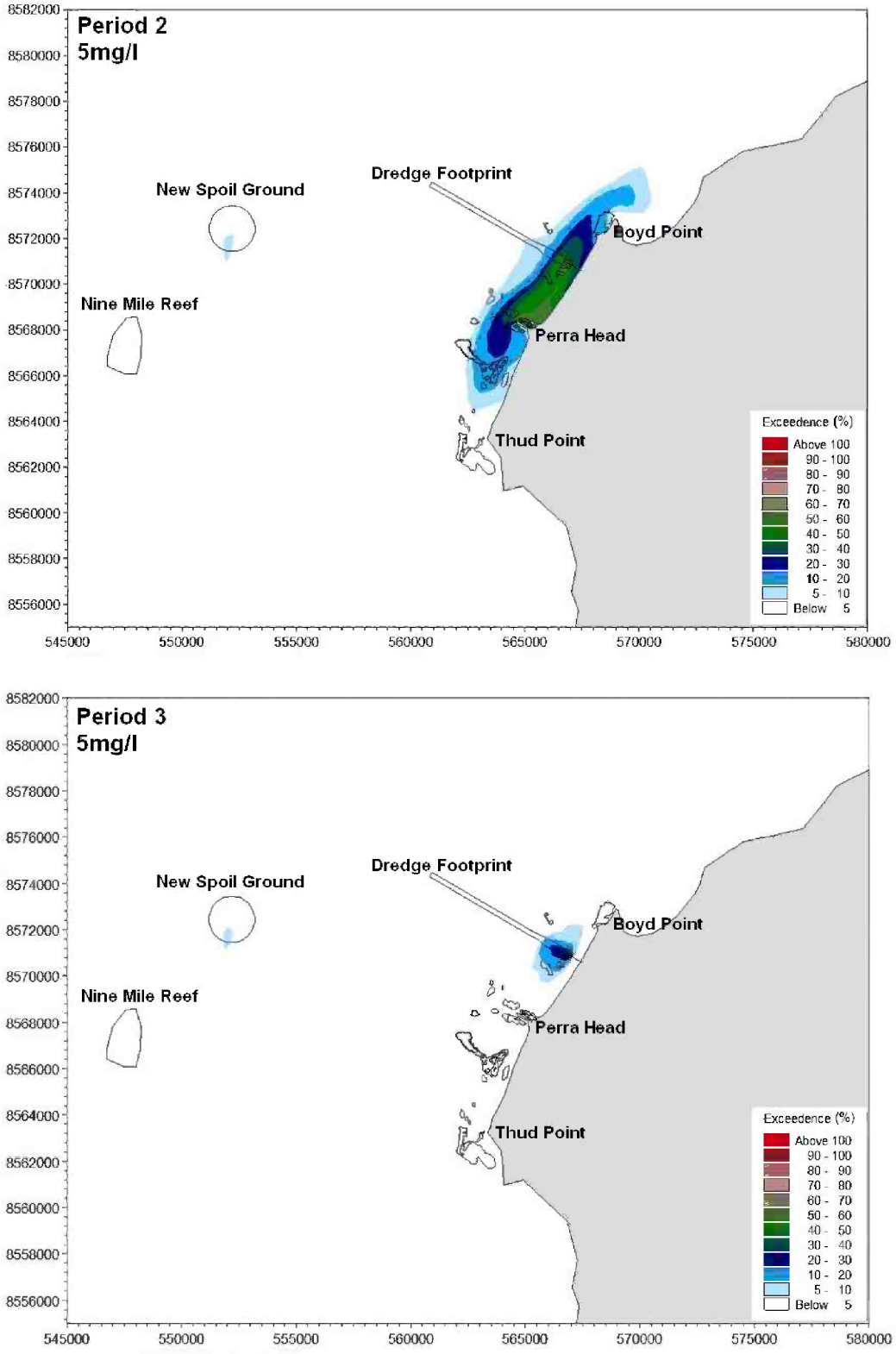


Figure 6-63a 5 mg/L Percentage Exceedance Plots for Dredge Period 2 (top) and Dredge Period 3 (bottom).

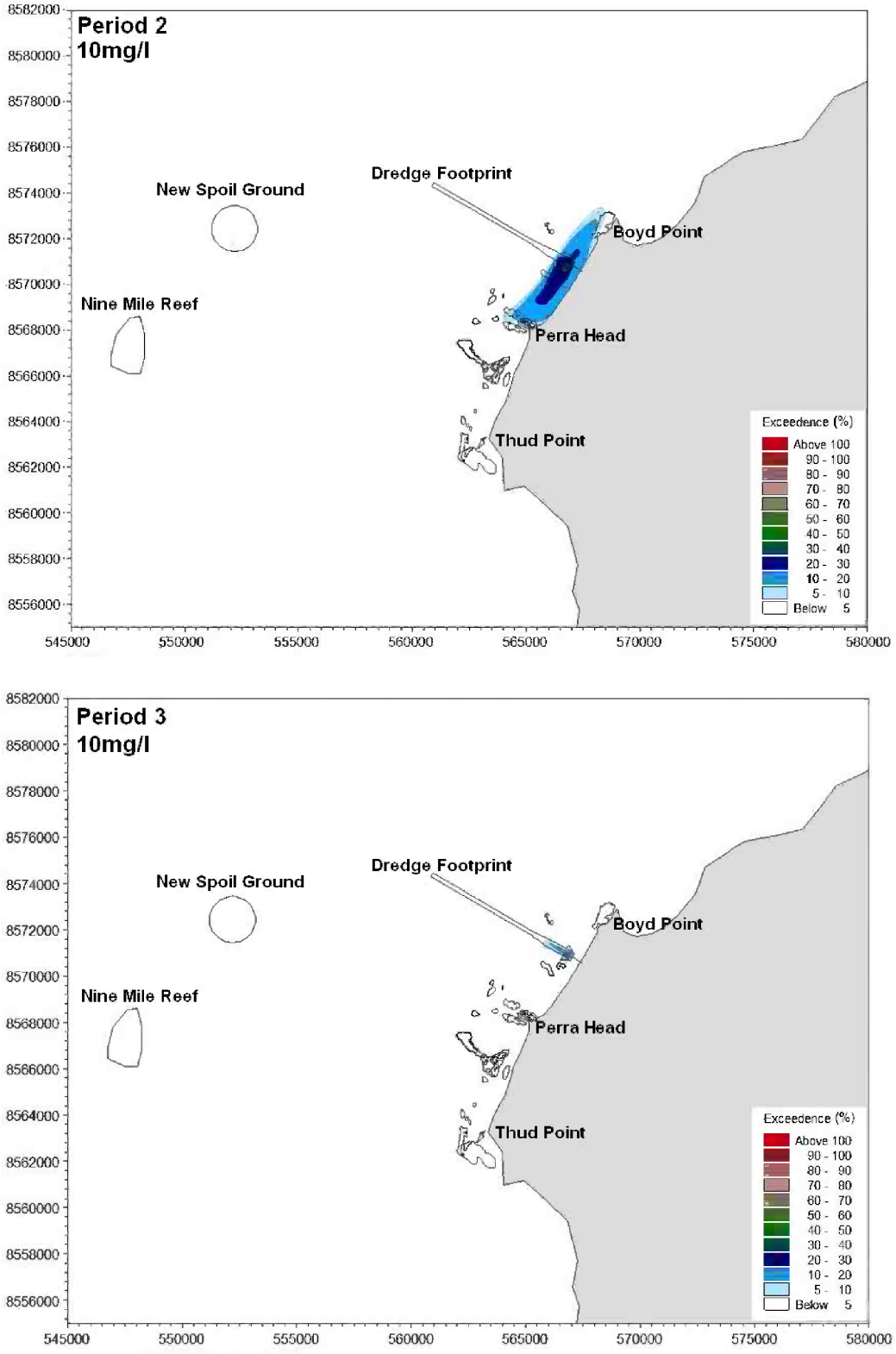


Figure 6-63b 10 mg/L Percentage Exceedance Plots for Dredge Period 2 (top) and Dredge Period 3 (bottom).

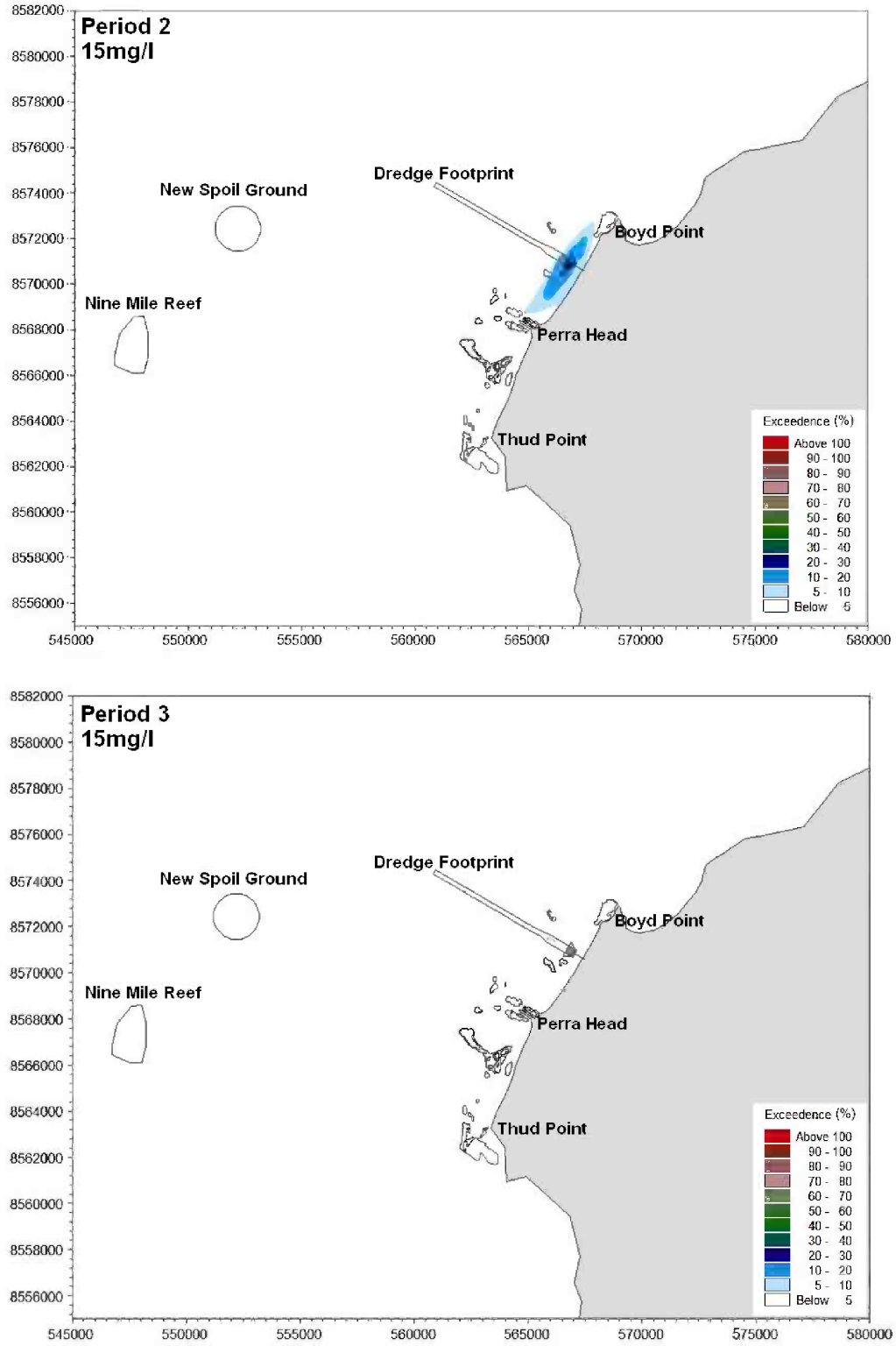


Figure 6-63c 15 mg/L Percentage Exceedance plots for Dredge Period 2 (top) and Dredge Period 3 (bottom).

Table 6-45 Above Background Total Suspended Solids Summary Statistics for Dredge Plumes at the Proposed Spoil Ground and Nine Mile Reef (refer Figure 6-61 for locations).

Location	Mean TSS (mg/L)							Median TSS (mg/L)							80th Percentile TSS (mg/L)							Maximum TSS (mg/L)						
Period	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Proposed Spoil Ground																												
SG 1	0	1.5	1.2	0.9	0.9	1	0.8	0	0.4	0.2	0.2	0.2	0.3	0.2	0	2.4	1.6	1.4	1.3	1.5	1.1	0	12.7	10.3	11.2	10.3	8.1	11.1
SG 2	0	0.3	0.2	0.2	0.2	0.2	0.2	0	0.1	0.1	0.1	0.1	0.1	0.1	0	0.5	0.2	0.2	0.3	0.3	0.3	0	5.6	4.7	2.2	2.4	2.4	1.9
SG 3	0	0.5	0.2	0.3	0.3	0.2	0.1	0	0.3	0.1	0.2	0.2	0.1	0.1	0	0.6	0.2	0.4	0.4	0.3	0.2	0	6.6	2.5	2.8	2.6	1.6	1.6
SG 4	0	0.9	0.6	0.5	0.5	0.5	0.5	0	0.4	0.2	0.3	0.3	0.2	0.2	0	1.3	0.7	0.7	0.8	0.8	0.7	0	7.1	5.7	3	2.9	3.3	2.8
SG 5	0	0.3	0.1	0.1	0.1	0.2	0.2	0	0.1	0	0	0.1	0.1	0.1	0	0.3	0.1	0.2	0.2	0.3	0.3	0	6.9	4.8	2.3	2.5	2.5	2.4
Nine Mile Reef																												
NM 1	0	0	0	0	0	0.1	0.1	0	0	0	0	0	0	0.1	0	0.1	0	0	0.1	0.1	0.2	0	0.5	0.2	0.3	0.3	0.5	0.5
NM 2	0	0	0	0	0	0.1	0.1	0	0	0	0	0	0	0.1	0	0	0	0	0.1	0.1	0.1	0	0.4	0.1	0.2	0.3	0.4	0.4
NM 3	0	0	0	0	0	0.1	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0.1	0	0.3	0.1	0.2	0.2	0.3	0.4
NM 4	0	0	0	0	0	0.1	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0.1	0	0.3	0.1	0.2	0.2	0.3	0.4
NM 5	0	0.1	0.1	0.1	0.1	0.1	0.2	0	0.1	0	0	0.1	0.1	0.2	0	0.2	0.1	0.1	0.2	0.2	0.2	0	1.2	0.3	0.6	0.7	0.7	0.8
NM 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0.1	0	0.2	0.1	0.1	0.1	0.2	0.2

6.9.2.4 Dredge Spoil Re-suspension at the Proposed Spoil Ground

The composition of in-situ bed material at the proposed spoil ground is 20% gravel, 57% sand, and 23% fines (silt and clay fractions) (refer **Section 6.5.5**). A substantial proportion of the material to be dredged is anticipated to be present in the dredge hopper as chunks of clay and siltstone. The silt clay fraction in the material to be dredged decreases with depth, with silts and clays representing approximately 79% in unconsolidated clays near the sediment surface, 61% in lower stiff sandy clays and 23% in the deeper siltstone material (refer **Section 6.5.4.2** and **Table 6-41**). Because of their mass, these chunks of material would not be easily remobilised by normal tidal currents and waves, and are unlikely to be mobilised in storm events. The hydrodynamic model predicts that maximum currents are not strong enough to transport substantial amounts of material from the spoil area during the disposal process. Although the flood tide current (peak value 0.3m/s) is the same as the ebb tide current, it lasts longer, resulting in a net drift towards the south-west.

Stronger currents associated with tropical cyclone activity, together with wind driven currents, are important to the long-term fate of spoil ground sediments. Currents may reach 2m/s or more in a severe storm that could track across the proposed new spoil ground from a wide range of directions.

Large waves may occur at the proposed new spoil ground site due to the depth of water. However, the percentage exceedance curves from the DERM wave buoy data in Albatross Bay indicate large waves only occur for brief periods, usually in the summer months. Significant wave heights, greater than 3m, occur only 0.1% of the time.

Sediment transport calculations were undertaken to assess the potential for spoil ground remobilisation based on the following:

- spoil ground characteristics;
- dredge material to be disposed of; and
- current and wave conditions specific to the site.

Results show the transport of the sand fraction increases with increasing current speed and wave height.

Spring and neap tide currents, less than 0.3m/s at the proposed new spoil ground site without wave action, do not transport sand because bed-stresses are too low. Sand transport, in combination with normal peak spring tide currents, is predicted to occur only under larger significant wave heights (greater than 2m) at the proposed spoil ground.

A current speed of 1.4m/s at the proposed spoil ground, combined with 3m significant wave heights (6 hour storm duration), has a capacity to transport approximately 4% of the sand material disposed during capital dredging. This remobilisation is considered to have a low potential impact because of the quantity involved and the limited extent of migration due to the short duration of the higher energy conditions.

The fine material deposited at the site would be resuspended under moderate to high wave and current conditions when critical bed-shear stresses for these fractions are exceeded, similar to the in-situ clays and silts presently at the site (36%). The extent of migration can be substantial for the deposited fine materials as they remain in suspension for long periods and deposition of sediment flocs starts to occur only once the critical bed-shear stress falls below a critical value (1.5N/m^2). The sediment direction of movement would be governed by storm-generated currents from any sector.

Benthic habitats within and adjacent to the proposed spoil ground are sparsely colonised, open muddy-sand substrates. Significant epibenthic habitats, such as seagrass or hard coral, were not observed in the disposal area during field investigations and are highly unlikely to occur there due to the depth of –23mLAT and resulting low light availability for photosynthesis. The soft coral – sponge dominated benthic habitat at Nine Mile Reef located 6km south-south-west of the proposed new spoil ground would not be impacted by remobilisation of sediments. Modelling undertaken in **Section 6.9.2.3** has identified currents and associated plumes occur along a south-south-east trajectory, thereby largely skirting Nine Mile Reef. During the dredge spoil disposal process, negligible increase in TSS was predicted at Nine Mile Reef (refer **Section 6.9.2.5)**. On that basis, it is expected that risks from resuspended sediments from the spoil ground post-disposal are similarly negligible. Should dredging-related turbidity be identified at Nine Mile Reef an investigation would be undertaken and appropriate mitigation measures implemented.

6.9.2.5 Inshore Sediment Deposition

Outputs from sediment deposition modelling have been plotted over the study area (refer **Figure 6-64**). These figures represent dredge Periods 2, 3 and 4 utilising theoretical settling velocities for particles using Stokes Law. The distribution of fine particle sizes used in the modelling was determined using geotechnical borehole material via hydrometer tests with a solution of 35g/L seawater. The use of seawater in the hydrometer tests provides a more realistic assessment of "effective" particle sizes since it takes into account the flocculative effects of seawater on clay particles. The flocculation of clay particles in seawater results in increased "effective" particle sizes and correspondingly faster settling rates.

The settling rates adopted for fine sediment fractions in turbid plume and deposition modelling are as follows:

- clay = 0.03mm/s
- silt = 1.0mm/s
- fine sand = 15.0mm/s

Ambient sediment deposition rates reported from Pera Head are compared with the predicted deposition regime within the footprint of the plume (refer **Table 6-46**). This table includes the modelled mean deposition predicted in mg/cm^2/day for representative dredge periods for model reef locations at Boyd Point, Pera Head and Thud Point (refer **Figure 6-61** for locations).

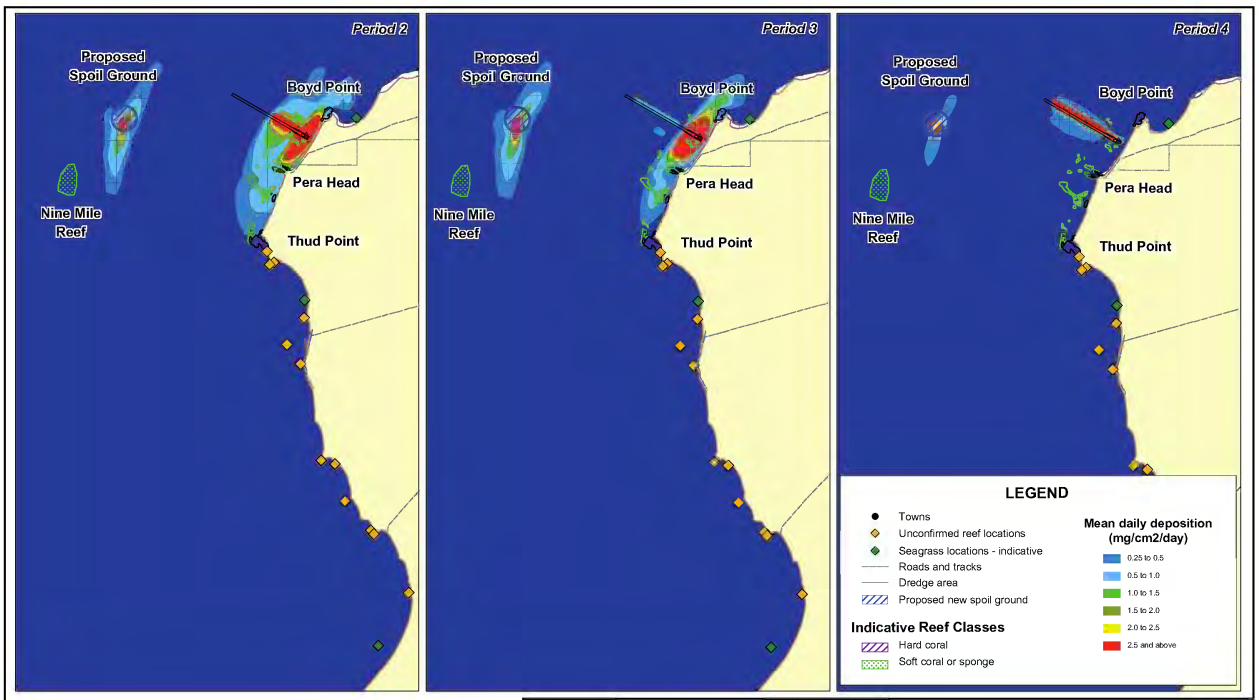
These results predict that mean deposition rates will remain less than 5% above background levels over key reef habitats. Locations adjacent to Pera Head are expected to experience the highest deposition rates and these are predicted to occur during Periods 2 and 3. Deposition rates during intervening periods are negligible compared to the ambient conditions, being less than 0.1mg/cm^2/day above background concentrations.

Based on the modelled sediment deposition rates and the duration of the dredging program, deposition impacts to reef systems between Boyd Point and Thud Point may be experienced. It should be recognised, however, that a complex relationship exists between deposition and actual impact within reef environments, driven by both physical and biological processes.

The process of remobilisation would act to limit deposition stress over coral habitats. However, given that dredge derived sediments are likely to be of a different physical and chemical nature to naturally derived materials, ambient water movements may be insufficient to fully remobilise these additional deposits.

Ambient fine sediments available for re-suspension and deposition can be described as existing in a complexed state, binding with organic particles which alter their behaviour (propensity for settling and remobilisation). The readily mobilised sediments can be described as a floc, moving into and out of suspension very easily. Sediments lost to the dredge plume are comparatively 'fresh', and mobilised to the plume relatively quickly once recovered from the seabed. They lack the complexing with organics and may demonstrate an increased cohesiveness, resulting in sediment deposits of a butter-like consistency, developing greater shear stresses after a period of compaction than ambient materials can obtain. These differing physical processes are important to consider when defining potential impact.

When plume derived sediment loads deposit with complex reef structures, the prevailing hydrodynamics of inter-reef spaces may not facilitate its complete remobilisation during 'average' events. This may lead to a scattered buildup of sediments within the reef, perhaps remobilised only during peak event periods (i.e. cyclones). Therefore, some storage of fine sediments within reef habitats can be expected for a period post dredging. Conversely, open reef surfaces over the corals themselves may be considered more open to remobilisation. These features result in a mosaic of sedimentation risk within the reef system.



Source Information

Indicative Seagrass Locations
Queensland Seagrass Meadows 1984-1988 Department of Primary Industries and Fisheries 2002
Coastal Habitat Resources Information System http://chrisweb.dpi.qld.gov.au/CHRIS/
Pers. Comm. Michael Rasheed, 2010

Modeled dredge plume point data provided by WorleyParsons Newcastle office on 19/07/2010.
This map incorporates data which is:
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While every care is taken to ensure the accuracy of this data, WorleyParsons makes no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and disclaims all responsibility and all liability (including without limitation liability in negligence) for all expenses, losses, damages (including indirect or consequential damage) and costs which might be incurred as a result of the data being inaccurate or incomplete in any way and for any reason.

0 10km

SCALE - 1 : 350,000 (at A4)

Map Grid of Australia - Zone 54
Geocentric Datum of Australia 1994

Rev	Date	Revision Description	ORIG	CHK	ENG	APPD
B	25/11/2010	Re-issued for review	JC	DH		
A	5/11/2010	Issued for information	JMM	DH		

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Figure 6-64 - Dredge plume deposition model for port area dredging and disposal at proposed spoil ground (Periods 2-4)

Project No: 301001-01069	Figure: 01069-00-GM-EN-0029	Rev: B

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Table 6-46 Summary Statistics - Sediment Deposition (mg/cm^2/day)

Location			Daily Mean/Median* Modelled Deposition Above Ambient Deposition Rate (mg/cm^2/day)		
	Mean Ambient (mg/cm^2/day)	Median Ambient (mg/cm^2/day)	Period 2	Period 3	Period 4
Measured Ambient Sediment Deposition Rates – June-August 2010					
Pera Head	17.5	2.38			
Modelled Deposition Rates					
Boyd 1			0.89	0.49	0.01
Boyd 3			0.59	1.38	0.03
Boyd 5			0.02	0.01	0.00
Pera 1			1.32	0.37	0.04
Pera 2			1.40	0.96	0.04
Pera 3			0.70	1.15	0.06
Pera 4			0.59	0.34	0.09
Pera 6			0.50	0.40	0.05
Thud 1			0.44	0.19	0.04
Thud 2			0.32	0.14	0.03
Thud 3			0.24	0.11	0.03

* model summary statistics indicate that mean and median values are consistent.

Mean modelled sediment deposition rates have been plotted over key habitat areas (refer **Figure 6-64**). Statistical analysis shows that the median modelled sediment deposition rate remains consistent with the mean (typical of the modelling processes when dealing with many small values). The following colour codes have been used to represent modelled sediment deposition rates presented within **Figure 6-64**:

- Mean modelled deposition 20% above median ambient (~0.5 – 1.0 mg/cm^2/day) – blue;
- Mean modelled deposition 40% above median ambient (~1.0 - 1.5 mg/cm^2/day) – green;
- Mean modelled deposition 60% above median ambient (~1.5 - 2.0 mg/cm^2/day) – brown;
- Mean modelled deposition 80% above median ambient (~2.0 – 2.5 mg/cm^2/day) – yellow; and
- Mean modelled deposition 100% above median ambient (~2.5 + mg/cm^2/day) – red.

Yellow and red represent a higher risk associated with deposition, brown and green moderate risk and blue, low risk. De'ath and Fabricius (2008) recommend a mean annual sediment deposition rate of 3mg/cm^2/day, and daily maximum of about 15mg/cm^2/day, to guard against excessive coral recruit mortality.

The median ambient sediment deposition rate recorded over Pera Head Reef was approximately 2.4mg/cm^2/day. During Period 2, reefs at Pera Head are predicted by the model to receive median above-ambient deposition rates approaching 1.5 to 2.0mg/cm^2/day (refer **Figure 6-64**), which represents an increase of 63% to 85%. Therefore the total rate of deposition may increase to a median of 3.9 to 4.4mg/cm^2/day for the duration of Period 2 dredging (approximately four weeks).During the same period, reef systems south of Pera Head to Thud Point are predicted to experience an increase in sediment deposition of 0.25 to 1mg/cm^2/day, a 10%-50% increase over ambient conditions. This would equate to an approximate median daily exposure of 2.7 to 3.4mg/cm^2/day. Therefore the total rate of deposition during Period 2 may represent a potential risk of mortality to coral recruits based on the recommended mean annual concentration of 3mg/cm^2/day. However the predicted sediment deposition rates remain much lower than the recommended daily maximum of about 15mg/cm^2/day. Corals already established on the reef are likely to be more resilient than recruits as demonstrated by colony survival following natural events where deposition rates would be significantly higher than the recommended daily maximum level recommended by De'ath and Fabricius (2008).

Similar deposition distributions are experienced during Period 3, though the extent of affect is markedly reduced. During Period 4, the footprint of deposition above 0.25mg/cm^2/day above ambient rates remains relatively localised around the dredge channel. Deposition at rates outside those readily accommodated by corals may lead to lethal or sublethal responses over a period of days to weeks. Evidence of fine sediment deposition from recent dredging programs in Queensland demonstrate a preferential deposition of sediments over hollows and indentations of at-risk corals, such as encrusting species of *Montipora* and massive species such as *Porities*. Other reef elements to experience deposition include uncolonised sand and silt patches and 'inter reef spaces' between live coral structures.

While the reef may be exposed to sediment deposition from the plume, the risk of deposition incurring damage is not consistent across coral habitats. In addition to the varying hydrodynamic features of the corals, some species exhibit larger polyps which physically remove sediment from the tissues by constant movement of their tentacles. Other corals such as branching *Acroporid* species maintain very limited surfaces open to deposition, being cylindrical in shape. Fungid corals observed within a fines deposition zone surrounding acute dredging disposal on the Great Barrier Reef survived within an area affected by approximately 5cm of fine silts and clays by a combination of hydrodynamic forces (scouring) and activity of the corals tentacles (the coral itself was only 4–5cm in height, and located almost totally beneath the deposition profile) (Pers. obs. T. Koskela 2002). Although species are variably designed to cope with a wide range of deposition regimes, the resulting stress caused from extended periods of deposition exposure may lead to a drain on general biological functions (mucus production, reproductive resources etc).

An important consideration when determining the fate of plume-derived deposition is the prevailing sea state. For example, under calm conditions the role of sedimentation as an impactor can be expected to increase. Relatively rapid increases in coral mortality have been observed (Pers. obs. T. Koskela 2002) from fringing reefs near Townsville during dredging in calm conditions, with rapid small scale deposition causing coral tissue necrosis over a five to seven day period. It is possible that periods of calm sea conditions over reef habitats during dredging may provide an increased level of risk to reef communities which would require considered management and monitoring to prevent long to medium term damage to corals within the deposition footprint.

The supply of additional fine sediment loads via the dredging process also has the capacity to induce chronic changes to those areas susceptible to the accumulation of fine sediments. The remobilisation of dredge derived sediments following the completion of dredging, particularly from shallow waters, is likely to persist for several years following dredging activity. However, the active nature of the coastline, and frequent passage of cyclones and tropical storms, is likely to limit such effects and favour a rapid rehabilitation phase as sediments are resorted to appropriate depositional environments.

As described above, the effects of deposition are not often experienced as a blanket of sediment within the far field plume environment. The implementation of a reactive monitoring program – designed to capture changes, define significance and respond with suitable management measures – is considered an important control mechanism during dredging operations.

6.9.2.6 Capital Dredging at Barge and Ferry Terminals

Minor volumes of material would be dredged at Hornibrook Terminal (18,680m^3), Humbug Terminal (10,670m^3) and Hey River Terminal (17,300m^3) to obtain sufficient draft for Project support vessels at the barge and ferry facilities. Dredge spoil would be disposed of at the existing Albatross Bay spoil ground.

Annual maintenance dredging activities have been undertaken in the Embley River by North Queensland Bulk Ports Corporation Limited (NQBP), formerly Ports Corporation of Queensland (PCQ), for more than 30 years and are a regular feature of port operations. As part of these activities, NQBP has undertaken aerial surveillance and turbidity monitoring during dredging campaigns. PCQ (2009) report that aerial surveillance and turbidity measurements during dredging campaigns suggested there were no significant adverse impacts from dredging on key marine resources in the area such as the seagrass meadows. The capital dredging proposed for the ferry and barge terminals represents a small proportion (5-10%) of the volume dredged regularly by NQBP. It follows that the minor dredging proposed by RTA would have a lesser impact than the NQBP dredging.

On the basis of the minor volumes of dredging required and results of previous monitoring undertaken for dredging projects in the Embley River, turbidity modelling at the three proposed barge/ferry terminal areas was not undertaken.

6.9.2.7 Albatross Bay Spoil Ground Disposal Plume Generation

The material to be dredged from the barge/ferry terminals has physical characteristics similar to Weipa shipping channel (South Channel) sediments. GHD (2005) has previously carried out an impact assessment study in relation to capital dredging of the shipping channel and placement of the material at the Albatross Bay spoil ground. The study examined impacts from capital dredging campaigns involving a much larger volume (greater than 3,000,000m^3) of maintenance and capital material. It concluded that the impacts to sensitive areas, such as seagrass meadows to the north-east, from migration of material would be low because the material is predicted to migrate south towards the South Channel. Modelling of turbidity plumes identified that turbidity generated at the spoil ground following release would travel a maximum of 3km within 11 hours of placement and that this would not extend to sensitive areas.

The combined volume of material to be dredged from the Embley and Hey River dredge areas is very small (<10%) compared to routine maintenance dredging at the Port of Weipa. Since the material to be placed at the spoil ground would likely migrate towards the existing shipping channel and plumes not extend to sensitive habitats, it is concluded that the potential for impact on sensitive habitats is very low. Consequently, modelling was not undertaken as part of the present study.

6.9.2.8 Capital Dredging Mitigation Measures

The most effective control strategy to minimise negative effects of dredging on adjacent habitats is to minimise dredging time, allowing sensitive receptors to enter a recovery phase as quickly as possible. It is anticipated the port area would be dredged over up to 10 months. However, there would be periods of respite as the dredging operations move between inshore and offshore locations. Dredging at barge/ferry terminals should take only one to two weeks, each representing short dredging campaigns.

It is likely that silt curtains would not be a suitable physical control measure at Boyd Point or Pera Head due to high current movements in those areas. Such measures are also not proposed for the Embley and Hey River sites as currents are likely to be problematic and the duration of dredging is short.

The proposed method of undertaking capital dredging works for the port area, using a self propelled cutter-suction dredger that deposits cuttings on the cut seabed area followed up by a trailing suction hopper dredge, was selected to minimise the turbidity generated through overflow, particularly for large dredging projects. Water entrained and subsequently overflowed during suction of pre-cut and deposited dredge material would be significantly less than that entrained during cutting and pumping of sediments to a waiting hopper barge.

To further minimise potential turbidity impacts at the dredge spoil disposal sites, the following measures to reduce loss of bulk material into the marine environment during dredging operations would be considered:

- Specifying that the trailing suction hopper dredge used during port development dredging includes a low-wash hull design, below keel discharge and electronic positioning systems.
- Specifying that hopper barges used in Embley River and Hey River dredging must have hopper door seals that are in good condition.
- Taking loaded hopper barges or hopper dredge to spoil disposal areas and discharging material as soon as possible to minimise clays settling and adhering to the hopper lining. (Removing the settled clays within a hopper barge's lining generally requires sailing the barge at full speed across the spoil grounds when disposing, causing unwarranted turbidity.)
- Where possible, placing a sandy silt lining (from dredge material) on the bottom of the barge before loading clays to facilitate clay discharge.
- Developing a spoil dumping plan to aid the even distribution of material over the spoil grounds.

Each spoil placement would be logged using both satellite navigation and standard bridge equipment, and would be electronically fixed using a differentially corrected global positioning system (GPS). Electronic track plots will mark the start of each placement process (hopper open), and the end of the process (hopper closed). Placement tracks usually show an arc, which the dredge follows to ensure that dredged material is placed within the designated spoil ground boundary. Position would be determined with an accuracy of at least 10m.

Maintenance dredging environmental management procedures and monitoring requirements for the port facility would be developed within a Long Term Management Plan that would be required for any long-term dredging and spoil disposal approval issued under the *Environmental Protection (Sea Dumping) Act 1981* (Cwlth) or *Environmental Protection Act 1994* (Qld).

6.9.2.9 Introduction of Contaminants During Operational Ship Loading

The process of conveying bulk material from shore to ship provides a mechanism through which bauxite material can enter the marine environment in the immediate vicinity of the port. Bauxite material that enters the marine environment during the loading process would primarily be in non-bioavailable solid form and would enter a typically turbid water body. It is expected that turbidity impacts arising from bauxite would be minor given the high degree of water movement within the bay between Pera Head and Boyd Point, relatively minor rate of dust generation, and existing turbid nature of the inshore waters. It should be noted that larger granular bauxite naturally occurs in the port development area sediments, having been derived from the adjacent cliff areas through natural erosion processes. These naturally deposited bauxite materials do not appear to have any impact on the marine environment.

The conveyor and ship loader would be designed and operational procedures adopted to minimise dust generation and spillage to the surrounding environment, particularly in the vicinity of transfer points. These measures would include the following:

- A catch tray would be positioned under the ship loader tripper to catch spillage from the inclined section of belt. The material collected from the tripper catch tray would be directed to the head end sump and then pumped onshore to a sediment holding pond.
- Three stage belt scraping with water sprays would be positioned at the conveyor head pulley to clean the belt. The scrapings and the water used for belt cleaning would be directed into the head end sump for pumping onshore into sedimentation dams.
- The wharf conveyor would be designed with variable speed drives to provide controlled belt starting, thereby minimising the potential for bauxite spillage.
- Belt drift switches would be installed on the wharf and ship loading conveyor that shuts down the conveyor drives if a belt moves from the designed position. Training idlers that track the belts would also be installed.
- When loading ships, the product reclaimer would be stopped and the conveyor allowed to empty before the ship loading boom travels between hatches to prevent bauxite spillage onto the deck of the ship.
- A sealed maintenance area would be provided at the end of the wharf so the ship loading boom can be serviced and cleaned within a bunded area. Runoff from this sealed maintenance area would report to the head end sump for pumping back to shore.
- No fuel or chemicals would be unloaded at the proposed wharf facilities.

6.9.2.10 Turbidity from Port Area Operational Shipping Movements

Turbidity is generally elevated immediately adjacent to port facilities as propeller wash and vessel movement/handling by tugs continually mobilise fine sediments. The absence of significant light dependent benthic habitats immediately adjacent to the proposed port would limit any effects of ship movements.

The nearest benthic habitats recorded from the vicinity of the port included sparse sponge and soft coral communities established on outcropping hard substrates located 150 to 800m from the proposed wharf. Such organisms are tolerant of variable sedimentation regimes so no significant impact is predicted. The more significant reef habitats located at Boyd Point and Pera Head are considered to

be too far away to be affected by operational increases in turbidity from vessel movement and are subject to naturally varying turbidities.

6.9.2.11 Maintenance Dredging Requirements and Turbid Plume Generation

Port Area

Considerable sediment is mobilised under current and higher wave conditions (refer **Section 6.1.5**). There is a high potential for the proposed berth pockets to accumulate the clay and silt fractions present in the surrounding seabed. Fine sand fractions would also be transported as bed load and suspended load during larger wave events.

The potential siltation depth for the proposed berths has been calculated using the percentage exceedance curves for wave heights from records at the Weipa wave buoy. Average annual siltation depth has been conservatively estimated to be 1.15m for the berth and departure apron area and 0.35m for the departure channel. This equates to approximately 890,000m^3 per year of material requiring dredging to maintain the design depths (refer **Table 6-47**). This includes 540,000m^3 from the berth and departure apron area and 350,000m^3 from the departure channel.

Table 6-47 Annual Siltation Depth of Port Area Based on Wave Exceedance

Per Cent Exceedance (All Data)	Exceedance (days)	Occurrence (days)	Significant Wave Height Hs (m)	Peak Energy Wave Period Tp (s)	TSS (mg/L)	Silt Depth (m)	
						Berths and Departure Area	Departure Channel
20%	73.0	58.40	>0.5	5	100	0.642	0.204
4%	14.6	7.30	>1	6	200	0.139	0.040
2%	7.3	5.48	>1.5	7	400	0.200	0.060
0.5%	1.8	1.53	>2	8	1000	0.131	0.039
0.1%	0.3	0.26	>3	10	1500	0.031	0.009
0.01%	0.0	0.04	>4	12	2000	0.006	0.002
Total						1.150	0.350

The potential siltation depth was also estimated based on two high energy wave events recorded with the ADCP at Boyd Point between late 2007 and early 2008 and has been calculated as 1.41m and 0.42m for the respective areas (the equivalent of approximately 1,000,000m^3 of infill). This result indicates the average annual siltation depths of 1.15m and 0.35m may be exceeded over a relatively short period following two or more significant events during a single wet season. Significant annual infill variability may be expected at the study site and is expected to be closely related to the timing, duration, and magnitude of events.

It is expected that this maintenance dredging would take approximately six weeks. This assumes that the dredging would be undertaken by a TSHD such as the *Brisbane*, which services many ports around Queensland, including the Ports of Karumba and Weipa in the Gulf of Carpentaria. Of the six-week dredging program, dredging would occur in the inshore berth and departure areas for approximately three to four weeks while dredging of the departure channel would take about two to three weeks, based on calculated siltation volumes in each area.

Modelling of maintenance dredging plumes has not been undertaken, but it is expected that the spatial extent of plumes would not exceed those generated during capital dredging works since turbid plume generation from both campaigns is primarily due to overflow dredging from the TSHD. Maintenance dredging would likely have higher concentration of fine sediments in the overflow, but this would be largely balanced by significantly lower overflow rates. Dredging plume generation would likely be similar to that of Period 2 in the capital dredging campaign.

The volume of annual maintenance dredging for the port would add approximately 0.4m height, on average, to the proposed new spoil ground prior to any consolidation or remobilisation of sediments.

Once Stage 2 of the port was developed to include an additional two berths, an extra 280,000m^3 per annum of maintenance dredging would be required, increasing the annual total of maintenance dredging for the port from 890,000m^3 to approximately 1,170,000m^3.

Embley and Hey River Barge/Ferry Terminals

The maintenance dredging for the ferry and barge terminals is expected to add approximately 7,000m^3 of material annually to the 400,000-900,000m^3 of material dredged from the Embley River and entrance channel for the Port of Weipa by North Queensland Bulk Ports.

Future maintenance dredging and disposal for the port site, and Embley and Hey River facilities would follow testing and reporting procedures outlined within the NAGD (Commonwealth of Australia 2009) or subsequent guideline.

6.9.3 Marine Habitat Impacts

Various impacts on marine habitats are likely to occur during construction and operational phases of the Project. The key habitats potentially impacted include:

- reef assemblages in the vicinity of the proposed port;
- soft sediment habitat in the vicinity of the proposed new spoil ground; and
- marine plant (seagrass and mangrove) habitat near Embley and Hey River barge/ferry terminals.

Impacts to these areas would arise either directly through removal or deposition, or indirectly through water quality impacts described in **Section 6.9.2**, particularly light attenuation.

Dredging at the Embley and Hey River barge/ferry terminals would not affect oyster banks on the Hey and Embley Rivers.

6.9.3.1 Inshore and Offshore Reef Habitat Turbidity

There are no reefs within the proposed port development footprint that need to be removed for dredging or wharf construction purposes.

The creation of a turbidity plume from dredging, and subsequent deposition and re-suspension of fine sediments, can result in potential indirect impacts on reef assemblages. This is particularly important for reef hard corals which require sunlight for photosynthesis. Small patches of sponge reef nearest the proposed Port facility may experience significant deposition during the dredging process. Some loss of habitat at these locations may be expected which may locally affect feeding preferences in marine turtles, however regional impacts are not predicted. The potential for impact to turtle feeding habitat is discussed further in **Section 6.9.4.3**.

Hard coral is present from Pera Head south to Thud Point and at Boyd Point (refer **Figure 6-18**). Due to their inshore location, hard corals on these reefs are presently exposed to naturally high deposition and turbidity and corresponding low light levels, a situation which can persist for several weeks at a time particularly during the wet season. Modelling of deposition over reef habitats is discussed in **Section 6.9.2.5**. Light availability, which correlates with depth and ambient suspended sediment regimes, restricts coral reef distribution. Based upon validation of reef distribution using video assessment, the maximum extent of reef development is though to occur between –8m and –12mLAT. Loggers situated at Pera Head were located 0.5m above the seabed at approximately –8m LAT, with data considered to represent conditions approaching the limits of coral tolerances. Analysis of TSS and PAR light data at Pera Head supports the development of light attenuation coefficients for varying TSS conditions to allow prediction of light regimes for the majority of shallow water reef habitats between Boyd Point and Thud Point.

Table 6-9 in **Section 6.4.4** presented three light regimes related to coral sustainability based on the relationship between TSS and light. These regimes were:

- Favourable – green:
- Light limited – orange; and
- Unsustainable – red.

Using the range of TSS values and depth profiles developed within **Table 6-9** a prediction of impact based on benthic light availability has been completed for reef habitats of the study area between Boyd Point and Thud Point. The following provides a summary of the analysis process:

1. Median TSS plots were extracted from the model for Periods 2, 3 and 4, as representative of the seven periods identified within the model (refer **Section 6.9.2.1**) and model TSS results (refer **Section 6.9.2.2**).
2. Reef habitats were mapped based on a combined analysis of bathymetric data, infield drop camera video assessment and aerial photograph interpretation.
3. Reef habitats were depth classified from available bathymetric survey provided by RTA.
4. Habitat, depth and modelled TSS concentrations were then cross-referenced against the predicted light attenuation regimes developed using spatial analysis tools.

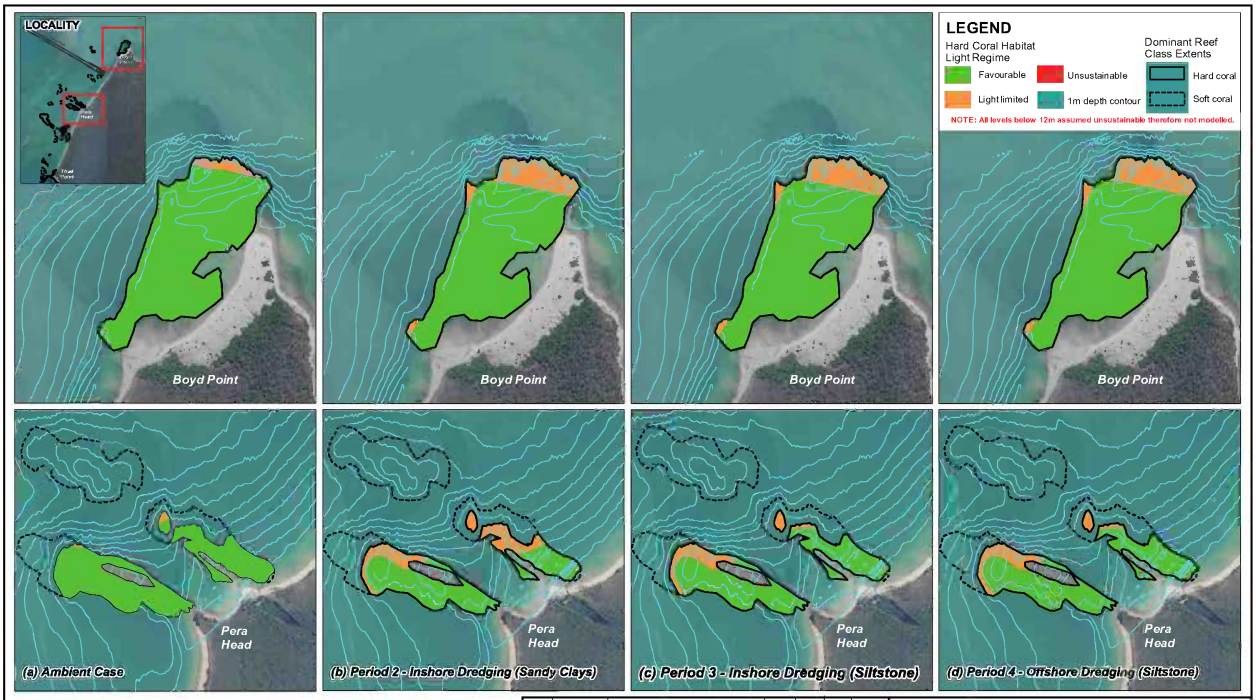
The results of this assessment have been mapped in the categories of "favourable" and "light limited" (analysis of an "unsustainable" class was assessed but returned null results during assessment). Light availability predictions comparing the ambient case against dredging Periods 2, 3 and 4 are presented for Boyd Point and Pera Head (**Figure 6-65a**), and reefs south of Pera Head to Thud Point (**Figure 6-65b**). Analysis incorporates TSS results from median case plume dispersion modelling. Impacts to near shore hard coral habitats are summarised within **Table 6-48**, which presents predicted changes in area (hectares and percentage) for favourable and limited light availability.

Overall, dredging is predicted to reduce the area of favourable light conditions over hard coral habitat by approximately 14%. This remains generally static over the dredging program. Pera Head is predicted to exhibit the greatest changes, with a reduction in favourable light condition habitat of approximately 33% during Period 2, reducing to approximately 16% for the remainder of dredging. The area of favourable light conditions at Boyd Point is predicted to reduce by approximately 11% during dredging, with no discernable difference between the dredge periods. A similar response is reported from reefs south of Pera Head to Thud Point (reduction in area of favourable light conditions of 11-12%).

Period 2 presents the peak affect on light attenuation, driven primarily by the increased clay and silt fractions within the first layers of material to be dredged using TSHD. The duration of the Period 2 dredging approaches 30 days, similar to ambient light reduction events recorded at Boyd Point during field investigations (23-30 days). However, the predicted plume TSS concentrations remain well below reported maximum ambient concentrations. Within the **Table 6-46**, light regime classification areas for Periods 3 and 4 remain consistent. This is a result of the differences in median TSS being up to about 1mg/L (refer **Table 6-44**).

Given the relatively short duration of light attenuation, and general respite provided to coral reef systems after Period 2, these predicted light reductions are not thought to be a driver of acute impact associated with the dredging process. Rather, a moderate proportion of coral habitats (11-14%) would enter an extended period of reduced light availability, approaching conditions presently experienced by corals living nearer the local limits for coral growth. Despite this, it is important to note that the analysis did not identify any coral habitats entering "unsustainable" light regimes, as described within **Section 6.4.4** (based upon median TSS concentrations within the plume).

Significant impact to coral resulting from light attenuation is not predicted. However, RTA would develop a reactive monitoring program which incorporates sub-lethal indicators of light stress, including bleaching. Modelling results indicate that, following the peak plume period (Period 2), receiving habitats enter a four to five week cycle of minor light reduction/increased TSS (Periods 3, 5 and 7), followed by four to five week periods of respite (Periods 4 and 6). Given that some level of stress is likely to occur during the first peak dredge plume period (Period 2), via light reduction and increased deposition, the recurring periods of respite are considered important to minimising overall coral stress. These periods provide an opportunity for corals to return to light dependent primary productivity and regenerate energy stores.



Source Information

2006 aerial photography
Supplied by client December 2008
Bathymetry
Extracted from bathy.dwg supplied by client December 2008
Conceptual port layout and dredge area
Extracted from S0K-2231-00001_Q.dwg supplied by client 19/05/2010
Coral Growth Classes
Classes based on predicted mean light regimes and light attenuation coefficient (Kd*m) for varying ambient TSS conditions and depth intervals (-1 to -12mLAT).

This map incorporates data which is
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0 1km

SCALE - 1 : 25,000 (at A4)

Map Grid of Australia - Zone 54
Geocentric Datum of Australia 1994

Rev	Date	Revision Description	ORIG	CHK	ENG	APPD
B	04/11/2010	Issued for review	JMM	DH		
A	07/10/2010	Issued for review	MM	KM		

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SOUTH OF THE EMBLEY PROJECT

Figure 6-65a

Light availability prediction for Boyd Point and Pera Head Reefs

Project No: 301001-01069	Figure: 01069-00-GM-EN-0027	Rev: B

Compiled by BRISBANE GEOMATICS

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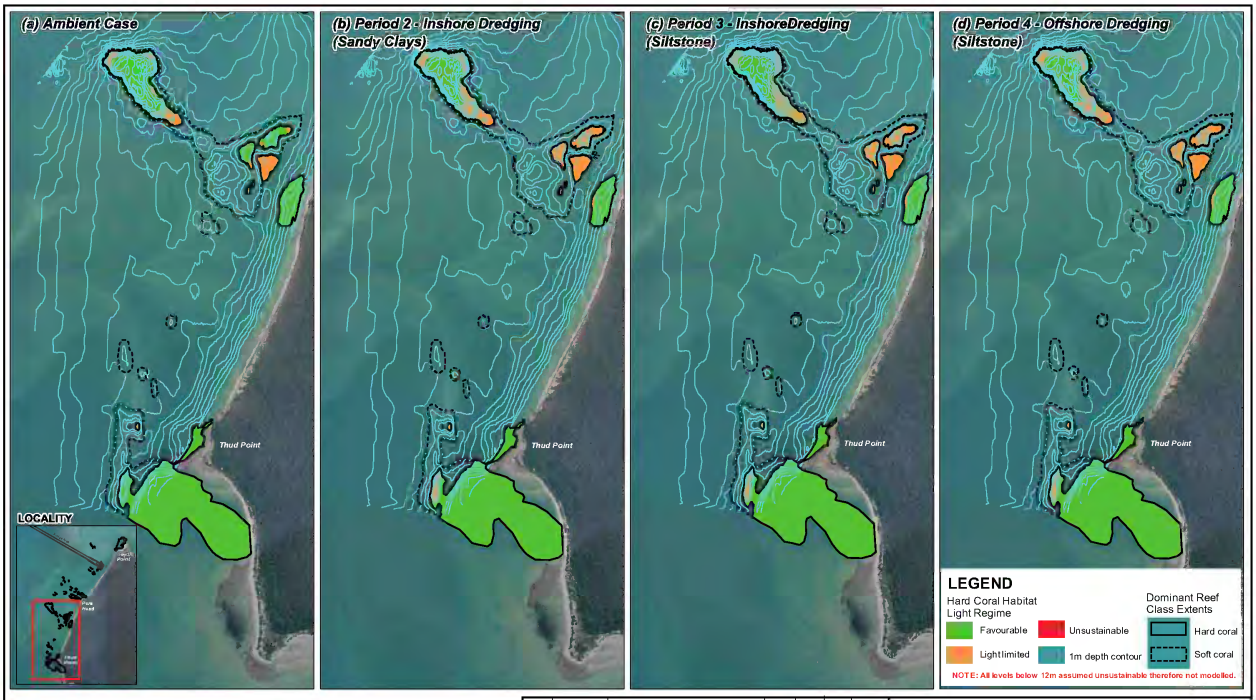

Source Information

2006 aerial photography
Supplied by client December 2008
Bathymetry
Extracted from bathy.dwg supplied by client December 2008
Conceptual port layout and dredge area
Extracted from S0K-2231-00001_Q.dwg supplied by client 19/05/2010
Coral Growth Classes
Classes based on predicted mean light regimes and light attenuation coefficient (Kd*m) for varying ambient TSS conditions and depth intervals (-1 to -12mLAT).

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0 1km

SCALE - 1 : 50,000 (at A4)

Map Grid of Australia - Zone 54
Geocentric Datum of Australia 1994

Rev	Date	Revision Description	ORIG	CHK	ENG	APPD
B	04/11/2010	Re-issued for review	MM	DH		
A	07/10/2010	Issued for review	MM	---		

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SOUTH OF THE EMBLEY PROJECT

Figure 6-65b

Light availability impact prediction for Thud Point Reefs

Project No: 301001-01069	Figure: 01069-00-GM-EN-0026	Rev: B

Compiled by BRISBANE GEOMATICS

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Table 6-48 Hard Coral Habitat for Overall Reef Areas, Boyd Point, Pera Head and Reefs South of Thud Point During Ambient, Dredging Period 2, Period 3 and Period 4.

a) Overall Hard Coral Reef Habitat

Dredging Period	Light Regime Classification	Area (ha)	Area (%)
Ambient	Favourable	208	91%
	Light Limited	22	9%
Period 2	Favourable	177	77%
	Light Limited	53	23%
Period 3	Favourable	180	78%
	Light Limited	50	22%
Period 4	Favourable	180	78%
	Light Limited	50	22%

b) Boyd Point Reef

Dredging Period	Light Regime Classification	Area (ha)	Area (%)
Ambient	Favourable	47.7	96%
	Light Limited	2.2	4%
Period 2	Favourable	42.3	85%
	Light Limited	7.6	15%
Period 3	Favourable	42.3	85%
	Light Limited	7.6	15%
Period 4	Favourable	42.3	85%
	Light Limited	7.6	15%

c) Pera Head Reef

Dredging Period	Light Regime Classification	Area (ha)	Area (%)
Ambient	Favourable	23.1	99%
	Light Limited	0.2	1%
Period 2	Favourable	15.4	66%
	Light Limited	6.7	29%
Period 3	Favourable	19.4	83%
	Light Limited	3.9	17%
Period 4	Favourable	19.4	83%
	Light Limited	3.9	17%

d) Thud Point Reefs

Dredging Period	Light Regime Classification	Area (ha)	Area (%)
Ambient	Favourable	137.8	88%
	Light Limited	19.3	12%
Period 2	Favourable	118.5	75%
	Light Limited	38.8	25%
Period 3	Favourable	118.5	75%
	Light Limited	38.8	25%
Period 4	Favourable	118.5	75%
	Light Limited	38.8	25%

Habitats that enter the "light limited" range as a result of the dredge plume are likely to undergo a period of photo adaptation, or acclimatisation, where corals increase photosynthetic pigments, improve photo efficiency and partition an increased portion of their energy budget to heterotrophy. Whilst not considered of sufficient change to initiate an acute response, the rate at which impacted corals can acclimatise is not well defined, and they remain at risk of developing sub-lethal responses to reduced light regimes. The additional processes of sediment deposition, such as lost photosynthetic area due to smothering and associated lost energy budgets also requires consideration (i.e. possible additive affects of light reduction and deposition).

Experimentation undertaken by Anthony *et al* (2007) under a range of manipulated temperature, light and turbidity regimes, identified responses in coral survivorship for *Acropora intermedia*. While response in low temperature regimes (28°C) did not demonstrate a pronounced change in survivorship, reduced light and increased sediment regimes influenced sub-lethal responses by way of reductions in chlorophyll-a and lipid content to some degree. These responses appeared more pronounced via light reduction than sediment increases, appearing to reach a process of decline after 10–20 days (sub lethal response – Lipid content). The duration of Period 2 exposures (25-30 days) exceed the 10–20 day threshold identified by Anthony *et al.* (2007), providing some indication that corals may begin to exhibit sub-lethal responses to light attenuation during the first peak plume period. Reactive monitoring designed to track sub-lethal responses in coral condition is considered an important management commitment over the entire dredge program.

Habitats maintaining a "favourable" light regime are not considered to be at risk over the dredge program. This represents approximately 86-89% of the reef systems inferred within the study area.

Maintenance Dredging Impacts

Maintenance dredging of approximately 890,000m^3 annually is expected, with 540,000m^3 from the inner port area (berths and departure area) and 350,000m^3 from the long departure channel (refer **Section 6.9.2**). Inshore dredging is estimated to take about three to four weeks and offshore dredging about two to three weeks.

The inshore reef areas of Pera Head and Boyd Point naturally experience extended periods of high suspended solids/turbidity and low light availability for three to four weeks in a single event (refer **Section 6.4.4.5**). Given that turbid plumes from maintenance dredging are expected to be well within natural ranges (refer **Section 6.9.2.11**), and duration of dredging plume generation is not more than that which occurs naturally, there is not predicted to be any significant impact to inshore reefs.

Reef Habitat Monitoring

For port area capital dredging, monitoring of turbidity, deposition and PAR is proposed to be undertaken at Boyd Point, Pera Head and Thud Point reef areas and at a control location outside the extent of the modelled dredge plume. Trigger levels would be developed for these water quality parameters primarily as alerts for coral health reactive monitoring. These levels would be identified within a Dredge Management Plan that would require approval from DSEWPaC.

TSS would be estimated based on the relationship between NTU-e and TSS (refer **Section 6.4.4.3**). The objective of this monitoring is to validate the turbid plume modelling and assist in identifying extended periods of high turbidity, high TSS and low PAR availability which can lead to coral stress. In-situ water quality loggers, like those used to collect background data for the present study, would continue to be used during the proposed monitoring program. Monitoring would begin a minimum of a month prior to dredging and extend until two months after the completion of dredging. Loggers would be either downloaded fortnightly or telemetry linked to allow for remote download so that data can be regularly reviewed.

Monitoring of hard corals is proposed at Boyd Point, Pera Head and reefs south to Thud Point. The objective of this is to identify when corals become stressed due to low light conditions or are being impacted by sediment deposition. Key parameters and response levels would be confirmed through a pilot program but would likely focus on a gradient of stress indicators such including coral colour, photosynthetic efficiency, sediment coverage, bleaching, injury and partial mortality, and mortality. These biological triggers focus on a range of sub-lethal indicators to best facilitate management response (although lethal response also to be recorded).

Due to the presence of potentially dangerous marine life, common coral monitoring techniques such as divers swimming fixed line transects for assessing changes in coral cover are not viable. Alternatively, it is proposed to use boat-based methods, including repeated measures of a range of individual corals attached to trays that can be extracted from the water and studied on-board the vessel. Some initial in-water work would be required to collect coral specimens and establish the monitoring sites, however ongoing risk to divers is minimised.

Should signs of unacceptable coral stress become apparent, opportunities for the manipulation of dredging operations (for example, relocation of the TSHD operations to offshore areas) would be reviewed to best allow inshore corals a period of respite and a return to more favourable conditions.

The final design of the reactive monitoring program would be prepared in consultation with DSEWPaC and DERM and incorporated into a Dredge Management Plan (refer **Section 6.10** for an outline of the Dredge Management Plan). The Dredge Management Plan would include:

- validation of plume dispersion modelling predictions (first six to eight weeks);
- marine water quality monitoring (loggers – TSS, light (PAR) and deposition); and
- coral health monitoring (fixed impact and control sites).

A monitoring response protocol, including management triggers, would be developed as part of the Dredge Management Plan.

Monitoring requirements for future maintenance dredging would be developed as part of the maintenance dredging approvals process and would be subject to the conditions of future sea dumping permits. This would be informed by outcomes from the monitoring undertaken during capital dredging.

Although modelling predicts that the turbidity plume generated by the spoil ground would not impact Nine Mile Reef (refer **Section 6.9.2.3** and **Section 6.9.2.4**), turbidity plume monitoring would be undertaken for the purposes of model validation of spoil disposal and will be described within the Dredge Management Plan. If monitoring determines that there are unacceptable impacts to Nine Mine Reef due to the turbidity plume associated with the spoil ground, then appropriate management measures would be developed and implemented in consultation with DSEWPaC. If the model is identified as validated, then no further turbidity monitoring would be proposed at Nine Mile Reef.

6.9.3.2 Mangrove Habitat

While scattered stunted individuals of *Avicennia marina* exist within the upper tidal range on rocky shores at Boyd Point, seagrass and mangrove marine plants are not present in the immediate area of the proposed port development.

The only proposed marine infrastructure location with mangroves in the immediate vicinity is the Hey River barge/ferry terminal. The mangrove communities have established within marginal, gravel habitat at the base of a small bauxite cliff. The area that would be disturbed by the Project is a very small proportion of the area of mangroves in the Albatross Bay assemblage and therefore there is unlikely to be significant impact on the environment. The clearing of 400m^2 of mangrove habitat to facilitate pontoon access and barge transfer represents 0.008% of the associated RE (3.1.1a) within the Project area and 0.003% of total mangrove communities within the Project area (refer **Section 8.6.1.5**). The proposed dredging and operation of the facility is not considered a significant ongoing threat to the viability of the adjacent mangrove system, or to fisheries values or habitat essential to significant fish species, such as juvenile sawfish or *Glyphis* species.

Approval is required under the *Fisheries Act 1994* to remove or destroy marine plants (such as mangroves). In line with the Fish Habitat Management Operational Policy (FHMOP005) *Mitigation and Compensation for Works or Activities Causing Marine Fish Habitat Loss* (DPI 2002), a condition of approval under the *Fisheries Act 1994* for removing mangroves may include a requirement to provide a compensatory measure as an offset. The types of compensatory measures include:

- best practice methodologies;
- habitat productivity enhancement;
- restoration or replacement of fish habitat;

- fisheries resource research and education support;
- the payment of bonds (held towards ensuring impacts are minimal);
- fish habitat creation;
- fish habitat acquisition/exchange (relinquishment of private tenure); or
- fisheries stock enhancement.

Any such compensatory measure would be discussed with DEEDI and could include restoring mangrove habitat elsewhere or contribution to a State-wide Compensation Program to fund research or extension on fish habitats.

6.9.3.3 Seagrass Habitat

Water quality conditions at the proposed port location between Boyd Point and Thud Point do not favour seagrass establishment. However, seagrass has been recorded from subtidal meadows between the headlands of Boyd Bay, to the north of Boyd Point, and from locations south of Thud Point (Norman Creek and meadows near Aurukun) (refer **Figure 6-20**). Turbidity plume modelling indicates that these seagrasses would not be subject to any appreciable change in TSS concentrations, with predicted median and 80th percentile concentrations being less than 0.25mg/L above ambient (refer **Figure 6-60**).

The Hornibrook Terminal dredge footprint does not contain seagrass, however, aggregated patches of *E. acroides* seagrass may be located adjacent to it. Similarly, seagrass is not present in the dredge footprint at the proposed Hey River Terminal; however, it may occur in the wider vicinity as isolated patches.

Isolated patches of *E. acoroides* have been identified at the spring low tide level within or immediately adjacent to the proposed dredge footprint at Humbug Wharf. A conservative estimate of less than 1.84kg dry weight seagrass biomass may be directly extracted during the dredging process, based on seagrass area of 1250m^2 within the dredge area and most recent biomass estimates for monitoring meadow A6 (1.47g dry weight per m^2). The 1250m^2 area represents about 0.003% of the seagrass meadows within the Weipa region and approximately 0.13% of the meadows monitored within the Intensive Monitoring Area, based on most recent (2008 2009) data (Chartrand and Rasheed 2009; McKenna and Rasheed 2010).

As noted in **Section 6.3.4.2**, DEEDI has identified that *E. acoroides* meadows in Weipa have experienced biomass losses, which is largely a response to regional and local climate conditions, driven particularly by tidal exposure, temperature and solar irradiance. In particular, the aggregated patches *E. acoroides* bed opposite Lorim Point (monitoring meadow A2) has experienced "burning" and is considered to be vulnerable to further cumulative impacts. While DEEDI considers that *Enhalus* biomass change is driven by climatic conditions, it does not discount that other natural and anthropogenic factors may contribute, including dredging operations and vessel movements (McKenna and Rasheed 2009).

Erftemeijer and Lewis (2006) collated information regarding critical thresholds of light availability, survival duration below those thresholds, and critical annual sedimentation thresholds for a range of seagrass species around the world. Significant differences were found between species in their respective critical levels and duration tolerances. No critical light availability or survival duration information was available for *E. acroides*; however, a critical sedimentation threshold of 10cm per year was reported for *E. acroides* from an experimental burial study by Vermaat *et al.* (1997) in the Philippines.

Variation between different seagrass species in their ability to tolerate and recover from periods of reduced light is related to their differing morphological and physiological characteristics (Erftemeijer and Lewis 2006). These characteristics represent different strategies for survival in response to stress or disturbance. Smaller, short-lived species (e.g. several *Halophila* spp.) do not survive long once environmental conditions are outside their environmental tolerance; however, they tend to recolonise rapidly following an impact. Conversely, larger seagrass species, including *E. acroides*, survive longer during periods of low light due to their greater stored reserves which can be mobilised to sustain the plant. Larger species tend to be slow growing, long-lived and therefore represent a resilience strategy, being more resistant to short-term to medium-term disturbances. However, if the impact persists to the point where the seagrasses have exhausted their stored reserves, they would die and recover

slowly or not at all (Erftemeijer and Lewis 2006). This slow recovery is consistent with the slow recovery from "burning" (aerial and subaerial exposure to increased irradiance) being exhibited in the A2 *E. acoroides* dominated meadow at Weipa (refer **Section 6.3.4.2**).

At each of the barge/ferry terminal facilities in the Embley and Hey Rivers, dredging is likely to take only one to two weeks and involves only minor dredge volumes ranging from 10,700m^3 to 18,700m^3. The dredging activity proposed at Hornibrook Point and Humbug Wharf in the Embley River is located on the opposite bank to the *E. acoroides* seagrass bed (A2) previously "burned" and considered vulnerable to cumulative impacts. Any turbidity generated by the backhoe dredge operating on the northern bank of the Embley River would be unlikely to migrate over the vulnerable meadow due to the strong tidal exchange in the channel separating the banks.

Given the minor scale and short duration of dredging, it is unlikely that sediment loads would be generated over the aggregated *E. acroides* patches adjacent to the proposed infrastructure at a thickness that would approach critical levels. Further, any reduction in light levels would be short-term and the large-structured *E. acroides* would likely have sufficient stored reserves to provide resilience to the predicted low impact.

The location of the proposed barge and ferry terminals is within the intensive seagrass monitoring area monitored at least annually by DEEDI. Any impacts from the initial dredging or ongoing vessel movements should be notable within the intensive monitoring undertaken.

Movement of the ferry through the water may generate waves, which result in increased turbidity and erosion. The magnitude of the waves is related to speed, size of the ferry, depth of water, and the distance between the ferry and receptor (e.g. shoreline, seagrass).

The ferry would operate from Hornibrook Terminal to Hey River Terminal approximately four times a day, increasing to six times per day with production increases above 15Mdptpa. The average ferry speed would be 25 knots when travelling in open water, with much lower speeds when departing and arriving at dock. The deepest section of the ferry route is off Hey Point at 17m and the shallowest is at the half-way point of approximately 6m. The estuary ranges from 2,200 to 3,550m wide along the proposed ferry route.

There could be some impact to the shoreline environment from the waves created by propeller wash. However, the impact on seagrass and mangroves, as well as oyster banks and cultural heritage sites on the Hey and Embley Rivers, is anticipated to be minimal as the ferry would slow to a low speed when departing and arriving at dock, it would only operate an anticipated four to six round trips per day, and the estuary is very wide.

In addition, turbidity generation from barge and ferry movements is expected to be minor but cumulative over that from vessel movements in adjacent areas including tug and bulk carrier vessels at Hornibrook Point and supply barges at Humbug Wharf. There currently are no regular vessel movements in the vicinity of the proposed terminal in the Hey River. It is possible that background turbidity may increase locally to the barge and ferry terminal locations, possibly impacting the isolated or aggregated patches of seagrass in the immediate vicinity.

Overall, the proposed Project poses a low risk to seagrass and mangrove habitat.

6.9.3.4 Soft Sediment Habitat

It is anticipated the spoil ground would receive 3–4m thickness of dredge spoil from capital dredging, and an annual maintenance dredging load of about 0.4m, so localised smothering of sediments would be significant. Unvegetated sediments of the Gulf of Carpentaria are not considered to be sensitive marine habitats. The areas proposed to be impacted would be extremely small relative to the area of unvegetated sedimentary habitats in the region.

6.9.4 Marine Fauna Impacts

Potential impacts on marine fauna and proposed management measures are discussed below, particularly with respect to listed species identified in **Section 6.6**. In some instances no impact is identified because the range of identified impacting processes cannot plausibly result in a measurable impact. Impacts may also be beneficial (e.g. increased species richness); where applicable this is also identified. The main potential impacts are summarised in **Table 6-49.**

Consideration of threatened and migratory species under the EPBC Act occurs in discussion of faunal groups in sections below and EPBC Act Significance of Impact Assessments for threatened and migratory fauna are presented in **Section 6.9.5**.

Table 6-49 Summary of Main Potential Impacts on Marine Fauna

Fauna	Potential impact	Project phase	Project component
Dugong and cetaceans	Disturbance from boating and shipping activities including alienation from habitat. Acoustic impacts from pile driving and vessel movement. Boat strike.	Construction and operation	Proposed new spoil ground, existing Albatross Bay spoil ground, barge/ferry terminals and port facility.
Marine turtles	Altered night-time light regime. Disturbance from boating and shipping activities including alienation from habitat. Acoustic impacts from pile driving and vessel movement. Boat strike. Offshore turbidity plume. Introduction of artificial hard substrate.	Construction and operation	Proposed new spoil ground, existing Albatross Bay spoil ground and port facility.
Macrobenthic infauna assemblage	Creation of a turbidity plume from dredging activities, spoil deposition and subsequent deposition re-suspension of fine sediments. Physical disturbance.	Construction	Proposed new spoil ground, existing Albatross Bay spoil ground, barge/ferry terminals and port facility.
Fish assemblage (including sharks and rays)	Creation of a turbidity plume from dredging activities, spoil deposition and subsequent deposition re-suspension of fine sediments.	Construction and operation	Proposed new spoil ground, existing Albatross Bay spoil ground, barge/ferry terminals and port facility.
Introduced marine pest species	Shipping, through ballast water and hull fouling, is a known source of introduced pests.	Operation	Shipping and port facility.

6.9.4.1 Dugong

The following aspects of the proposed Project may affect Dugong:

- loss of foraging habitat from dredging activities;
- creation of a turbidity plume from dredging activities, and subsequent deposition and re-suspension of fine sediments;
- boat strike;
- direct impact from dredging activities;
- disturbance from boating and shipping activities including alienation from habitat; and
- acoustic impacts.

There is current scientific evidence suggesting that death and injury caused by boat strike has a significant impact on Dugong populations in Queensland (Grech and Marsh 2008). It is commonly accepted that vessel speed and water depth are the main factors affecting the risk of boat strikes. The risk of boat strike is higher in shallower water. A recent study has found that the reaction time of Dugongs does not change in accordance with the speed of an approaching vessel and therefore faster moving vessels have a greater probability of causing Dugong mortality (Hodgson and Marsh 2007).

The Project involves operating a ferry from Hornibrook Terminal to Hey River Terminal. The ferry would operate at an average speed of 25 knots in shallow water. The operation of the ferry is predicted to pose a moderate risk to Dugong in the Embley estuary where seagrass beds are present. Transit lanes would be defined to reduce the overall area of disturbance from vessel activities. Where possible, these transit lanes would follow greatest water depths to avoid significant meadows of seagrasses.

Slow moving displacement vessels such as bulk carriers, barges and tugs do not pose a boat strike risk and as such are not considered a risk in the operational phase of either the port area or in the Embley and Hey Rivers. TSHDs are similarly slow moving however in accordance with typical permit conditions for dredging and sea disposal, RTA will ensure that before beginning TSHD dredging and

dumping activities during daylight hours, a check will be undertaken, using binoculars from a high observation platform, for Dugongs (and whales) within a monitoring zone (approximately 300 metres of any point on the dredging/dumping run about to be commenced). If any Dugong (or whales) are sighted in the monitoring zone, dredging/dumping activities will not commence until after the last Dugong (or whale) is observed to leave the monitoring zone; or alternatively the dredge will to move to another area of the dredge or disposal site to maintain a minimum distance of 300 metres between the vessel and any Dugong (or whale). CSDs are essentially stationary during dredging, and so do not pose a risk to Dugong. Any injury or death of a Dugong from dredging would be documented and reported within 24 hours of the incident to DERM and DSEWPaC and further monitoring and/or management requirements discussed.

As well as direct impacts from boat strike, boating activities have been implicated in the disturbance and alienation of Dugong from their feeding habitats along the Queensland east coast (Hodgson and Marsh 2007). There is no Dugong feeding habitat in the vicinity of the proposed wharf and shipping channel, so the risk of strike by bulk carriers at the port and the risk of alienation from habitat is low. While Dugongs may move through the proposed port area when periodically migrating between feeding areas, the proposed port and port activities do not represent a barrier to migration that is likely to result in any meaningful impact on Dugong populations in the region. Overall, Project-related vessel movements are likely to have a low risk of impact on Dugongs in the vicinity of the proposed port.

Seagrass is absent from both the proposed port site and proposed new spoil ground location. Therefore Dugong foraging habitat would not be directly disturbed by port dredging and spoil disposal nor affected by turbidity plumes from port dredging. At the barge/ferry terminals, minor capital dredging is proposed. The area of seagrass to be disturbed is not significant in terms of a Dugong foraging resource (**Section 6.3.4.2**). Given the minor scale and short duration of dredging, at each of the barge/ferry terminals it is unlikely that Dugong foraging areas would be significantly affected by turbidity plumes.

Dugongs are potentially sensitive to underwater noise and construction activities, such as pile driving, have the potential to temporarily drive Dugongs from the area or cause physical damage to the auditory system or cause temporary changes in behavioural patterns (refer **Section 10.2.5**). As discussed previously, the proposed port area is not suitable Dugong habitat; as such, it is predicted that an avoidance response to underwater construction activities would pose a low risk of impact to Dugongs at this site. Seagrass beds are typically present in the lower reaches of the Embley River (refer **Section 6.3.4**), therefore, an avoidance response to construction activities in the Embley estuary pose a moderate risk of impact to Dugongs. However, pile driving would be a one-time event of short duration (approximately 15 days). Risk from physical damage to the auditory system from pile-driving activities would be minimised where possible through a "soft-start" approach and the monitoring of an exclusion zone (refer **Section 10.5**). "Soft-start" refers to the increasing of pile energy gradually over a period of time.

6.9.4.2 Cetaceans (Whales and Dolphins)

Four cetacean species are known to frequent the Project area: Indo-pacific Humpback Dolphin, inshore and offshore Bottlenose Dolphins, and Australian Snubfin Dolphin. Bryde's Whale (*Balaenoptera edeni*) inhabits inshore tropical waters, so it may occur sporadically in the vicinity of the port area, but not in the shallower estuarine areas of the Embley and Hey Rivers.

The following aspects of the proposed Project may affect dolphin and whale species in the vicinity of the Project activities:

- boat strike;
- direct impact from dredging activities;
- disturbance from boating and shipping activities including alienation from habitat; and
- acoustic impacts.

In Australia, dolphin species in particular co-exist with coastal development including extensive port facilities (Hale *et al.* 1998). The most important area for Indo-Pacific Dolphins in Moreton Bay is the Port of Brisbane (Hale *et al.* 1998). Indo-Pacific Humpback Dolphins and Australian Snubfin Dolphins are also associated with port infrastructure at Cleveland Bay, Townsville (Parra 2006). Bottlenose

Dolphins also inhabit inshore areas where significant amounts of recreational vessel and commercial water-based activities occur including Moreton Bay (Chilvers *et al.* 2005), Richmond and Clarence Rivers (NSW) (Fury and Harrison 2008), and Port Stephens and Jervis Bay (NSW) (Möller *et al.* 2002).

The potential for boat strike on whales would be similar for Dugong in the coastal waters of the Gulf of Carpentaria given their size and similar mobility. Whales do not inhabit the estuarine areas of the Embley and Hey Rivers. The slow moving displacement vessels that would operate in the proposed port area do not pose a boat strike risk to whales.

As indicated for Dugong in **Section 6.9.4.1**, despite TSHDs being slow moving displacement vessels, visual checking would be undertaken during daylight hours for whales in an approximately 300m monitoring zone, and if they were present, the dredging location would be changed or operations suspended until after the last whale has left the monitoring zone. CSDs are essentially stationary during dredging, and so do not pose a risk to cetaceans. Any injury or death of a cetacean from dredging would be documented and reported within 24 hours of the incident to DERM and DSEWPaC and further monitoring and/or management requirements discussed.

The potential for boat strike on dolphins would be less than for Dugongs and whales overall due to their greater mobility and ability to quicker response to disturbances. The slow moving displacement vessels operating in the proposed port area and Embley and Hey Rivers do not pose a risk to dolphins. The ferry that would operate in the Embley and Hey Rivers presents a low risk compared to the moderate risk for Dugong on the basis that dolphins are more agile and able to better react to and avoid approaching vessels. Following from this low risk of boat strike, the potential for disturbance from boating and shipping activities and possible alienation from habitat is considered minor, particularly given preferred pelagic foraging habitats are not located in the Embley and Hey Rivers where the ferry would provide transportation services.

A number of human-caused marine noises can be highly intensive and detectable at ranges of several kilometres (Gordon and Moscrop 1996). Cetaceans have been found to avoid some human sound sources for ranges of several kilometres, abandoning valuable habitat in the process (Tyack 2008).

Jefferson *et al.* (2009) identified that Indo-Pacific Dolphins avoid areas during pile driving but return once construction ceases. Such short-term responses by dolphins to pile driving and other construction activities are expected from the proposed Project, but no significant long-term impacts are predicted. While no significant impacts are expected, risk of acoustic impacts from pile-driving activities would be minimised where possible through a "soft-start" approach and the monitoring of an exclusion zone (refer **Section 10.5**).

6.9.4.3 Marine Turtles

The primary factor currently impacting sea turtle nesting success at the proposed Port site is predation by feral pigs (refer **Section 6.6.5**). The intensity of nest disturbance by feral pigs is very high, particularly at Boyd Point immediately to the north of the proposed port area where there are no cliffs impeding beach access.

The following aspects of the Project may affect marine turtles:

- altered above-water, night-time light regime;
- boat strike;
- disturbance from boating and shipping activities including alienation from habitat;
- direct impact from suction dredging activities;
- creation of a turbidity plume from dredging activities, and subsequent deposition and re-suspension of fine sediments on feeding habitats;
- introduction of hard substrate (e.g. piles); and
- acoustic impacts from pile driving activities on turtles.

These factors are discussed below in terms of management.

Altered Above-Water Night-Time Light Regime

Altered above-water night-time light regime can affect nesting adult female turtles and hatchlings (refer **Section 6.6.5**). Design and operational guidelines for mitigating lighting impact on turtle

hatchings associated with coastal development have been developed (Witherington and Martin 1996). These guidelines are designed more for residential developments and roads than the proposed development type, but some general principles are relevant and would be utilised where applicable for the proposed port. Australian examples exist where the impacts of artificial lighting on turtles have been mitigated in part. At Thevnard Island (North West Shelf) light impacts were mitigated from offshore petroleum production by minor shielding, re-positioning and, in some cases, time-switching of the lights. It is difficult, however, to mitigate the impacts of a changed lighting regime in its entirety. A lighting plan for the port is considered an important part of both construction and operation environmental management. Turtle sensitive lighting approaches would also need to consider safety requirements, navigation requirements and the need to minimise light spill on turtle sensitive areas. A lighting plan has been developed with consideration of the following:

- ensuring lighting is minimised overall to that which is essential for safe and efficient operation of the facility;
- ensuring non-essential lighting will be switched off or dimmed when there are no ships at berth or being piloted in the area;
- shielding and/or recessing of lights to minimise light spill;
- installation of long wavelength lights; and
- any other lighting options that further reduce impacts to marine turtles while allowing for the safe and efficient operation of the port facility.

The lighting plan is detailed in **Table 6-50**. RTA proposes an adaptive approach to work with the Traditional Owners and DERM to minimise the impacts of changes to the light regime during both the construction and operation phases of the proposed port on marine turtles, while still allowing a safe working environment. An altered above-water night-time light regime without mitigation is anticipated to cause the largest single potential threat to marine turtles. In addition to the lighting plan, a feral pig control program would be implemented between Pera Head and Boyd Point to reduce nest predation and enhance turtle population survivorship. It is considered that this measure would produce an overall increase in hatchling numbers and therefore there would not be an overall significant adverse impact on threatened marine turtles.

Boat Strike, Boating, Shipping Disturbance and Habitat Alienation

There is the possibility of impacts on marine turtles from both boat strike from fast moving vessels and alienation from habitat by boating activity. These impacts are relevant primarily at the proposed port site. The barge/ferry terminals are not in areas that have habitat likely to be frequently utilised by marine turtles. Therefore the operation of the ferry is predicted to pose a low risk.

Review of the Queensland Marine Wildlife Stranding and Mortality Database annual reports from 1999-2004 (most recent), does not indicate that there are any significant number of dead turtles with boat strike markings from the Weipa or Western Cape York region. Most incidences are from Moreton Bay and Townsville. This situation is unlikely to change as a result of Project construction or operation.

Unlike the Dugong, there is no available information to demonstrate that boating activity alienates marine turtles from their habitat although this cannot be discounted. Marine turtles are known to co-exist in areas with very high levels of boating activity (e.g. southern bay islands of Moreton Bay).

Direct Impact from Dredging Activities

The use of self propelled trailing suction hopper dredgers has the potential to entrain marine turtles during dredging activities. The use of turtle exclusion devices on the suction heads is now standard equipment on such dredgers and minimises the potential for entrainment. Any TSHD contracted for the port area dredging (and future maintenance dredging) would be required to have turtle exclusion devices fitted. Entrainment by cutter suction dredges is less likely due to the slow rate of progress of dredging. Bucket type dredges, such as those potentially used for Embley and Hey River dredging activities, do not pose an entrainment hazard to turtles. Any injury or death of a turtle from dredging would be documented and reported within 24 hours of the incident to DERM and DSEWPaC and further management requirements discussed.

Table 6-50 Lighting Plan

Facility	Description	Mitigation measures
Phase: Design		
Shiploader	Only in use when shiploading. Only equipment would be lit. Lighting required to enable worker to enter cabin. When in use light would be required for conveyor belts, transfer shoots and discharge point to hull. Shiploader height about 8–10m above top of wharf level.	• Long wave length lighting (low pressure sodium or equivalent) • Turn off unnecessary lights when not in use and minimise usage to that required for safe operation
Wharf deck	Light access walkway and conveyor bends as needed	• Long wave length lighting (low pressure sodium or equivalent) • Turn off unnecessary lights when not in use and minimise usage to that required for safe operation • Shielding, height (keep low) and direction to minimise light spill
Jetty	Light access walkway and roadway as needed	• Long wave length lighting (low pressure sodium or equivalent) • Turn off unnecessary lights when not in use and minimise usage to that required for safe operation • Shielding, height (keep low) and direction to minimise light spill
Dolphin walkway	Light access walkway as needed	• Long wave length lighting (low pressure sodium or equivalent • Turn off unnecessary lights when not in use and minimise usage to that required for safe operation • Shielding, height (keep low) and direction to minimise light spill
Tug berth	Light access berth and walkways as needed	• Long wave length lighting (low pressure sodium or equivalent) • Turn off unnecessary lights when not in use and minimise usage to that required for safe operation • Shielding, height (keep low) and direction to minimise light spill
Tug boat	Required for safe movement around deck of tug	• Limit usage to that required for safe operation
Bulk carrier (decks)	Required for safe movement around deck of bulk carrier	• Limit usage to that required for safe operation
Navigation lights	Must meet the requirements of Queensland Transport; however RTA would work to implement mitigation measures wherever possible	• Flashing lights
Emergency lighting throughout wharf / tug berth area	Only used as needed	• Turn off unnecessary lights when not in use and minimise usage to that required for safe operation
Stockpile area	No lighting required, machine (stacker/reclaimer) would be sufficient	• No tower flood lighting (stacker/reclaimer mounted lights are sufficient)
Stacker/reclaimer	Stacker would operate continuously – machinery to be lit. Reclaimer would operate when ship loading – machinery to be lit	• Long wave length lighting (low pressure sodium or equivalent) Turn off unnecessary lights when not in use and minimise usage to that required for safe operation • Shielding, height (keep low) and direction to minimise light spill • Vegetation buffer of *Eucalyptus tetradonta* forests estimated at 25–30m high at 200m width (between stacker/reclaimer and port)
Beneficiation plant	Operate continuously – machinery and work area to be lit	• Shielding, height (keep low) and direction to minimise light spill • Vegetation buffer of *Eucalyptus tetradonta* forests estimated at 25–30m high at over 200m width (between beneficiation plant and port)
Phase: Construction and Operation		
All	Administrative controls to minimise the potential for impact	• Standard ground clearing management procedures to retain vegetation buffer • Training workforce regarding potential impacts and management measures • Limit access to beach areas • Standard incident reporting procedure for sea turtle incidents, hazards or near misses • Lighting requirements as per design would be maintained • Reactive monitoring for deposition and light

Note: Embley River and Hey River are not nesting areas for turtles, so lighting impacts from barge/ferry terminals is not a potential impact.

Turbid Plume Generation and Sediment Deposition/Re-suspension on Feeding Habitat

The creation of a turbidity plume from dredging activities, and subsequent deposition and re-suspension of fine sediments, can potentially impact foraging habitat of marine turtles. The diverse reef assemblages provide a food source for marine turtles, particularly Hawksbill Turtles which prefer sponges, seagrass and algae. Approximately 71ha of sponge/soft coral habitat occurs between Boyd Point and Pera Head (inclusive) (refer **Section 6.3.2**). It is predicted that sediment deposition would be at its greatest between these two locations (refer **Section 6.9.2.5**) and may locally affect feeding preferences in marine turtles. It is estimated that 117ha of similar habitat occurs between Pera Head and Thud Point (refer **Section 6.3.2**), with more likely to occur at inshore reef areas south of Thud Point and north of Boyd Point, so regional impacts to feeding habitats are not predicted.

At the barge/ferry terminals in the Embley and Hey Rivers, minor capital dredging is proposed. The area of seagrass to be disturbed is not significant in terms of a marine turtle foraging resource (**Section 6.3.4.2**). Given the minor scale and short duration of dredging at each of the barge/ferry terminals it is unlikely marine turtle foraging areas would be significantly affected by turbidity plumes from barge/ferry terminal dredging. The overall risk to marine turtles from restriction of food availability then is low.

Introduction of Hard Substrate

The width of the jetty structure that crosses the beach would be 10.9m which is a very small proportion of the beach length (5.81km between Boyd Point and Pera Head). Once the jetty is constructed, turtles would still have access to the area under the jetty, except where the foundations for the two piles on the beach (81m^2 each) are located. Therefore the impact from the construction and operation of the jetty related to removal of habitat for nesting of turtles is considered minor. Bell (2003) also identifies that marine turtles co-exist with port infrastructure, with green and flatback turtles nesting within port limits of Lucinda and Abbot Point.

The introduction of hard surfaces such as jetty pilings would provide a long-term surface upon which a range of sessile flora and fauna may establish and present local feeding opportunities to turtle species, particularly those that prefer reef-type foraging habitats. Sessile organisms likely to establish include solitary and colonial ascidians, sponges, soft corals and macroalgae, which present possible food sources for Hawksbill and Flatback Turtles.

Establishment of sessile organisms on the artificial surfaces is likely to take several years and experience successional development of different assemblages over time, beginning with a few pioneering species before increasing in complexity. While this may provide local benefits in the long-term it would not compensate for localised reduction in food resources over the reef areas in the short to medium term during port development capital dredging.

Acoustic Impacts from Pile Driving Activities on Turtles

There is limited data on the potential underwater noise impacts to marine turtles from pile driving activities, however SVT (2009) conducted underwater noise modelling and assessment for pile driving activities proposed for the Cape Lambert Port B Development in Western Australia. The following conclusions were made regarding marine turtles:

- physical injury would be likely to occur at peak pressure levels greater than 222dB re 1µPa at a sound exposure level (SEL) of 198dB re 1µPa^{2}s;
- hearing damage may occur at peak pressure levels greater than 222dB re 1µPa;
- avoidance behaviour was estimated to occur at peak pressure levels greater than 120dB re 1µPa based on the auditory bandwidth of turtles; and
- there is no supporting literature to establish acceptable levels of continuous noise to prevent threshold shift in marine turtles.

While no significant impacts associated with pile driving activities on marine turtles are expected, the risk of underwater acoustic impacts from pile-driving activities would be minimised where possible through a "soft-start" approach and the monitoring of an exclusion zone as discussed below.

Management Measures

RTA is committed to working with the DERM to reduce threats to marine turtles, particularly in the proposed port area, and assist with marine turtle research programs. RTA has placed sand temperature loggers near Boyd Point as part of a DERM research project to examine the potential impacts of climate change on marine turtle populations. RTA would document any strandings of marine turtles (e.g. animals entangled in ghost nets) and report these to DERM for inclusion in the Wildlife Stranding and Mortality Database and would remove ghost nets in the vicinity of the proposed port development.

RTA would work with Traditional Owners and DERM to develop and implement measures to reduce feral pig numbers in the Pera Head to Boyd Point area. Currently feral pigs are the primary factor reducing the success of sea turtle reproduction (hatchling emergence). The Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia, 2003) identifies the major significance of predation by pigs on turtle nests. Data from some similar programs is provided below to indicate the success a feral pig control program can have on reducing predation on turtle nests and increasing the chances of hatchling survival.

Based on observations, NPWS and DPI (2003) states that if feral pig predation continues and remedial action is not taken, nesting by sea turtles in the Western Cape will cease by 2030. This report also notes that, on average, 90% of marine turtle nests that have been observed in the area have had some form of disturbance by feral pigs.

GHD (2007b) notes that of the 15 nests observed, 10 of these nests showed evidence of predation by feral pigs.

Bell (2003) notes that of the 236 nests observed between Aurukun and Marpoon (to the south and north of the proposed port area), there was evidence of predation by feral pigs in most nests.

Bell *et al* (2004) shows that all nests that were protected by Feral Pig Control Devices had not been subject to predation, while the majority of nests that were not protected by the devices showed evidence of predation by feral pigs.

The Cape York Weeds and Feral Animal Control Program's marine turtle conservation program has managed to eradicate approximately 28,000 feral pigs in areas of Cape York since June 2006. This has resulted in predation levels on turtle nests dropping to 30% from 90% (67% reduction) prior to the commencement of the program. This has also resulted in a significant increase in the amount of turtle hatchlings reaching the water. The program has included beach areas north and south of the Project area, but not beaches within the Project area itself.

The above evidence suggests that feral pig control programs would provide a significant benefit to the marine turtle population's breeding success that use the beaches within the Project area for nesting.

A review of the Queensland Marine Wildlife Stranding and Mortality Database annual reports from 1999-2004 (most recent), indicates that, on average, 11-15% of all turtles found dead had evidence of boat strike markings. Extrapolation for the Western Cape during this period indicates that on average 1-2 dead turtles per year would be attributed to boat strike.

The 2008 EIS turtle nesting survey (carried out over 3 days) reported predation of 5 nests. Limpus (2007) reports that Flatback Turtle nests on Crab Island contain approximately 55 eggs, and Limpus presents data showing that of those eggs not subject to predation, there is relatively high emergence (85.8%) and low mortality on the beach (14%). A 67% reduction in predation would result in 135 additional turtle hatchlings expected to have made it to the water from these 5 nests. This is therefore expected to result in a net benefit to the turtle population as the increase in hatchling emergence (135 per 5 nests) would far outweigh the potential incidence of boat strike on turtles (1-2 per annum) within the vicinity of the Project.

RTA would work with DERM to evaluate whether relocating nests is appropriate. A monitoring program would be developed in conjunction with Traditional Owners and DERM with consideration of turtle nesting activities (number, type, predation, success), behaviour (hatchling activity) and incident reporting.

To minimise the potential underwater noise impacts on marine turtles during pile driving activities, it is proposed that a "soft start" approach be used to disperse marine fauna (including marine turtles) in the vicinity of these activities prior to normal pile driving. The "soft start" involves commencing pile

driving with a partial capacity strike, or giving a warning with an underwater airgun prior to normal pile driving. It is proposed that an exclusion zone surrounding pile driving activities be established and monitored by an observer prior to normal pile driving commencing and during normal pile driving. Normal pile driving activities would not commence or be temporarily suspended if marine turtles or other threatened marine fauna are observed within the exclusion zone. Normal pile driving activities would not recommence until marine turtles or other threatened marine fauna are considered to be outside the exclusion zone. The extent of the exclusion zone would be defined based on further literature review and quantitative analysis of the potential underwater noise impacts from pile driving relating to marine turtles or other threatened marine fauna. The final extent of the exclusion zone would be defined in consultation with DSEWPaC.

6.9.4.4 Macrobenthic Infauna

Macrobenthic infaunal assemblages are temporally and spatially highly variable at several different scales. Macrobenthic infaunal assemblages are likely to be affected at the site of the proposed port facility, new spoil ground, the barge/ferry terminals and the Albatross Bay spoil ground. Dredging and spoil deposition has impacts as a result of:

- physical disturbance of sedimentary habitats and fauna from dredging; and
- creation of a turbidity plume, and subsequent deposition and re-suspension of fine sediments.

As identified in **Section 6.9.3.4**, there would be deposition of 3–4m over the spoil ground during capital dredging and approximately 0.4m during ongoing annual maintenance dredging. Despite the potentially significant local impact on the infauna assemblage through smothering during capital dredging spoil disposal, physical disturbance of the dredge sites, deposition of spoil, and the re-suspension of disturbed and deposited sediment poses a low risk on a regional scale.

Macrobenthic infaunal assemblages can recover over time from the impacts of dredging and spoil disposal. Recovery of the macrobenthic assemblage from spoil deposition at the current Weipa spoil ground in Albatross Bay is considered to be rapid (GHD 2005). Macrobenthic infaunal assemblages in the region are exposed to periodic but significant physical disturbance and elevated turbidity occurring during extreme weather events.

Monitoring of infauna is proposed be undertaken at the new spoil ground location following capital dredging and at the proposed port to identify the extent of smothering impact, spoil migration and recovery over time. Collection of infauna was undertaken in June 2010 from 15 sites within and adjacent to the proposed new spoil ground. Identification and enumeration of these samples would provide a baseline for post-dredging impact assessment.

The spatial survey design is represented in **Figure 6-66** and is based on the bulk of the disposed material remaining within the proposed spoil ground, with a primary impact zone constrained to within the spoil ground boundary (i.e. 0.5nm radius). Sample collection would occur at the following locations:

- Four samples from each of five sites within the spoil ground (centre (SG1), north (SG2), west (SG3), south (SG4), east (SG5));
- Four samples from each of five sites with distance 125m (E1), 250m (E2), 500m (E3), 1000m (E4), 2000m (E5) on an easterly axis from the boundary of the spoil ground. This axis acts as a reference area, being perpendicular to the direction of plume travel;
- Four samples from each of five sites with distance 125m (S1), 250m (S2), 500m (S3), 1000m (S4), 2000m (S5), on a southerly axis from the boundary of the spoil ground approximately in line with the direction of current (and hence plume) travel;

Samples are collected using a grab deployed from a boat. Samples would be sieved using a 1mm mesh sieve and the retained infauna material, preserved, identified and enumerated. One sediment sample per site would be analysed for particle size distribution (to 63µm) as this can have a major influence on benthic community composition. Univariate and multivariate statistical techniques would be used to test for temporal and spatial differences in abundance, diversity and infauna assemblage composition.

This sampling design has been used successfully in spoil monitoring programs at the Ports of Bundaberg and Cairns. The design is based on monitoring programs commonly undertaken in relation

to monitoring of offshore oil and gas wells. The design has previously been reviewed and approved for use in the context of spoil ground monitoring by the DSEWPaC (then DEWHA) in 2004 (in relation to monitoring at the Port of Bundaberg spoil ground). It has been proven to be effective in identifying impacts within and outside spoil grounds.

Monitoring is also proposed for the ongoing maintenance dredging campaigns at a frequency of five years, consistent with that required for long-term maintenance dredging for the Port of Weipa.

Monitoring at the Albatross Bay spoil ground is not proposed due to the minor dredge volumes involved, particularly in comparison to far larger volumes disposed there regularly from routine maintenance dredging of the Port of Weipa.

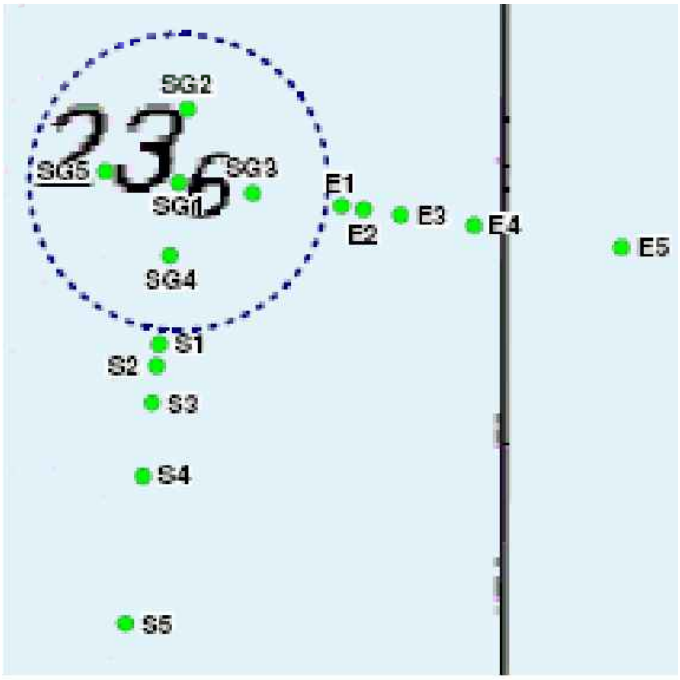

Figure 6-66 Infauna monitoring locations at the proposed offshore spoil ground

6.9.4.5 Fish Assemblages (including sharks and rays)

Fish assemblages may be affected by:

- introduction of hard artificial substrata (e.g. piles) into the marine environment;
- physical disturbance of sedimentary habitats and fauna from dredging and from construction of infrastructure; and
- creation of a turbidity plume, spoil deposition and re-suspension of fine sediments.

It is well documented that the introduction of piles and other port structures act as de-facto artificial reefs that attract many species of fish and this generally leads to an increased species richness and abundance of the fish assemblage at the local scale (Clynick *et al*. 2008). At the proposed port location, species richness and overall abundance of the fish assemblage is predicted to increase in response to the addition of piles. The addition of hard artificial substrata may also result in impacts of minor magnitude on the structure of fish assemblages. That said, the predicted impact on the fish assemblage, namely increased abundance and species richness, is generally considered by the public as beneficial and the science of artificial reefs is predicated on it.

The fish assemblage is exposed to periodic but significant physical disturbance and elevated turbidity during extreme weather events. Fish species are also mobile and as such can move away from any local areas that are affected by a disturbance (e.g. dredging and dredge spoil deposition). Physical disturbance to the dredged site, deposition of spoil, and the re-suspension of disturbed and deposited

sediment probably would have impacts of minor magnitude at the proposed port facility, the proposed new spoil ground, and the barge/ferry terminals.

Information relating to potential impact on fish assemblages in estuarine areas is provided in **Sections 8.14 to 8.17** and **Appendix 8C**.

The projected change in population (refer **Table 16-3**) is not predicted to increase recreational fishing activity in the area significantly. The projected population of Weipa would decrease from the 2007/08 population during the 15Mdptpa and 30Mdptpa scenarios. Recreational fishing activity as a result of the Project is therefore expected not to increase from levels in recent years. If the Project expands to 50Mdptpa (subject to market demand), then the population of Weipa is only projected rise approximately 400 (10%) above the peak of the 2007-2008 population. This increase at 50Mdptpa would be unlikely to significantly increase recreational fishing activity in the area or subsequently the impact of recreational fishing impacts on fish assemblages, including sawfish and shark species.

The Project is predicted to pose a low risk to sharks and rays, including sawfishes, and a low risk to bony fishes.

6.9.4.6 Introduced Marine Pests

It is likely that construction dredging for the port area would require the services of internationally sourced dredgers. RTA proposes to manage the potential for introduced marine pest incursions from this source based on a risk-based approach. Initially, this would be based on a review of the ships work and maintenance history. Where operations or duration since last maintenance period are extended or the information not provided, certification from the dredging contractor by way of hull inspection clearance would be requested. Clearance of the vessel for fouling prior to its mobilisation to Australia would be considered as an item for contract, including diver or dry dock inspection. This approach is consistent with the biofouling risk assessment framework outlined within the *National Biofouling Guidance for Non-trading Vessels* (Commonwealth of Australia 2008). Detail of the proposed management and monitoring measures will be provided in the Dredge Management Plan.

The risk of marine pest introduction from vessels during operations is likely to be similar to the current risks associated with port operations at the Port of Weipa because vessel activity associated with bauxite export would merely shift over time from the Port of Weipa to the Project port area. Currently approximately 20% of exports from Weipa are destined for China, Korea and Japan. The Project port would operate in similar export proportions and destinations to that of the current Port of Weipa.

Under the DSEWPaC-approved Port of Weipa Long Term Environment Management Plan for Dredging and Dumping Activities (SKM 2009a), the Port of Weipa is considered a low risk port for marine pests and hence there is currently no requirement to undertake a comprehensive marine pest survey of the port. However, consistent with the low risk rating, limited routine monitoring is undertaken at the Port of Weipa. Larval monitoring plates are deployed at three sites (Evans Landing, and Lorim Point Wharf east and west). These traps are retrieved and checked every three months and no pest species have been identified to date.

RTA proposes to deploy similar larval plates at two locations along the Project jetty. They would be retrieved and checked for introduced marine pest larvae every three months.

In the event of a pest incursion during either dredging or operations, RTA would advise Biosecurity Queensland immediately and work with them in planning and implementing a response. The nature of the response would be determined largely by the type of organism and its lifecycle, substrate affected and extent of incursion.

6.9.5 Summary of EPBC Act "Significance of Impact" Assessments for Threatened and Migratory Fauna

The summary "assessments of significance of impact" in this section are based on the *Significant impact guidelines* (DEWHA 2009a) and draws on discussion provided in **Section 6.9.4**.

6.9.5.1 Threatened Marine Fauna

Individual significant impact assessments are provided below for each of the EPBC Act listed threatened marine fauna species assessed as *likely* or *known to occur* in the Project area as identified in **Section 6.6.1**.

These include:

- Endangered species
    - Leatherback Turtle (*Dermochelys coriacea*)
    - Loggerhead Turtle (*Caretta caretta*)
    - Olive Ridley Turtle (*Lepidochelys olivacea*)
- Vulnerable species
    - Hawksbill Turtle (*Eretmochelys imbricata*)
    - Flatback Turtle (*Natator depressus*)
    - Green Turtle (*Chelonia mydas*)
    - Green Sawfish (*Pristis zijsron*);
    - Dwarf Sawfish (*Pristis clavata*).

Key definitions from the DSEWPaC guidelines that apply to this assessment are as follows:

- "Population of a species" is an occurrence of the species in a particular area. In relation to critically endangered, endangered or vulnerable threatened species, occurrences include but are not limited to:
    - a geographically distinct regional population, or collection of local populations; or
    - a population, or collection of local populations, that occurs within a particular bioregion.
- "Habitat critical to the survival of a species or ecological community" refers to areas that are necessary:
    - for activities such as foraging, breeding, roosting, or dispersal;
    - for the long-term maintenance of the species or ecological community;
    - to maintain genetic diversity and long-term evolutionary development; or
    - for the reintroduction of populations or recovery of the species or ecological community.

  Such habitat may be, but is not limited to:
    - habitat identified in a recovery plan for the species or ecological community as habitat critical for that species or ecological community; and/or
    - habitat listed on the Register of Critical Habitat maintained by the Minister under the EPBC Act.
- An "invasive species" is an introduced species, including an introduced (translocated) native species, which out-competes native species for space and resources or which is a predator of native species. Introducing an invasive species into an area may result in that species becoming established. An invasive species may harm listed threatened species or ecological communities by direct competition, modification of habitat or predation.

Leatherback Turtle (*Dermochelys coriacea*): Endangered

The Leatherback Turtle is a pelagic feeder, found in tropical, subtropical and temperate waters throughout the world. In the vicinity of the Project area, Albatross Bay is identified as a potential foraging area for the species. They principally feed upon soft bodied invertebrates such as colonial ascidians and jellyfish. Leatherback Turtles are considered likely to occur in the Project area, potentially using it for foraging. They are rarely found in Queensland and have not been recorded to have nested in eastern Australia since 1996.

The best available data for population size at a global level are the numbers of adult females that breed in particular years. According to the DSEWPaC (2010) SPRAT database, the most recent estimate, in 2004, was that 35,800 females bred that year. There is insufficient data to determine whether the Australian population is distinct, geographically separate or whether it moves in/out of Australia's jurisdiction. The Leatherback Turtle is the most pelagic of all marine turtles, spending much

time in the open ocean, with individuals traversing thousands of kilometres, so it is likely that the population is continuous within Australia.

Given the rarity of this species in Queensland waters and the large home ranges they may have, the Project area is not considered to be of particular importance to this species. The Project area is not considered to contain an important population, geographically distinct regional population or local population that occurs within a particular bioregion.

Will the proposed works ...	**Leatherback Turtle (*Dermochelys coriacea*)**
... lead to a long-term decrease in the size of a population?	It is unlikely that this species utilizes Project area beaches for nesting since the leatherback turtle has not been recorded nesting in eastern Australia since 1996 and they are rarely found in Queensland. The impacting processes are not of a sufficient scale or magnitude to lead to a long-term decrease in the size of a population, particularly where their occurrence is normally rare.
... reduce the area of occupancy of the species?	Globally, the Leatherback Turtle occupies a broad latitudinal range, from tropical to sub-tropical waters. The Project would not reduce the area of occupancy of the leatherback turtle in any ecologically meaningful way.
... fragment an existing population into two or more populations?	The Project development and operation would not create any barriers to movement for Leatherback Turtles.
... adversely affect habitat critical to the survival of a species?	While some feeding habitat would be disturbed as a result of proposed dredging of the port area, suitable feeding habitats are found throughout coastal areas of the Gulf of Carpentaria. The constructed jetty would provide a surface for potential food sources (e.g. ascidians) to grow.
... disrupt the breeding cycle of a population?	Nesting is not known to occur in the vicinity of the Project area, so no disruption to the breeding cycle would result.
... modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?	While habitat would be disturbed as a result of dredging of the port area, the impact is not of a sufficient scale to affect the survival of any marine turtle species.
... result in invasive species that are harmful to an endangered species becoming established in the endangered species' habitat?	It is considered unlikely that an invasive species that is harmful to Leatherback Turtles would be introduced due to the development or operation of the Project marine infrastructure.
... introduce disease that may cause the species to decline?	Disease is not known as a threat to this species. It is considered unlikely that a disease harmful to the Leatherback Turtle would be introduced due to the development or operation of the Project marine infrastructure.
... interfere with the recovery of the species?	There is a recovery plan in place for all marine turtle species found in Australia. Use of turtle deflectors on suction hopper dredgers would minimise potential for entrainment of turtles during development and maintenance dredging for the port area. The Project is not expected to interfere with the recovery of the species.

Loggerhead Turtle (*Caretta caretta*): Endangered

The Loggerhead Turtle has a global distribution throughout tropical, sub-tropical and temperate waters with nesting mainly concentrated on sub-tropical beaches. In Queensland nesting is concentrated in the south-east, particularly along the Bundaberg coast. It prefers a range of habitats including subtidal and intertidal reefs, seagrass meadows and soft-bottomed habitats. It has a diverse diet but typical food items include crabs and bivalve and gastropod molluscs.

Surveys have found no nests in the Project area. It is considered likely that this species would be transient in the Project area, using it for foraging or resting, but highly unlikely for nesting.

There are no concise estimates of global population or annual nesting female numbers for the Loggerhead Turtle. The Loggerhead Turtle is considered to comprise of two distinct genetic stocks in Australia—the eastern Australian genetic stock and the western Australian genetic stock. The DSEWPaC (2010) SPRAT Database identifies that in 2000 it was estimated that there were 500 nesting females per year in the eastern Australian stock. Adult females comprise approximately 20% of the population.

Loggerhead Turtles occurring in the vicinity of the Project area are not considered to constitute an important population, geographically distinct regional population or local population that occurs within a particular bioregion.

Will the proposed works ...	Loggerhead Turtle (*Caretta caretta*)
... lead to a long-term decrease in the size of a population?	The impacting processes are not of a sufficient scale or magnitude to lead to a long-term decrease in the size of a population, particularly in an area where individuals would be transient.
... reduce the area of occupancy of the species?	Globally, the Loggerhead Turtle is a circum-tropical species. The Project would not reduce the area of occupancy of the Loggerhead Turtle in any ecologically meaningful way.
... fragment an existing population into two or more populations?	The Project development and operation would not create any barriers to movement for Loggerhead Turtles.
... adversely affect habitat critical to the survival of a species?	While some feeding habitat would be disturbed as a result of proposed dredging of the port area, suitable feeding habitats are found throughout coastal areas of the Gulf of Carpentaria.
... disrupt the breeding cycle of a population?	Nesting is not known to occur in the vicinity of the Project area, being centred principally in Queensland's south-east. No disruption to breeding cycles would occur.
... modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?	While habitat would be disturbed as a result of dredging of the port area, the impact is not of a sufficient scale to affect the survival of any marine turtle species.
... result in invasive species that are harmful to an endangered species becoming established in the endangered species' habitat?	It is considered unlikely that an invasive species that is harmful to Loggerhead Turtles would be introduced due to the development or operation of the Project marine infrastructure.
... introduce disease that may cause the species to decline?	Disease is not known as a threat to this species. It is considered unlikely that a disease harmful to the Loggerhead Turtle would be introduced due to the development or operation of the Project marine infrastructure.
... interfere with the recovery of the species?	There is a recovery plan in place for all marine turtle species found in Australia. Use of turtle deflectors on suction hopper dredgers would minimise potential for entrainment of turtles during development and maintenance dredging for the port area. The Project is not expected to interfere with the recovery of the species.

Olive Ridley Turtle (*Lepidochelys olivacea*): Endangered

The Olive Ridley Turtle nests throughout tropic waters and migrates through tropical and sub-tropical areas of the world. They generally inhabit shallow unvegetated coastal waters where they feed on gastropod molluscs and crabs

The Olive Ridley Turtle is the most numerous of all marine turtles in the world largely due to major global nesting areas occur in Pacific Costa Rica and Pacific Mexico. The DSEWPaC (2010) SPRAT database identifies studies that estimate global annual nesting populations to be 852,000 and 2,000,000. Detailed information on the size of nesting and foraging populations in Australia is unknown although the nesting population is expected to be in the order of a few thousand. Low density nesting has been historically recorded from a number of locations including the eastern Gulf of Carpentaria; however, there is some uncertainty whether nesting still occurs on Western Cape York.

Olive Ridley Turtles occurring in the vicinity of the Project area are not considered to constitute an important population, geographically distinct regional population or local population that occurs within a particular bioregion.

Will the proposed works ...	Olive Ridley Turtle (*Lepidochelys olivacea*)
... lead to a long-term decrease in the size of a population?	The Project aspects with the greatest potential for long-term impact and decrease in local Olive Ridley Turtle activity are dredging and onshore lighting (assuming turtle nesting continues to occur on western Cape York and in the vicinity of the proposed port). The use of turtle deflectors on trailing suction hopper dredgers and implementation of a lighting plan would minimise the risk of any long-term population decline. Implementation of a lighting plan would minimise long-term impacts from hatchling disorientation. Population survivorship would be enhanced through ghost-net removal and reducing feral pig numbers which currently cause major reductions in egg and hatchling survivorship. The impacting processes are not of a sufficient scale or magnitude to lead to a long-term decrease in the population size of this species.
... reduce the area of occupancy of the species?	The Project development and operation would not reduce the area of occupancy of the Olive Ridley Turtle in any ecologically meaningful way.
... fragment an existing population into two or more populations?	The Project development and operation would not create any barriers to movement for Olive Ridley Turtles or fragment an existing population.
... adversely affect habitat critical to the survival of a species?	While some local feeding habitat would be disturbed as a result of dredging of the proposed port area, suitable feeding habitats are found throughout coastal areas of the Gulf of Carpentaria.
... disrupt the breeding cycle of a population?	There is uncertainty whether Olive Ridley nesting continues to occur on western Cape York. Implementation of a lighting plan would minimise above-water lighting disorientation to hatchlings and impacts to local breeding success, should nesting still occur in the Project area. Hatchling survivorship would be enhanced through reduction in feral pig numbers in the vicinity of the proposed port development.
... modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?	While habitat would be disturbed as a result of dredging of the port area, the impact is not of a sufficient scale to affect the survival of any marine turtle species.
... result in invasive species that are harmful to an endangered species becoming established in the endangered species' habitat?	It is considered unlikely that an invasive species that is harmful to Olive Ridley Turtles would be introduced due to the development or operation of the Project marine infrastructure.
... introduce disease that may cause the species to decline?	Disease is not known as a threat to this species. It is considered unlikely that a disease harmful to the Olive Ridley Turtle would be introduced due to the development or operation of the Project marine infrastructure.
... interfere with the recovery of the species?	There is a recovery plan in place for all marine turtle species found in Australia. Use of turtle deflectors on trailing suction hopper dredgers would minimise potential for entrainment of turtles during development and maintenance dredging for the port area. Implementation of a lighting plan would minimise the risks of local breeding impacts from hatchling disorientation. Recovery of turtle species occurring in the area would be enhanced through removal of ghost netting on beaches in the vicinity of the port development and reduction of feral pig numbers. The Project is not expected to interfere with the recovery of the species.

Hawksbill Turtle (*Eretmochelys imbricata*): Vulnerable

Hawksbill Turtles are found in tropical, subtropical and temperate waters in all the oceans of the world. Nesting is mainly confined to tropical beaches. There are no concise estimates of global Hawksbill Turtle population numbers; however, Australia holds the largest breeding populations of Hawksbill Turtles in the world. There are two genetically separate subpopulations: one in the northern Great Barrier Reef, Torres Strait and Arnhem Land (north-eastern subpopulation); and the other on the North West Shelf of Western Australia (north-western subpopulation). The SPRAT database identifies that 'several thousand' females nest in Queensland each year.

For the north-eastern subpopulation, the northern Great Barrier Reef, and particularly Milman Island and the inner Great Barrier Reef Cays north from Cape Grenville, are considered to be important foraging grounds and juvenile habitat. The preferred foraging habitat of the Hawksbill Turtle is rocky and coral reefs where preferred food items include algae, seagrass and sponges.

Low density nesting is recorded from a number of locations from False Pera Head to Boyd Bay in the vicinity of the port development area. Reef habitat is likely to provide significant local foraging habitat.

Hawksbill Turtles occurring in the vicinity of the Project area are not considered to constitute an important population, geographically distinct regional population, or local population that occurs within a particular bioregion.

Will the proposed works...	Hawksbill Turtle (*Eretmochelys imbricata*)
... lead to a long-term decrease in the size of an important population of a species?	The impacting processes are not of a sufficient scale or magnitude to lead to a long-term decrease in an important population of this species.
... reduce the area of an important population?	Globally, the Hawksbill Turtle is a widely distributed species. The Project development and operation would not reduce the area of occupancy of the Hawksbill Turtle in any ecologically meaningful way.
... fragment an existing important population into two or more populations?	The Project development and operation would not create any barriers to movement for Hawksbill Turtles.
... adversely affect habitat critical to the survival of a species?	While some local feeding habitat would be disturbed as a result of dredging of the proposed port area, suitable feeding habitats are found throughout coastal areas of the Gulf of Carpentaria. The creation of a turbidity plume from dredging activities, and subsequent deposition and re-suspension of fine sediments, can potentially impact diverse reef assemblages which provide a food source for hawksbill turtles. While decreased light availability from turbid plumes may have an impact on marine plants and hard corals, any reduction in their immediate availability over the reef area would be buffered by the diversity of other foods available to hawksbill turtles that are not as sensitive to light or suspended solids changes, such as sponges, seagrass and algae. The constructed jetty would provide a surface for potential food sources (e.g. algae and sponges) to grow in the long term.
... disrupt the breeding cycle of an important population?	Low density Hawksbill Turtle nesting occurs in the area but it does not represent a critical breeding area, so no significant disruption is likely. Implementation of a lighting plan designed to minimise above-water lighting disorientation to hatchlings would minimise potential disruption to local breeding success. Hatchling survivorship would be enhanced through reduction in feral pig numbers in the vicinity of the proposed port development.
... modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?	While foraging habitat would be impacted as a result of dredging of the proposed port area, the impact is not of a sufficient scale to affect the survival of any marine turtle species.
... result in invasive species that are harmful to an vulnerable species becoming established in the vulnerable species' habitat?	It is considered unlikely that an invasive species that is harmful to hawksbill turtles would be introduced due to the development or operation of the Project marine infrastructure. Population survivorship would be enhanced through ghost-net removal and feral pig control measures. Currently feral pigs are the primary factor reducing the success of sea turtle reproduction (hatchling emergence). RTA would work with Traditional Owners and DERM to develop and implement measures to reduce feral pig numbers in the Pera Head to Boyd Point area.
...introduce disease that may cause the species to decline?	Disease is not known as a threat to this species. It is considered unlikely that a disease harmful to the Hawksbill Turtle would be introduced due to the development or operation of the Project marine infrastructure.
...interfere substantially with the recovery of the species?	There is a recovery plan in place for all marine turtle species found in Australia. Use of turtle deflectors on trailing suction hopper dredgers would minimise potential for entrainment of turtles during development and maintenance dredging for the port area. Implementation of a lighting plan would minimise the risks of local breeding impacts from hatchling disorientation. Recovery of turtle species would be enhanced through removal of ghost netting on beaches in the vicinity of the proposed port development and reduction of feral pig numbers. The Project is not expected to interfere with the recovery of the species.

Flatback Turtle (*Natator depressus*): Vulnerable

The Flatback Turtle does not have a global distribution. It is found only in the tropical waters of northern Australia, Papua New Guinea and Irian Jaya. The population size of the Flatback Turtle is currently estimated to be approximately 20,285 nesting females (Sea Turtle Conservancy 2010a).

It is considered that nesting is confined to Australia. Nesting locations occur from the Bundaberg region, north to west of the Northern Territory – Western Australia border. Within Australia, the most significant breeding site is Crab Island in the western Torres Strait. The beaches of western Cape York represent medium density nesting habitat. Flatback Turtle nesting occurs in the vicinity of the proposed port area with nesting occurring all year round, but peaking in May through to September.

Foraging habitats for the species are shallow coastal environments including rocky reef and sedimentary habitats where they feed principally on soft bodied animals including sea cucumbers, sea pens and soft corals.

Flatback Turtles occurring in the vicinity of the Project area are not considered to constitute an important population, geographically distinct regional population or local population that occurs within a particular bioregion.

Will the proposed works ...	Flatback Turtle (*Natator depressus*)
... lead to a long-term decrease in the size of an important population of a species?	The Project aspects with the greatest potential for long-term impact and decrease in local flatback turtle activity are dredging and onshore lighting. The use of turtle deflectors on trailing suction hopper dredgers and implementation of a lighting plan would minimise the risk of any long-term population decline. Implementation of a lighting plan would minimise long-term impacts from hatchling disorientation. Population survivorship would be enhanced through ghost-net removal and reducing feral pig numbers which currently cause major reductions in egg and hatchling survivorship. No significant long-term impact to an important population is expected.
... reduce the area of an important population?	The Project development and operation would not reduce the area of occupancy of the Flatback Turtle in any ecologically meaningful way.
... fragment an existing important population into two or more populations?	The Project development and operation would not create any barriers to movement for Flatback Turtles.
... adversely affect habitat critical to the survival of a species?	While some local feeding habitat would be disturbed as a result of dredging of the proposed port area, suitable feeding habitats are found throughout coastal areas of the Gulf of Carpentaria.
... disrupt the breeding cycle of an important population?	Medium density Flatback Turtle nesting occurs in the area but does not represent a critical breeding area, so no significant disruption is likely. Implementation of a lighting plan designed to minimise above-water lighting disorientation to hatchlings would minimise potential disruption to local breeding success. Hatchling survivorship would be enhanced through reduction in feral pig numbers in the vicinity of the proposed port development.
... modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?	While habitat would be disturbed as a result of dredging of the proposed port area, the impact is not of a sufficient scale to affect the survival of any marine turtle species.
... result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?	It is considered unlikely that an invasive species that is harmful to Flatback Turtles would be introduced due to the development or operation of the Project marine infrastructure. Population survivorship would be enhanced through ghost-net removal and feral pig control measures. Currently feral pigs are the primary factor reducing the success of sea turtle reproduction (hatchling emergence). RTA would work with Traditional Owners and DERM to develop and implement measures to reduce feral pig numbers in the Pera Head to Boyd Point area.
... introduce disease that may cause the species to decline?	Disease is not known as a threat to this species. It is considered unlikely that a disease harmful to the Flatback Turtle would be introduced due to the development or operation of the Project marine infrastructure.
... interfere substantially with the recovery of the species?	There is a recovery plan in place for all marine turtle species found in Australia. Use of turtle deflectors on trailing suction hopper dredgers would minimise potential for entrainment of turtles during development and maintenance dredging for the proposed port area. Implementation of a lighting plan would minimise the risks of local breeding impacts from hatchling disorientation. Recovery of turtle species occurring in the area would be enhanced through removal of ghost netting on beaches in the vicinity of the proposed port development and reduction of feral pig numbers. The Project is not expected to interfere with the recovery of the species.

Green Turtle (*Chelonia mydas*): Vulnerable

Green Turtles are found in tropical and subtropical waters throughout the world. It is estimated that globally there are approximately 88,520 nesting female turtles (Sea Turtle Conservancy 2010b). Green Turtles nest, forage and migrate across tropical northern Australia. Green Turtles forage in shallow coastal areas, in particular seagrass beds. The nearest important foraging ground to the Project is Wellesley Islands in the south-western corner of the Gulf or Carpentaria. Numerous nesting areas are identified for Australian waters including western Cape York. The SPRAT database identifies that the total Australian population of Green Turtles is estimated to be more than 70,000 individuals, distributed across seven genetically distinct regional populations.

Green Turtles are likely to forage in the Project area, including the Embley and Hey Rivers where seagrass beds occur, but do not nest in the Project area. They feed principally on seagrass and seaweeds although juveniles are also carnivorous. It is uncertain which sub-population Green Turtles in the Project area would belong to, as their reported geographic distributions do not include the Project area. They could belong to the Northern Great Barrier Reef population (containing around 41,000 individuals), or the Southern Gulf of Carpentaria population (containing around 5,000 individuals), or both.

Will the proposed works...	Green Turtle (*Chelonia mydas*)
... lead to a long-term decrease in the size of an important population of a species?	At the Project scale, Green Turtles occurring in the vicinity of the Project area do not constitute a geographically distinct regional population or local population that occurs within a particular bioregion. The Project aspect with the greatest potential for long-term impact and decrease in local Green Turtle activity is dredging. The use of turtle deflectors on trailing suction hopper dredgers would minimise the risk of any long-term population decline. Minor removal of seagrass from barge/ferry terminal berth areas would not impact Green Turtle feeding resources, with more significant seagrass meadows occurring elsewhere in the Weipa region. The impacting processes are not of a sufficient scale or magnitude to lead to a long-term decrease in an important population of this species.
... reduce the area of an important population?	The Project development and operation would not reduce the area of occupancy of the Green Turtle in any ecologically meaningful way.
... fragment an existing important population into two or more populations?	The Project development and operation would not create any barriers to movement for Green Turtles.
... adversely affect habitat critical to the survival of a species?	The Project area does not include any critical habitat areas for the species.
... disrupt the breeding cycle of an important population?	Surveys have found no nests in the Project area. No large rookeries are present in the region. Disruption to the life cycle of marine turtles is not anticipated as a result of the Project.
... modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?	Minor removal of seagrass from barge/ferry terminal berth areas would not impact Green Turtle feeding resources, with more significant seagrass meadows occurring elsewhere in the Weipa region.
... result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?	It is considered unlikely that an invasive species that is harmful to Green Turtles would be introduced due to the development or operation of Project marine infrastructure.
...introduce disease that may cause the species to decline?	Disease is not known as a threat to this species. It is considered unlikely that a disease harmful to the Green Turtle would be introduced due to the development or operation of Project marine infrastructure.
...interfere substantially with the recovery of the species?	There is a recovery plan in place for all marine turtle species found in Australia. Use of turtle deflectors on trailing suction hopper dredgers would minimise potential for entrainment of turtles during development and maintenance dredging for the proposed port area. The Project is not expected to interfere with the recovery of the species.

Green Sawfish (*Pristis zijsron*): Vulnerable

No quantitative data are available on global population size of the Green Sawfish. Green Sawfishes were once widely distributed in the northern Indian Ocean, westwards to South Africa, around South and Southeast Asia and around northern Australia. However, this species may now be virtually extinct in Southeast Asia, and northern Australia may be the last region where significant populations of green sawfish exist. There are no quantitative data regarding the Australian Green Sawfish population, but it is evident that there has been a significant decline in population number around the 1960s and 1970s, corresponding to an increase in commercial fishing.

The Australian population of the Green Sawfish is considered to be unfragmented and occurring throughout northern Australia. It is presumed that since it is a large species, and presumably is capable of long distance movements along the coast, they should form a continuous population (Stevens *et al.* 2005). On that basis, Green Sawfish within the Project area are not considered to represent an important population.

Green Sawfish inhabit estuaries, river mouths, embayments and along muddy and sandy beaches. This species may move into marine waters after the wet, and during the wet season enter estuarine or less saline environments (though not freshwater) to breed (Peverell 2005 and DSEWPaC 2010). They feed primarily on shoaling fish, baitfish, prawns, molluscs and small crustaceans.

This species has not been recorded in surveys of the Project area but it has been recorded from Albatross Bay. The Project area, including the port development area and barge/ferry terminals in the Embley and Hey Rivers, contain suitable habitat for the species. Further information relating to listed threatened Sawfish species in estuarine areas is provided in **Section 8.17** and **Appendix 8C**.

Will the proposed works...	Green Sawfish (*Pristis zijsron*)
... lead to a long-term decrease in the size of an important population of a species?	The impacting processes are not of a sufficient scale or magnitude to lead to a long-term decrease in an important population of this species given there is abundant suitable habitat available to it.
... reduce the area of an important population?	Given the extent of suitable habitat in northern Australia, the Project development and operation would not reduce the area of occupancy of the Green Sawfish in any ecologically meaningful way.
... fragment an existing important population into two or more populations?	The Project development and operation would not create any barriers to movement for Green Sawfish.
... adversely affect habitat critical to the survival of a species?	While some local habitat would be impacted as a result of proposed dredging activities in the Embley and Hey Rivers, suitable habitats are found throughout coastal areas of the Gulf of Carpentaria and northern Australia.
... disrupt the breeding cycle of an important population?	Development and operation of the barge/ferry terminals would not be at a sufficient scale or magnitude to lead to significant disruption to the Green Sawfish population, which is considered to occupy much of coastal northern Australia. Pupping is believed to occur in coastal or estuarine areas.
... modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?	While habitat would be impacted as a result of dredging of the barge/ferry terminals, the impact is not of a sufficient scale to affect the survival of the Green Sawfish.
... result in invasive species that are harmful to an vulnerable species becoming established in the vulnerable species' habitat?	It is considered unlikely that an invasive species that is harmful to Green Sawfish would be introduced due to the development or operation of the Project marine infrastructure.
... introduce disease that may cause the species to decline?	It is considered unlikely that a disease harmful to the Green Sawfish would be introduced due to the development or operation of the Project marine infrastructure.
... interfere substantially with the recovery of the species?	Globally the threats to the Green Sawfish include fishing pressure, shark finning, habitat degradation and Australian Indigenous harvesting. The low reproductive rate and late maturation of Green Sawfish limits the ability of the species to recover from listed threats (Stevens *et al.* 2005). The Project would not result in any substantial interference with the recovery of this species.

Dwarf Sawfish (*Pristis clavata*): Vulnerable

There are no confirmed records of the Dwarf Sawfish outside of Australian waters. The extent of distribution is considered to be from Cairns around Cape York Peninsula, across northern Australian waters to the Pilbara coast in Western Australia; however there have been no records of the species from the eastern coast of Cape York Peninsula. The DSEWPaC (2010) SPRAT Database identifies that there are insufficient data available to estimate the total numbers of mature individuals of Dwarf Sawfish in Australian waters.

Dwarf Sawfish inhabit shallow (2–3m) coastal waters and estuarine habitat, moving into marine waters after the wet season. The species prefers highly turbid environments (DSEWPaC, 2010) and are only usually found in silt sections of an estuary which are completely devoid of instream structure (Thorburn *et al.* 2003). However DSEWPaC (2010) does note that this species may rest either side of high tide in inundated mangrove forests. During the wet season enter estuarine or brackish waters to breed. Juveniles are more commonly encountered in coastal foreshores and embayments; adults in marine waters (DEEDI, 2009). Estuarine habitats are used as nursery areas by Dwarf Sawfish, with immature juveniles remaining in these areas up until three years of age (Thorburn *et al.* 2007). Adults are known to seasonally migrate back into inshore waters (Peverell 2007). They feed principally on schooling fish, particularly mullet. Individuals appear to move only small distances and occupy only a relatively restricted area.

This species has not been recorded in surveys of the Project area but are considered likely to occur in the estuarine and lower brackish reaches of the Project area's main drainage systems. Further information relating to listed threatened Sawfish species in estuarine and freshwater areas is provided in **Section 8.17** and **Appendix 8C**.Any population within the project area is likely to be locally important on the basis that individuals occupy restricted areas and travel only short distances.

Will the proposed works...	Dwarf Sawfish (*Pristis clavata*)
... lead to a long-term decrease in the size of an important population of a species?	The Project is unlikely to result in a long-term decrease in the size of the local dwarf sawfish population. The only shallow water (2–3m) development relates to the barge/ferry terminals where minor dredging would be required to a depth of approximately 2m. The proposed port area works in those shallow depths may relate only to piling as dredging starts at –11m LAT depth.
... reduce the area of an important population?	The minor works proposed in the shallows of the Project area would not cause any significant reduction in the area of a local population.
... fragment an existing important population into two or more populations?	Barges and ferries docked within the terminal areas may present temporary blocks to movement but this would not likely result in fragmentation as vessels would move several times per day.
... adversely affect habitat critical to the survival of a species?	The minor works proposed in the shallows of the Project area would not adversely affect habitat to the extent that it significantly impacts the local population or survival of the species as a whole.
... disrupt the breeding cycle of an important population?	The development and operation of the port and barge/ferry terminal areas is unlikely to disrupt the breeding cycle of the Dwarf Sawfish, which is believed to move into marine waters after the wet season, and during the wet season enter estuarine or fresh waters to breed. The infrastructure or activities are unlikely to present a significant barrier to movement.
... modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?	While habitat would be disturbed as a result of dredging and operation of barge/ferry terminal areas, the impact is not of a sufficient scale to significantly decrease the availability or quality of shallow muddy habitat as there is abundant similar habitat in the Project area.
... result in invasive species that are harmful to an vulnerable species becoming established in the vulnerable species' habitat?	It is considered unlikely that an invasive species that is harmful to dwarf sawfish would be introduced due to the development or operation of the Project marine infrastructure.
... introduce disease that may cause the species to decline?	It is considered unlikely that a disease harmful to the Dwarf Sawfish would be introduced due to the development or operation of the Project marine infrastructure.
... interfere substantially with the recovery of the species?	Threats to the Dwarf Sawfish include fishing pressure, habitat degradation and Australian Indigenous harvesting. The low reproductive rate and late maturation common to sawfish likely limits the ability of the species to recover from listed threats. The Project would not result in any substantial interference with the recovery of this species.

6.9.5.2 Migratory Marine Fauna

Individual significant impact assessments are provided below for each of the EPBC Act listed marine migratory fauna species that are not threatened species and are assessed as *possible, likely* or *known to occur* in the Project area as identified in **Section 6.6**. These include:

- Indo-Pacific Humpback Dolphin (*Sousa chinensis*);
- Australian Snubfin Dolphin (*Orcaella heinsohni*);
- Bryde's Whale (*Balaenoptera edeni*); and
- Dugong (*Dugong dugon*).

Key definitions from the DSEWPaC guidelines that apply to this assessment are as follows:

An area of "important habitat" for a migratory species is:

- habitat utilised by a migratory species occasionally or periodically within a region that supports an ecologically significant proportion of the population of the species; and/or
- habitat that is of critical importance to the species at particular life-cycle stages; and/or
- habitat utilised by a migratory species which is at the limit of the species range; and/or
- habitat within an area where the species is declining.

Listed migratory species cover a broad range of species with different life cycles and population sizes. Therefore, what is an "ecologically significant proportion" of the population varies with the species (each circumstance would need to be evaluated). Some factors that should be considered include the species' population status, genetic distinctiveness and species-specific behavioural patterns (for example, site fidelity and dispersal rates).

"Population", in relation to migratory species means the entire population or any geographically separate part of the population of any species or lower taxon of wild animals, a significant proportion of whose members cyclically and predictably cross one or more international jurisdictional boundaries including Australia.

Indo-Pacific Humpback Dolphin (*Sousa chinensis*) and Australian Snubfin Dolphin (*Orcaella heinsohni*)

Two species of dolphins – Indo-Pacific Humpback Dolphin (*Sousa chinensis*) and the Australian Snubfin Dolphin (*Orcaella heinsohni*) – that are listed as cetaceans and migratory species under the EPBC Act are known to occur in the Project area from incidental sightings during field work for the present marine study.

Both the Indo-Pacific Humpback Dolphin and the Australian Snubfin Dolphin usually inhabit shallow coastal waters of less than 20m depth and are often associated with rivers and estuarine systems, enclosed bays and coastal lagoons (Corkeron *et al*. 1997, Hale *et al*. 1998, Parra 2006).

Parra (2006) examined habitat use of both Indo-Pacific Humpback Dolphins and Australian Snubfin Dolphins in Cleveland Bay (Townsville). While there was significant overlap in habitat use by the two species, differences were also found. Australian Snubfin Dolphins preferred slightly shallower (1–2m) waters than Indo-Pacific Humpback Dolphins (2–5m). Shallow areas with seagrass ranked high in the habitat preferences of Australian Snubfin Dolphins, whereas Indo-Pacific Humpback Dolphins favoured dredged channels.

It is noted that the listed Bottlenose Dolphin species (*Tursiops aduncus* and *Tursiops truncatus*) may occur in the Project area; however, neither of these are threatened or migratory. The Arafura / Timor Sea sub-population of *T. aduncus*, which is migratory, does not have a distribution extending to the Project area. There are no *Significant impact guidelines* criteria for listed cetacean species that are not threatened or migratory; however, the potential for significant impacts from the proposed marine works and activities to these Bottlenose Dolphin species would be no greater than for the other migratory cetacean species considered.

Bryde's Whale (*Balaenoptera edeni*)

Bryde's Whale occurs in pelagic temperate to tropical waters, principally in continental shelf waters, but also extending into coastal and inshore waters. There are considered to be two forms of Bryde's Whale: inshore and offshore.

Insufficient information exists as to how Australian Bryde's Whales use their habitat, as no specific feeding or breeding grounds have been discovered off Australia. The inshore form appears to be resident in waters containing suitable prey stocks of pelagic shoaling fishes, while the offshore form appears to undergo extensive migrations between subtropical and tropical waters during the winter months.

Bryde's Whale is considered to be a fairly opportunistic feeder, readily consuming whatever shoaling prey is available, with inshore coastal forms feeding on schooling fishes such as pilchard, anchovy, sardine, mackerel, herring and others. Little is known regarding breeding in Australian waters but the inshore form is considered likely to breed all year round. There is no evidence of large-scale movements of the inshore form of Bryde's Whales, which contrasts with seasonal migration of the offshore form.

The recording of Bryde's Whale from inshore tropical waters makes it possible that the species could occur sporadically within the Project area, but the area would not represent preferred habitat. It is highly unlikely they would venture into estuarine habitats of the Embley and Hey Rivers.

The following assessment considers the whale and dolphin species together, as the impacting processes are the same and the likely responses are similar.

***Will* the proposed works ...**	**Indo-Pacific Humpback Dolphin (*Sousa chinensis*), Australian Snubfin Dolphin (*Orcaella heinsohni*), Bottlenose dolphin (*Tursiops aduncus)* and Bryde's Whale (*Balaenoptera edeni*)**
... substantially modify, destroy or isolate an area of important habitat for a migratory species?	Cetaceans may be impacted by: disturbance from boating and shipping activities including alienation from habitat, acoustic impacts, boat strike and creation of an offshore turbidity plume during dredging. The construction of the wharf would involve pile driving. The underwater noise generated by the hammer hitting the top of the pile is of short-term duration and therefore can be described as impulsive noise. The time taken to drive each pile would depend on the hardness of the seabed in each location. There is potential for marine animals in an area close to the piling to incur hearing damage as a result of the piling. It is anticipated the construction activity would deter most marine mammals from the immediate area; however for precautionary purposes, it is proposed that a "soft-start" approach would be used to disperse animals in the vicinity prior to normal pile driving. The "soft-start" involves commencing pile driving with a partial capacity strike, or giving a warning with an underwater airgun prior to normal pile driving. Construction of the proposed port, operation and spoil disposal are not anticipated to substantially modify important habitat for the migratory species confirmed as known or possible to occur within the Project area.
... result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species?	The Project is unlikely to lead to the introduction of any invasive fauna that could affect migratory species. RTA would conduct routine monitoring of the port for marine pests, similar to that currently undertaken for Port of Weipa high-risk areas.
... seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species?	There is the potential for alienation of cetaceans in the immediate vicinity of the port and barge/ferry terminal areas primarily during construction activities, particularly during pile driving for the bulk loading wharf. "Soft-start" pile driving procedures are proposed to limit disturbance during pile driving activities. The proposed port development would not present a barrier to migration as there is large coastal area for transit and avoidance of any underwater noise. Disturbance in estuarine areas would be minor and not represent any substantial barrier to movement of dolphins. They are highly unlikely to occur in the Embley and Hey Rivers. Dolphins present within the Project area are not identified as representing a significant proportion of the population of their respective species. No significant impact to the lifecycle of dolphins is likely. No meaningful disruption to the lifecycle of Bryde's Whale would occur as a result of the Project given the Project area is not preferred habitat and any occurrence would be sporadic.

Dugong (*Dugong dugon*)

The Dugong has a large range across tropical and subtropical coastal and island waters from east Africa to Vanuatu. A significant proportion of the world's Dugongs are found in north Australian waters from Shark Bay in Western Australia to Moreton Bay in Queensland. The Torres Strait region is the most important Dugong habitat in the world. Within the Gulf of Carpentaria, the Sir Edward Pellew Islands on the Northern Territory coast and the mouth of the Limmen Bight River are the most important areas and represent the fourth most important site in Australia (Marsh *et al* 2002).

Dugong almost solely consume seagrass and are associated with seagrass beds in the Weipa region, but the region is not identified as supporting large populations of these animals. Dugongs are known to occur in low densities in Albatross Bay (Saalfield and Marsh 2004) and are closely associated with the seagrass beds in the Embley estuary.

Dugongs prefer seagrasses that are early or "pioneer" species, particularly species of the genera *Halophila* and *Halodule* (DEWHA 2010). The long, strap-like seagrass *Enhalus acoroides*, which dominates the seagrass beds of the Embley and Hey Rivers, is not a preferred species in the Dugong diet.

Traditional Owners report that Dugong migrate through the Boyd Bay region. The species is highly migratory and would traverse coastal waters between seagrass beds.

Will the proposed works...	Dugong (*Dugong dugon*)
... substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species?	The construction of the wharf would involve pile driving. The underwater noise that is generated by the hammer hitting the top of the pile is of short-term duration and therefore can be described as impulsive noise. The time taken to drive each pile would depend on the hardness of the seabed in each location. There is potential for marine animals in an area close to the piling to incur hearing damage as a result of the piling. It is anticipated the construction activity would deter most marine mammals from the immediate area, however for precautionary purposes, it is proposed that a "soft-start" approach would be used to disperse animals in the vicinity prior to normal pile driving. The "soft-start" involves commencing pile driving with a partial capacity strike, or giving a warning with an underwater airgun prior to normal pile driving. The minor area of seagrass that may be impacted by dredging at the Humbug Terminals not significant in terms of a Dugong foraging resource and is not considered to be an area of important Dugong habitat.
... result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species?	It is considered unlikely that an invasive species that is harmful to Dugong would be introduced due to the development or operation of the Project. RTA would conduct routine monitoring of the port for marine pests, similar to that currently undertaken for Port of Weipa high-risk areas.
... seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species?	See above for management of potential acoustic impacts during construction. Of all potential impacts, boat strike from operation of the ferry from Hornibrook Terminal to Hey River Terminal is anticipated to represent the highest risk. RTA would operate the ferry to minimize the impacts to Dugong. Transit lanes would be defined to reduce the overall area of disturbance from vessel activities. Serious disruption to the life cycle of an ecologically significant population of Dugong within the Project area is not anticipated.

6.9.6 Marine Fisheries Resources Impacts

The Project may affect fisheries through impacts on the target species directly, the habitats of target species, or through changes to fishing access. Each fishery that may be affected by the proposed development is discussed in turn.

6.9.6.1 Northern Prawn Fishery

The NPF could potentially be affected by the proposed new spoil ground as a result of:

- providing habitat less suitable for banana prawns after spoil is deposited;
- changing the local distribution of banana prawns as they respond to the turbidity plume generated by spoil disposal;
- trawlers being unable to access the proposed spoil ground area due to the uneven seabed, a consequence of spoil deposition. Trawl nets snagging on an uneven seabed may lead to safety being compromised and expensive trawling equipment being lost;
- reduced nursery habitat within the Embley estuary; and
- potential disruption to prawn migration.

Dredging of the port area and spoil disposal at the proposed new spoil ground is expected to take up to 10 months. The fishery is active in the Weipa area from July to March. Hence there is the potential for an effect on the local distribution of banana prawns as a result of spoil deposition.

Overall, the area where the NPF operates is large (thousands of km^2) and there is considerable area of suitable habitat remaining in the Weipa area for banana prawns, where the fishery can still operate unimpeded if the proposed development proceeds. It is predicted that operators in the NPF would be able to, if necessary, adapt their fishing operations to avoid the spoil ground without incurring a significant financial impact. Fine scale spatial information on the actual area of operation of the fishery in the Weipa area is lacking and the actual area will vary considerably between years. However, it is predicted that the area of the proposed spoil ground represents less than 1% of the available prawn trawl habitat in the Weipa area. The spoil ground footprint has been constrained to a 0.5nm radius to minimise the area sterilised from the NPF. It is predicted that a wedge of fine sediment deposition would occur running north-north-east and south-south-west from the disposal ground to a distance of approximately 4km in each direction (**Figure 6-60a-c**). This represents the mobilisation of fine fractions (fine sands, silt and clays) as material is released at the spoil ground.

The removal of mangrove habitat in the Embley estuary would potentially reduce the area of prawn nursery habitat within the Embley estuary. However, existing information is insufficient to quantify the

impact of this disturbance on fishery production. The area of the fishery is very large and the area of disturbance is extremely small relative to available nursery habitat in the eastern Gulf of Carpentaria.

The small scale and short duration of dredging for the barge/ferry terminals in the Embley and Hey Rivers presents low risk to prawn migration and would not warrant a requirement to dredge outside the peak period of August to April.

6.9.6.2 Gulf of Carpentaria Commercial Inshore Finfish Fishery

Currently finfish can be caught commercially on the foreshores between Boyd Point and Pera Head. The proposed port would prevent access to the fishery adjacent to the wharf structures. Provisions of the *Fisheries Regulations 2008* (Qld) create an exclusion zone to mesh nets of 200m around a wharf or jetty.

The area where the fishers can operate is very large and the area around the proposed port is not considered important for the fishery. This is based on the fishers mostly operating in the rivers and the creeks draining into the Gulf of Carpentaria and the shoreline directly adjacent to such areas where the principal target species (barramundi) are abundant (McPhee 2008).

Any changes in access to the fishery as a result of the proposed port would not impact the Gulf of Carpentaria Commercial Inshore Finfish Fishery.

Mesh net fishing is prohibited in the rivers and creeks that drain into Albatross Bay so the proposed barge/ferry operations pose a low risk of impact on mesh netting activities.

Changes to the seabed at the spoil grounds, as a result of spoil deposition, would not affect access by this fishery as the nets do not touch the seabed.

6.9.6.3 Gulf of Carpentaria Commercial Line Fishery

Commercial line fishermen recognise the reef areas in the vicinity of Pera Head, Boyd Point and Thud Point as key locations for Spanish mackerel (*Scomberomorus commerson*) in the Weipa region. The proposed port development dredging has the potential to locally affect commercial line fishing over Pera Head and inshore reefs extending to Thud Point through turbid plume generation and possible avoidance of the area by target species. Boyd Reef would experience lesser impacts from turbid plumes and may present an area of refuge from the more affected areas. The duration of proposed dredging is approximately 10 months and would cover the period between August and November, which is the peak season for this fishery in the Weipa area.

While there may be localised impact during the dredging period, the risk to the overall line fishery in the Gulf of Carpentaria is minor due to the relatively minor proportion of the reef area likely to be affected.

Suitable habitats for line fish occur within spoil grounds and within the associated dredge plumes, but impacts would be localised and there would be periods of respite between spoil disposal activities. The risk to line fishing in these areas is low.

Commercial line fishers do not presently operate near the proposed barge/ferry terminals in the Embley and Hey Rivers. It is therefore predicted that the proposed terminals would not directly impact the target species habitats or the current operator access patterns, and as such pose a low risk.

6.9.6.4 Recreational and Guided Fishing

Recreational fisherman and guided fishing tour operators would likely be affected by the proposed port development in the short term. Both these sectors extensively utilise the reefs and the foreshore flats between Boyd Point and Thud Point. For those targeting reef fish, the impact on the fishery is likely to be proportional to the changes in turbidity and loss or damage to the adjacent reef areas. There are extensive foreshore flats north of Boyd Point which provide similar recreational fishing opportunities to the area between Pera Head and Thud Point. As such, it is predicted that the proposed port development poses a moderate local risk of impact on species targeted by recreational fishers.

Suitable habitat for the target species is unlikely to be abundant at the proposed new spoil ground and Albatross Bay spoil ground. It is therefore predicted that those components of the Project have a low risk of impact on recreational or guided fishing. Modelling of turbid plumes from the proposed new spoil ground predicts that turbid plumes generated at the proposed new spoil ground would not

adversely affect Nine Mile Reef and therefore no impact on recreational or guided fishing over that area is predicted.

Recreational and guided fisherman are likely to access the Hornibrook Point, Humbug Point and Hey River areas; however, it is uncertain whether these locations represent prime fishing locations.

6.9.6.5 Other Fisheries Impacts

It is predicted the Project would not affect either the commercial Mud Crab Fishery or the Developmental Finfish Trawl Fishery as no development would occur in the important habitats for these target species. The development poses a low risk of impact on these fishing activities.

6.9.7 Cumulative Marine Impacts

This assessment has considered all marine components of the Project: port facility, the proposed spoil disposal ground, existing disposal ground (Albatross Bay), and barge/ferry terminals. These Project components are generally spatially isolated from each other and not interconnected. The exceptions to this are the sites for ferry and barge facilities. However, it is not predicted that any cumulative effects between Project components would arise.

A small increase in vessel traffic would occur within the Embley/Hey River estuaries due to barge and ferry movements between the Hey River Terminal and Hornibrook and Humbug terminals. These movements are additional to existing commercial and recreational boating undertaken from Weipa, and may be considered a cumulative effect. However, the present vessel utilisation of the estuary is relatively limited, and due to its remote nature is not facing significant pressures in terms of growing recreational or commercial demands. Vessel operations within the Embley River estuary are not considered a significant cumulative threat. Vessel movements in the Port of Weipa are discussed in **Section 14.4.6**.

The proposed port is in a remote, undeveloped location. A reduced utilisation of the adjacent beaches and foreshore by recreational boats, fishermen and pig hunters is anticipated due to port security requirements.

RTA's proposed port has been designed to allow for the option of shipping bauxite produced from neighbouring projects in the event that the parties are able to reach an agreement. **Section 1.4** describes the neighbouring projects to the RTA SoE Project and discussion of any potential for co-location and/or sharing of certain infrastructure, including wharf facilities. Such arrangements would minimise cumulative impact.

The existing Albatross Bay spoil ground would be used to receive a minor volume of spoil from capital dredging activities at the barge/ferry terminals in the Embley and Hey Rivers. The proposed volume of additional spoil to be deposited at the existing Albatross Bay spoil ground is minimal compared with annual maintenance dredge volumes of the Weipa Port.

6.9.8 Summary of Impact Mitigation Strategies

A summary of management and monitoring actions proposed during construction and operation are presented in **Table 6-51** and **Table 6-52** respectively for impacts identified in **Table 6-40**.

Table 6-51 Summary of proposed construction impact management and monitoring activities

Potential Impact	Port Area	New Disposal Ground	Embley River – Hornibrook & Humbug Terminals	Albatross Bay Spoil Ground	Hey River Terminal
Creation of a turbidity plume, and subsequent deposition and re-suspension of fine sediments	Reactive monitoring program including: • Deposition and light monitoring leading up to and during dredging. • Inshore reef coral monitoring leading up to and during dredging. • Monitoring of the progress of the turbidity plume. Relocate TSHD dredger offshore if unacceptable coral impacts detected.	Uniform deposition of dredge spoil within spoil ground boundary. Below keel discharge of sediments. Turbidity model validation. Consultation with DSEWPaC regarding identification of unacceptable impacts to Nine-Mile Reef due to dredging.	Continuation of long-term seagrass monitoring by DEEDI within intensive monitoring area.	Uniform deposition of dredge spoil within spoil ground boundary.	Continuation of long-term seagrass monitoring by DEEDI within intensive monitoring area.
Physical disturbance to benthic habitats and fauna from dredging and construction of infrastructure	Inshore reef coral monitoring during dredging. Relocate TSHD dredger offshore if unacceptable coral impacts detected.	Post-construction infauna assemblage monitoring.	Continuation of long-term seagrass monitoring by DEEDI within intensive monitoring area.	Management and monitoring not proposed.	Continuation of long-term seagrass monitoring by DEEDI within intensive monitoring area.
Changes to coastal processes (erosion and deposition)	Monitor any changes to beach profile and mitigate if cliff erosion is exacerbated.	—	—	—	—
Introduction of pollutants to marine waters and sediments	Design construction conveyor and ship loader to minimise dust generation and spillage, particularly in vicinity of transfer points. Dredge Management Plan to include waste management plan and emergency spill plan.	—	Dredge Management Plan to include waste management plan and emergency spill plan.	—	Dredge Management Plan to include waste management plan and emergency spill plan.
Underwater acoustic impacts from pile driving activities and vessel movement	"Soft-start" approach for piling activities. Piling megafauna exclusion zone.	—	"Soft-start" approach for piling activities. Piling megafauna exclusion zone.	—	"Soft-start" approach for piling activities. Piling megafauna exclusion zone.
Disturbance from boating and shipping activities including exclusion from habitat	Management and monitoring not proposed.	—	Management and monitoring not proposed.	—	Management and monitoring not proposed.
Introduction of hard artificial substrata (e.g. piles) into the marine environment	—	—	—	—	—

Potential Impact	Port Area	New Disposal Ground	Embley River – Hornibrook & Humbug Terminals	Albatross Bay Spoil Ground	Hey River Terminal
Altered light regime	Develop lighting plan with DERM. Implement measures to reduce feral pig numbers. Turtle nesting activity and monitoring in collaboration with DERM.	—	—	—	—
Boat strike or dredging causing injury or death.	Visual observation for dugong or whales within approx 300m monitoring zone. If present, move dredge or temporarily suspend dredging until after last dugong or cetacean has left monitoring zone. Incident reporting of injury or death of dugong, cetaceans or turtles.	Incident reporting of injury or death of dugong, cetaceans or turtles.	Identify transit lanes for ferries Incident reporting of injury or death of dugong, cetaceans or turtles.	Incident reporting of injury or death of dugong, cetaceans or turtles.	Identify transit lanes for ferries. Incident reporting of injury or death of Dugong, cetaceans or turtles.
Introduction of pest species	Overseas dredging vessels inspected prior to establishment. Work with Biosecurity Queensland in event of pest incursion. Ballast water management as per Section 13.3.8	—	—	—	—

TSS = Total Suspended Solids
— = Low risk of impact

Table 6-52 Summary of proposed operations impact management and monitoring activities

Potential Impact	Port Area	New Disposal Ground	Embley River – Hornibrook & Humbug Terminals	Albatross Bay Spoil Ground	Hey River terminal
Creation of a turbidity plume, and subsequent deposition and re-suspension of fine sediments	As required under future sea dumping permits	Uniform deposition of dredge spoil within spoil ground boundary. Below keel discharge of sediments.	Management and monitoring not proposed.	Uniform deposition of dredge spoil within spoil ground boundary.	Management and monitoring not proposed.
Physical disturbance to benthic habitats and fauna from dredging	—Management and monitoring not proposed.	Post-construction infauna assemblage monitoring. Routine maintenance dredging monitoring every five years.	Continuation of long-term seagrass monitoring by DEEDI within intensive monitoring area.	Management and monitoring not proposed.	Continuation of long-term seagrass monitoring by DEEDI within intensive monitoring area.
Changes to coastal processes (erosion and deposition)	Monitor any changes to beach profile and mitigate if diff erosion is exacerbated.	—	—	—	—
Introduction of pollutants to marine waters and sediments	Maintain conveyor and shiploaders to minimise dust.	—	Develop and implement waste management plan.	—	Develop and implement waste management plan.
Underwater acoustic impacts	Management and monitoring not proposed.	—	Management and monitoring not proposed.	—	Management and monitoring not proposed.
Disturbance from boating and shipping activities including exclusion from habitat	Management and monitoring not proposed.	—	Management and monitoring not proposed.	—	Management and monitoring not proposed.
Introduction of hard artificial substrata (e.g. piles) into the marine environment and shading effects from wharf structures	Management and monitoring not proposed.	—	Management and monitoring not proposed.	—	Management and monitoring not proposed.
Altered light regime	Implement lighting plan with DERM. Implement measures to reduce feral pig numbers. Turtle nesting activity and monitoring in collaboration with DERM.	—	—	—	—
Boat strike	Incident reporting of injury or death of dugong, cetaceans or turtles.	—	Ferries use transit lanes. Incident reporting of injury or death of dugong, cetaceans or turtles.	—	Ferries use transit lanes. Incident reporting of injury or death of dugong, cetaceans or turtles.

Potential Impact	Port Area	New Disposal Ground	Embley River – Hornibrook & Humbug Terminals	Albatross Bay Spoil Ground	Hey River terminal
Introduction of pest species	Ballast water management as per **Section 13.3.8** Larval plate monitoring consistent with that for Port of Weipa. Work with Biosecurity Queensland in event of pest incursion.	—	—	—	—

— = Low risk of impact

6.10 Dredge Management Plan Outline

Separate dredge management plans (DMP) would be developed for the dredging of the port area at Boyd Point, and for the dredging associated with the development of the barge/ferry terminals located in the Embley and Hey Rivers.

This DMP would describe approval conditions, monitoring and management response arrangements for capital dredging and dredged material disposal to be undertaken by RTA as part of the Project. The DMP would support applications for Sea Dumping under the Commonwealth *Environment Protection (Sea Dumping) Act* (1981) and approval for capital dredging under the Queensland *Coastal Protection and Management Act* 1995.

Core operational objectives of the DMP for the Project would include:

- Providing a platform for delivering legislated approval conditions for the development as evidenced by practical and achievable action plans;
- Implementation of an adaptive management and monitoring strategy which provides data for management at suitable spatial and temporal scales to enable effective environmental management outcomes;
- Delivering monitoring systems to overcome site based logistical and safety constraints, whilst maintaining rigour of design, and applicability to decision processes;
- Establishment of an agreed framework for the management of dredging and dredged material disposal which is transparent to stakeholders; and
- Provision of guidance to RTA and its contractors with regards to dredging and disposal activities, including the process of environmental management triggers and response requirements.

The DMP would follow the assessment framework originally developed by the *Convention of the Prevention of Marine Pollution by Dumping Wastes and Other Matter* (London Convention 1972), and outlined within the *National Assessment Guidelines for Dredging* (NAGD) (Commonwealth of Australia, 2009). It would also apply the principles of environmental management as referenced within Guidance documents released from DERM. Key components include:

- Dredging and disposal management framework;
  - Commonwealth and State permits and approvals; and
  - Roll of the Technical Advisory and Consultative Committee in the overall management approach.
- Dredging and disposal Project description;
- Characterisation of materials to be dredged;
- Existing environment;
  - Habitats;
  - Significant species;
  - Existing users.
- Potential impacts;
  - Habitats;
  - Significant species;
  - Existing users.

- Receiving habitats monitoring program (proposed monitoring regime, development of triggers; and
- Management and control strategies, including;
  - Dredge management;
    - (i) Schedule of operations;
    - (ii) Dredge vessel specification;
    - (iii) Adaptive monitoring and management systems to protect receiving habitats (including triggers, decision pathways, management actions and roll of the TACC/MRG);
    - (iv) Marine mammals interaction (whales, dugong, dolphins);
    - (v) Turtle interaction;
    - (vi) Introduced marine pests;
    - (vii) Disposal ground management;
    - (viii) Noise;
    - (ix) Air quality;
    - (x) Waste management;
    - (xi) Hydrocarbons and other hazardous substances; and
    - (xii) Operational audits.
  - Monitoring programs;
    - (i) Routine monitoring;
    - (ii) Reactive monitoring; and
    - (iii) Post dredging.
  - Security and maritime safety;
  - Emergency planning and response;
  - Reporting, auditing and improvement processes;
  - Roles and responsibilities; and
  - Training.

The proposed monitoring methods and management protocols within the DMP would be selected to provide an 'adaptive' approach to dredging impact response. These responses are tiered, with increasing levels of operational intervention and monitoring evidence depending upon the conditions of receiving habitats. This approach is designed to prevent significant environmental disturbance, working through routine monitoring to reactive monitoring as stress levels increase.

Management trigger levels would be included for key physical parameters (deposition, light attenuation), and biological response of coral communities to these stressors (coral colour, photosynthetic efficiency, sediment coverage, bleaching, injury and partial mortality, and mortality etc.). These biological triggers would focus on a range of sub-lethal indicators to best facilitate management response, although mortality response would also to be recorded.

The identified monitoring program is geared towards the use of rapid response indicators, for both physicochemical/physical factors (deployed loggers with telemetry) and biological response within

receiving habitats (deployed reference coral trays). The remote nature of the area between Boyd Point and Pera Head, the presence of dangerous marine animals, and the low visibility conditions has focused attention on diver-free methods of assessment. These constants are reflected in the adopted methods of monitoring.

A process of model validation is proposed to occur early in the dredging program. This will refine the understanding of the materials to be dredged, and their fate in the receiving environment. Comparison between the EIS predictions and the updated information will refine the appreciation of potential environmental risk. Monitoring and management processes can be adjusted accordingly early in the dredge program.

Rio Tinto Alcan

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Environmental Impact Statement for South of Embley Project

This Environmental Impact Statement has been prepared to meet the assessment requirements for the Project under the *State Development and Public Works Organisation Act 1971* (Qld) and the *Environment Protection and Biodiversity Conservation Act 1999* (Cth).

Rio Tinto Alcan

Volume 2

7. Terrestrial Flora and Fauna
8. Aquatic Ecology
9. Air Quality
10. Noise and Vibration
11. Cultural Heritage
12. Visual Amenity
13. Waste
14. Transport
15. Consultation

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Environmental Impact Statement for South of Embley Project

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Environmental Impact Statement

for South of Embley Project

Section 7

Terrestrial Flora and Fauna

7 TERRESTRIAL FLORA AND FAUNA

7.1 Biogeographic Setting

The Weipa area is located within the Cape York Peninsula Bioregion (after Stanton and Morgan 1977, and Sattler and Williams 1999) which, based on broad vegetation formations and landform, is recognised as one of the distinct biogeographic regions of Australia (Thackway and Cresswell 2006).

The Project area and wider Weipa area are located within the Weipa Plateau province (subregion) of the Cape York Peninsula Bioregion (Sattler and Williams 1999). Although the Weipa Plateau province is only one of the six provinces (or subregions) of the Bioregion, it is the most extensive, and covers a large area of the central and north-western portions of the Cape York Peninsula. This area is relatively homogenous in vegetation and landform, and is characterised by large areas of Darwin Stringybark (*Eucalyptus tetrodonta*) open forests or woodlands, dissected by smaller areas of riparian vegetation, vine thicket patches and paperbark swamps.

7.2 Protected Areas, Conservation Areas and Biodiversity Areas

7.2.1 Protected Areas

There are three protected areas located on northern Cape York comprising (refer **Figure 7-1**):

- the western section of the Mungkan Kandju National Park, located approximately 30km to the east of the lower section of the Project area;
- the Iron Range National Park, located 150km east of the Project area on the east coast of Cape York Peninsula; and,
- the Heathlands Resources Reserve and Jardine River National Park and Resources Reserve, approximately 125km to the north-east of the study area.

None of these reserves are located downstream or within the Project area.

There is currently no World Heritage Area (WHA) listed for the northern Cape York Peninsula, although the Queensland Parks and Wildlife Service (QPWS) has commissioned preliminary works investigating the extent to which parts of Cape York Peninsula satisfy the criteria for WHA listing (Valentine 2006). The report identifies several scenarios for areas to be nominated for inclusion for WHA listing but it appears that the Mining Lease areas would not be included in any of these nominations.

The Uningan Nature Reserve is located across the Embley River at Weipa approximately 10km north of the Project area.

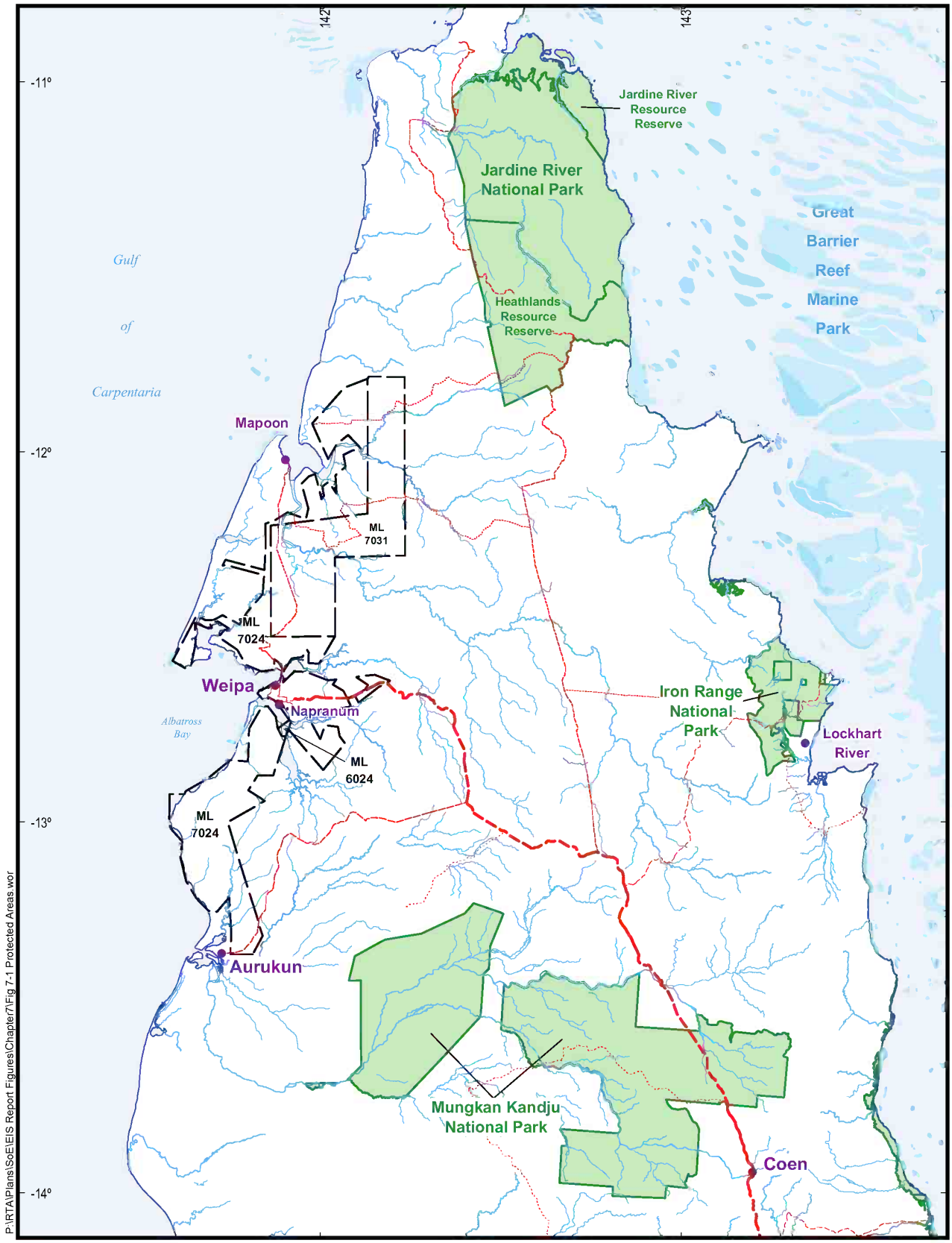
7.2.2 Other Identified Conservation and Biodiversity Areas

Cape York Peninsula Land Use Strategy (CYPLUS)

The CYPLUS report (Abrahams *et al.* 1995) identifies 36 areas across Cape York of regional conservation significance as a result of the presence of outstanding habitat or ecological features, or high wilderness values. In this context, wilderness value comprises a measure of ecological integrity and the extent of recent human induced disturbance. Wilderness value does not ignore the fact that Traditional Owners have occupied and derived an existence from the area for many thousands of years.

Within the Project area, an area of 670ha centred on Pera Head is noted for the following natural values:

- the coast in the Pera Head area has an extensive and aesthetically prominent landscape, comprising cliffs of red bauxite overlying white kaolin;
- about 60% of the area is of very high wilderness quality; and
- representative vegetation present in the area includes patches of tussock grassland and bare saltpans with a sparse herbland.



P:\RTA\Plans\SoE\EIS Report Figures\Chapter7\Fig 7-1 Protected Areas.wor

RTA Mining Lease boundary
Township
Drainage
Road/track
National Park / Reserve
Reef

Queensland

South of Embley Project

Fig. 7-1: Protected Areas

N

10 0 30km

Datum/Projection: GDA94/MGA Zone 54 Date: 01/04/2011

The Hey–Embley Rivers Area overlaps the northern part of the Project area and is reported to have natural conservation significance because:

- about 70% of the area is of very high wilderness quality; and
- about 40% of the area (chiefly the eastern section) is covered by vegetation areas that are amongst the best examples of their vegetation class on the Peninsula. Representative vegetation occurring in the area is predominantly types of *Eucalyptus tetrodonta* woodlands.

Reference to the eastern section of the Hey–Embley Rivers Area suggests an area lying outside of the Project area.

It is likely that re-assessment of the Wilderness values of the identified Pera Head area, the portions of the Hey–Embley area within the Project area, and the broader Boyd and Norman Creek areas would produce lower wilderness value rankings given recent exploration activity.

Rapid Appraisal of Key and Endangered Sites (RAKES) and Stanton (1976)

Stanton (1976) assessed the conservation significance of Cape York and identified key conservation areas. The rapid conservation assessment of Queensland (RAKES) undertaken by Stanton and Morgan (1977) also identified Key and Important Areas in the Cape York Bioregion. Neither of these assessments identified significant conservation areas within or adjacent to the Project area.

Biodiversity Planning Assessment

There is currently no Biodiversity Planning Assessment undertaken for the Cape York Bioregion by the Queensland Department of Environment and Resource Management (DERM).

International Significance of Cape York Peninsula Vegetation

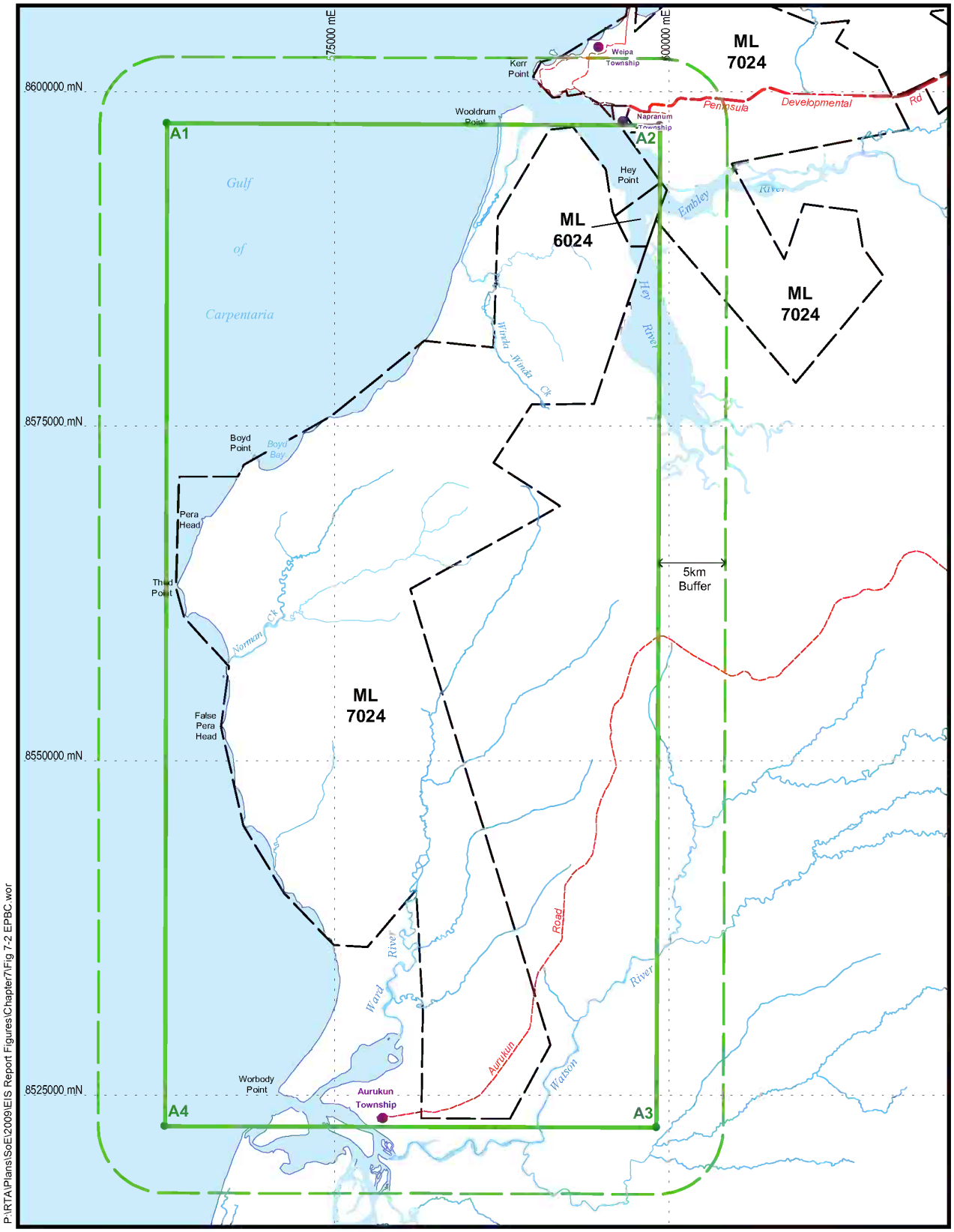
Mackey *et al.* (2001) completed an assessment of the natural heritage significance of the Cape York Peninsula, and concluded that the savannahs of Cape York Peninsula are of global significance. Woinarski *et al.* (2007) analysed the state of the world's tropical savannahs and concluded that the largest expanses of tropical savannah woodland remaining in good condition are in Northern Australia, making Australian tropical savannahs of very high conservation value at a global level. The Mackey *et al.* (2001) and Woinarski *et al.* (2007) assessments were broad assessments of the whole Cape and did not contain particular information pertaining to the Project area.

7.3 Matters of National Environmental Significance

This section identifies the species and communities listed as "matters of national environmental significance" (MNES) under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) (Cwlth) that potentially occur in the vicinity of the Project area. A search of the Department of Sustainability, Environment, Water, Population and Communities (DSEWPC) (formerly the Department of Environment, Water, Heritage and Arts (DEWHA)) Protected Matters search tool was conducted. The search area is shown in **Figure 7-2** and detailed in **Table 7-1**.

Table 7-1 MNES Search Area Coordinates

Boundary Point	Latitude			Longitude		
	degrees	minutes	seconds	degrees	minutes	seconds
A1	–12	41	4.5	141	34	34
A2	–12	41	4.5	141	54	55
A3	–13	21	43	141	54	55
A4	–13	21	43	141	34	34



P:\RTA\Plans\SoE\2009\EIS Report Figures\Chapter7\Fig 7-2 EPBC.wor

RTA Mining Lease boundary
Township
Road/track
Project area
Area of Database Search
EPBC Search Area Coordinates

South of Embley Project

Fig. 7-2: Area of Database Search (Terrestrial)

N

5 0 5km

Datum/Projection: GDA94/MGA Zone 54 Date: 16/07/2010

Table 7-2 summarises the search results with respect to terrestrial ecosystems and species. Detailed discussion of the terrestrial MNES is provided in the following respective vegetation, flora and fauna sections.

Table 7-2 MNES Terrestrial Ecosystems

Matters of National Environmental Significance (MNES)	Result for Terrestrial Ecosystems
World Heritage Properties	There are no World Heritage Properties within or near the area affected by the proposed development.
National Heritage Places	There are no National Heritage Places within or near the area affected by the proposed development.
Threatened Ecological Communities	No endangered ecological communities (EECs) were returned by the database search of the Project area. A review of the regional ecosystem types that are mapped in the Project area indicates EECs are not likely to occur in the Project area.
Threatened Species	4 plants 3 birds 3 mammals
Migratory Species	17 birds 1 reptile

It should be noted that a Protected Matters search of the pre-defined Cape York Natural Resource Management (NRM) region (accessed on the 25/03/2011) identifies the potential occurrence of the threatened ecological community '*The community of native species dependent on natural discharge of groundwater from the Great Artesian Basin'.*

The threatened ecological community does not occur in the Project area, or Cape York, as the required discharge springs are not present (see **Section 5.3.4**)

7.4 Overview of Flora Survey Methods

The main objectives of the flora survey program was to characterise the flora in the habitats present and also provide considerable coverage of threatened species listed under the EPBC Act, as these are the primary matters of national environmental significance relevant for the Project area (i.e. in the absence of threatened communities or populations). The secondary survey methodology of the Queensland Herbarium (Neldner *et al.* 2005) was used to characterise main vegetation types, together with extensive targeted survey traverses in likely habitats for threatened species.

Surveys were undertaken of vegetation communities and flora within the Project area. Preliminary surveys were undertaken in July 2006 and May 2007 with dedicated surveys for the EIS undertaken in December 2007, May 2008, December 2008 and May 2009. The spread of survey events provided survey effort over the two key seasons for detecting vegetation and floristic variability within the Project area, namely mid dry season (July) and late wet season (May). Extensive survey during the wet season was not possible due to the difficulty of access to and within the Project area at this time of heavy rainfall when most track crossings of streams and low lying areas are impassable. Nevertheless, the late wet season surveys in May 2008 and May 2009 were conducted as soon as vehicle access to the Project area was possible and most of the wet season flora was still evident.

The two preliminary flora surveys focussed on *Eucalyptus tetrodonta* dominated communities on the bauxite plateau. These are the communities that occur within the proposed mining areas. Prior to the dedicated EIS surveys, a gap analysis was undertaken to identify vegetation communities requiring further survey effort to adequately describe their structural and floristic attributes. As a result, the May 2008 and May 2009 surveys concentrated survey effort within non *Eucalyptus tetrodonta* dominated communities occurring predominantly in riparian, seasonally inundated, and beach areas and on vine forest patches occurring on the bauxite plateau. Additional surveys were also undertaken in *Eucalyptus tetrodonta* dominated communities to extend the distribution of survey sites and coverage throughout the Project area.

The location of vegetation survey sites and traverses undertaken within the Project area is indicated in **Figure 7-3**. **Table 7-3** details the survey effort employed during all surveys in the Project area. A detailed description of the flora survey methods is provided in **Appendix 7A**.

Table 7-3 Vegetation and Flora Survey Effort

Survey Effort	Survey Level	Vegetation Community and Floristics	Targeted Threatened Flora Searches
No. of survey days		41	12
No. of survey sites	Secondary	134	n/a*
	Tertiary	6	n/a*
	Quaternary	847	n/a*

* Targeted threatened flora searches comprised traverses and broad searches for target species.

7.5 Vegetation Community

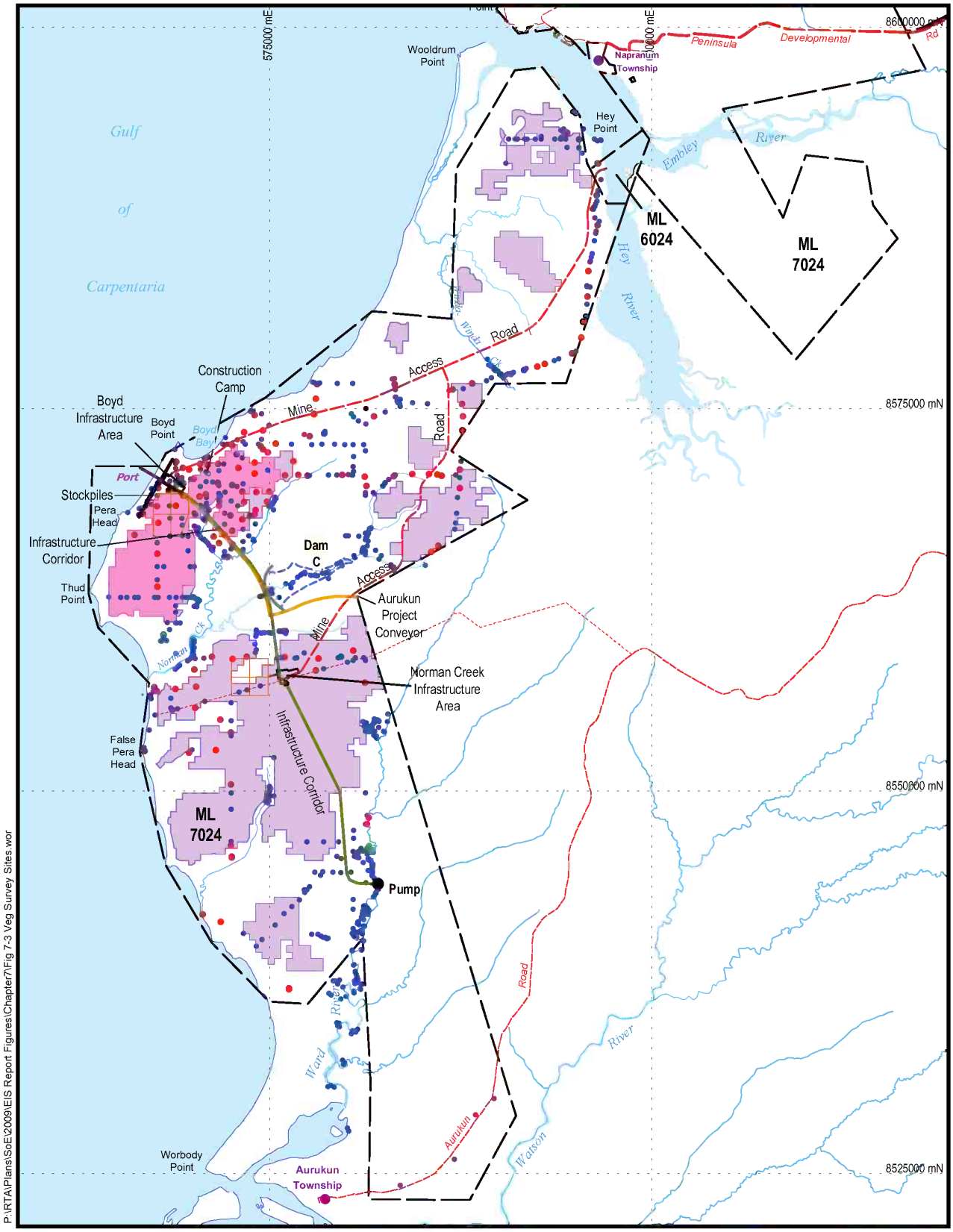
7.5.1 Vegetation Units

Vegetation unit mapping for the Project area is provided in **Figures 7-4 to 7-4d**. Thirty-two of the vegetation (land) units defined by Godwin (1985) and Gunness *et al.* (1987) were mapped in the Project area, with three of these further divided into sub-units, for a total of 38 vegetation units. Subdivision was required to adequately describe the vegetation variation evident in the Project area that was not present in the Weipa area where the vegetation unit scheme was originally derived. **Table 7-4** lists the vegetation units present and indicates the mapped area of each within the Project area. Of these, unit 2b (*Eucalyptus tetrodonta / Corymbia nesophila* Tall Woodland on lateritic red earths) is clearly the most widespread vegetation unit within the Project area (85,941ha), accounting for approximately 86% of the vegetation within the Project area and occurring almost exclusively upon the bauxite plateau areas (which is the area where mining is proposed). The remaining vegetation units are of much smaller spatial extent within the Project area and associated predominantly with drainage systems and coastal complexes that are peripheral to the bauxite plateau. The vegetation units and their equivalent REs are described in **Table 7-5,** and detailed descriptions of the vegetation of the Project area relating vegetation units to REs are provided in **Section 7.5.2** and **Appendix 7B**.

Figure 7-5 illustrates the typical sequence of vegetation types from the bauxite plateau to a middle freshwater reach of one of the major streams such as Norman Creek. This sequence of vegetation units is aligned with the changes in topography and substrate that occur from the top of the plateau, through the gentle sloping surfaces on the margins of the bauxite plateau, onto colluvial/alluvial flats, and finally into the moderately incised stream channel. The length and complexity of this vegetation sequence is generally less in upper reaches of drainage systems with more complex and extensive sequences occurring in downstream areas where greater incision of the bauxite plateau has typically occurred.

One of the key determinants of vegetation pattern within the Project area is the widespread occurrence of shallow groundwater discharge at the margins of drainage lines that dissect the laterite plateau. The shallow aquifer release occurs as a result of seepage of infiltrated rainfall that passes slowly through the surface strata and discharges from the sloping surfaces between the bauxite plateau and stream channels. This discharge may occur for an extended period after wet season rainfall has ceased.

In-stream spring heads mark the commencement of riparian gallery forest, including rainforest species (units 4a2, 4a3), which extends downstream; lateral seepage of shallow groundwater onto the landward margin of drainage corridors during and following the wet season promotes a swampy low woodland vegetation dominated by *Banksia dentata* with a sedge ground cover (units 5j1, 5j2, 5j3, 5j4, 7d). The rainforest/palm vegetation patches associated with head springs are very small and have affinities with unit 4a2 (refer **Table 7-4** and **Figure 7-8**). Where discharge is most persistent and of greater magnitude (typically in lower reaches) resultant elevated streamflows and lateral discharge has given rise to semi-permanent Melaleuca wetlands with associated sedgelands (units 3b, 12a, 12b).



P:\RTA\Plans\SoE\2009\EIS Report Figures\Chapter7\Fig 7-3 Veg Survey Sites.wor

RTA Mining Lease boundary
Township
Road/track
Freshwater dam
Tailings storage facility
Mining Years 1 -13
Mining Years 14 - 40

Vegetation Site Type

- Secondary (134 locations)
- Tertiary (6 locations)
- Quaternary (847 locations)

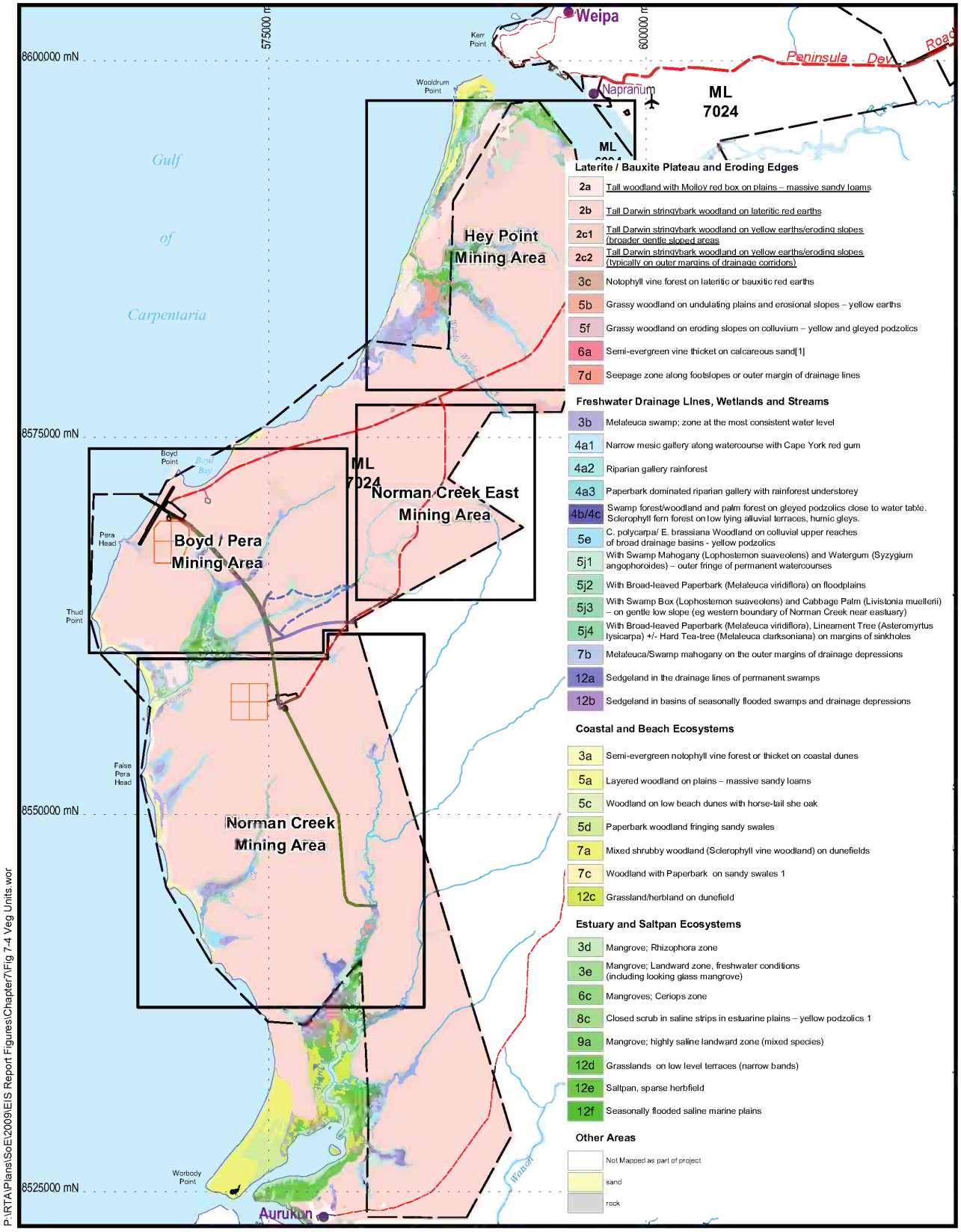
South of Embley Project

Fig. 7-3: Vegetation Survey Sites

N

5 0 5km

Datum/Projection: GDA94/MGA Zone 54 Date: 16/07/2010



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RTA Mining Lease boundary
Township
Road/track
Drainage
Freshwater dam
Tailings storage facility

RioTintoAlcan

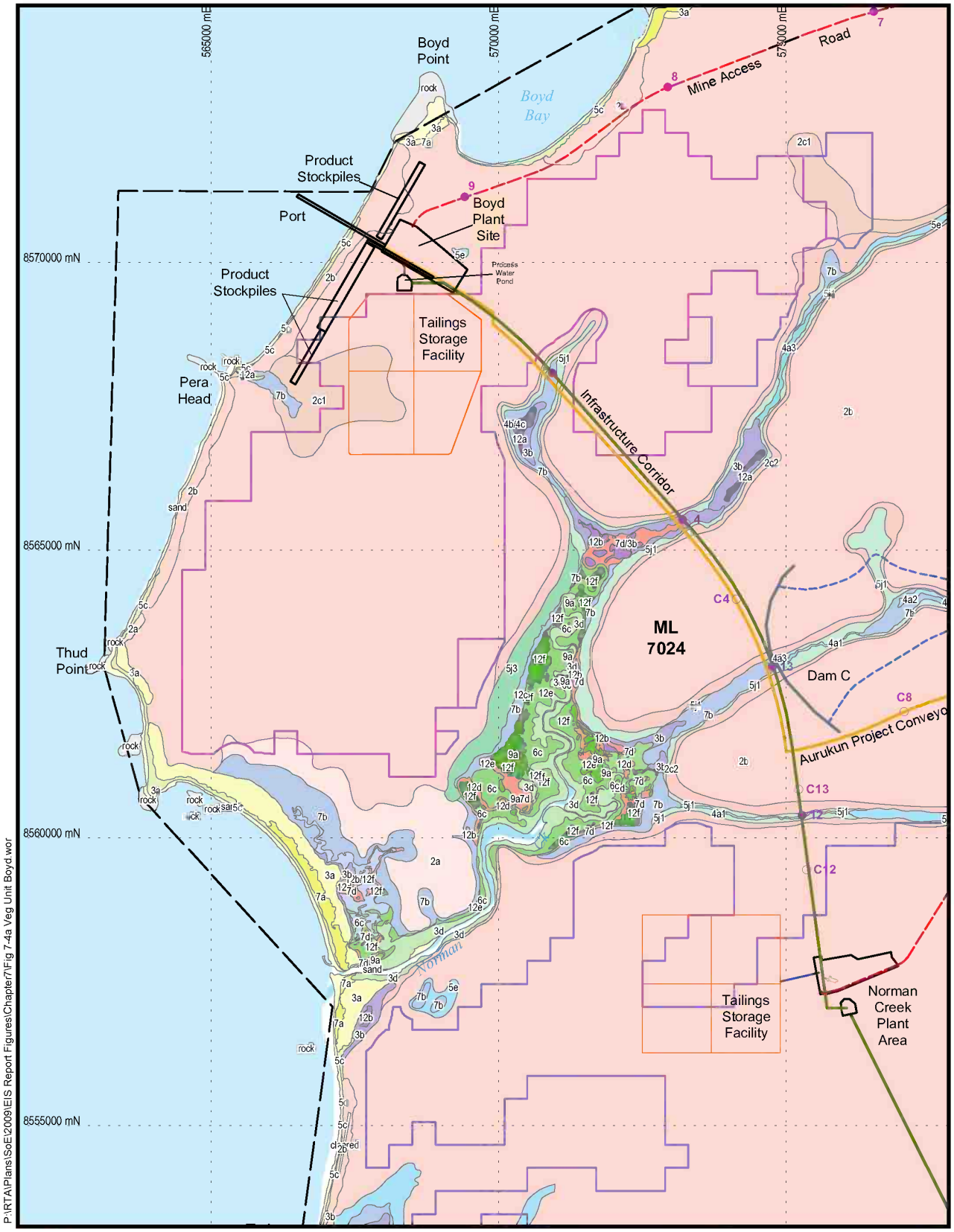
South of Embley Project

Fig. 7-4: Vegetation Units (Ground Surveyed)

N

5 0 5km

Datum/Projection: GDA94/MGA Zone 54 Date: 21/07/2010



P:\RTA\Plans\SoE\2009\EIS Report Figures\Chapter7\Fig 7-4a Veg Unit Boyd.wor

RTA Mining Lease boundary
Freshwater dam
Tailings storage facility
Mining Years 1- 13
Mining Years 14- 40
Culverts

For Vegetation Unit Descriptions See Fig 7-4

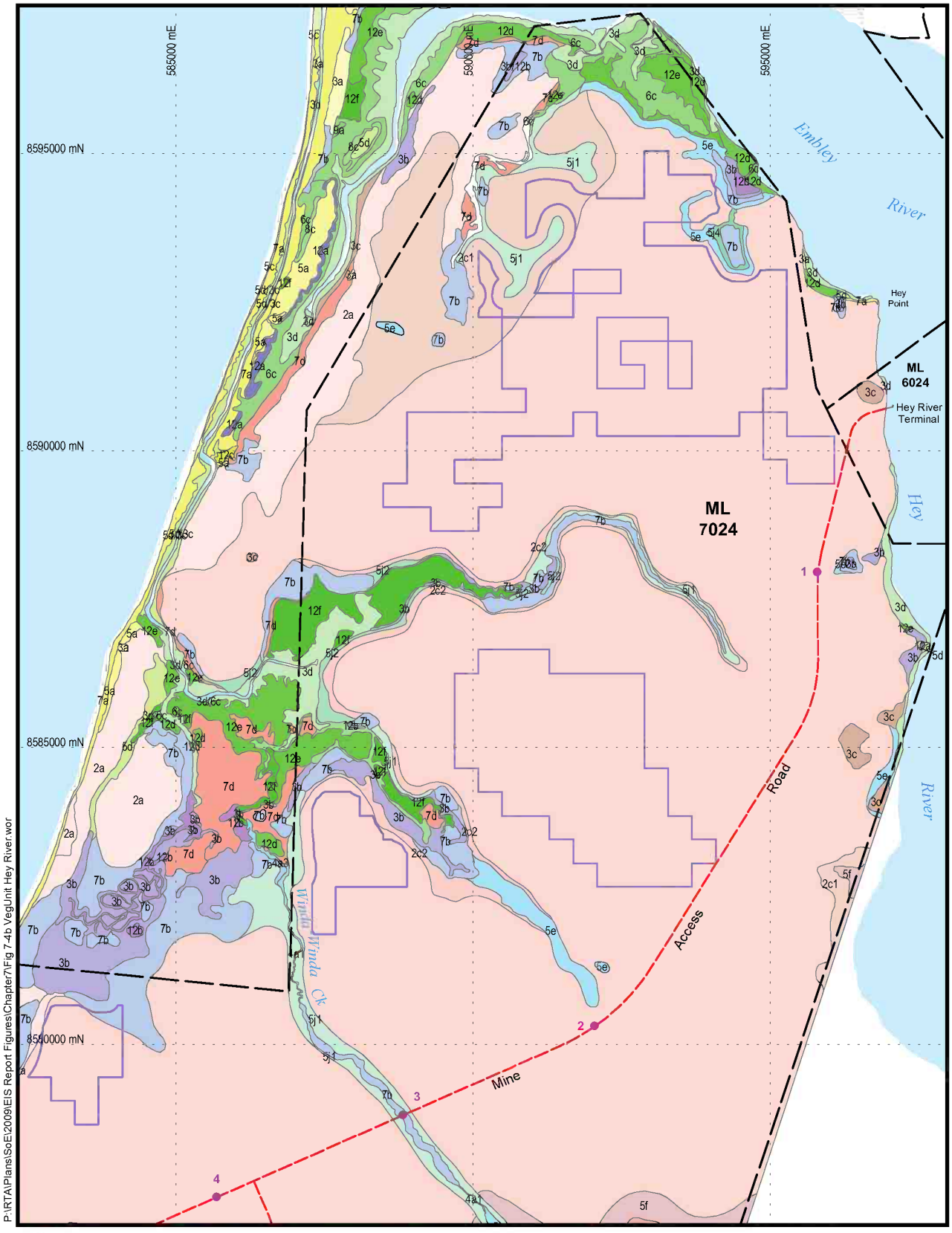
South of Embley Project

Fig. 7-4a: Vegetation Units (Boyd/Pera Mining Area)

N

1 0 1 2km

Datum/Projection: GDA94/MGA Zone 54 Date: 16/07/2010



P:\RTA\Plans\SoE\2009\EIS Report Figures\Chapter7\Fig 7-4b VegUnit Hey River.wor

RTA Mining Lease boundary

Mining Years 14- 40

Culverts

For Vegetation Unit Descriptions See Fig 7-4

Rio Tinto Alcan

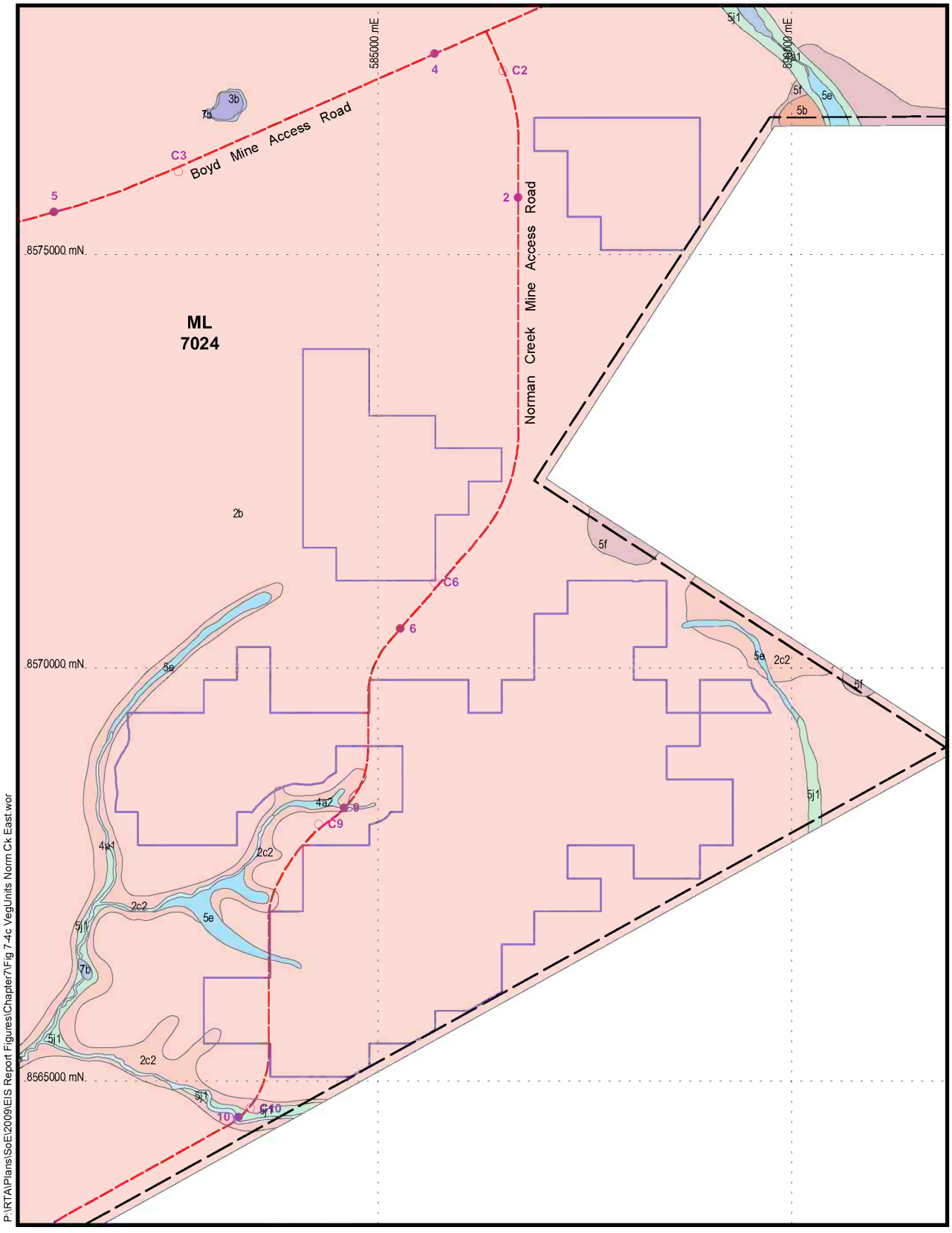
South of Embley Project

Fig. 7-4b: Vegetation Units (Hey Point Mining Area)

N

1 0 1 2km

Datum/Projection: GDA94/MGA Zone 54 Date: 16/07/2010



P:\RTA\Plans\SoE\2009\EIS Report Figures\Chapter7\Fig 7-4c VegUnits Norm Ck East.wor

RTA Mining Lease boundary

Mining Years 14- 40

Culverts

For Vegetation Unit Descriptions See Fig 7-4

Rio Tinto Alcan

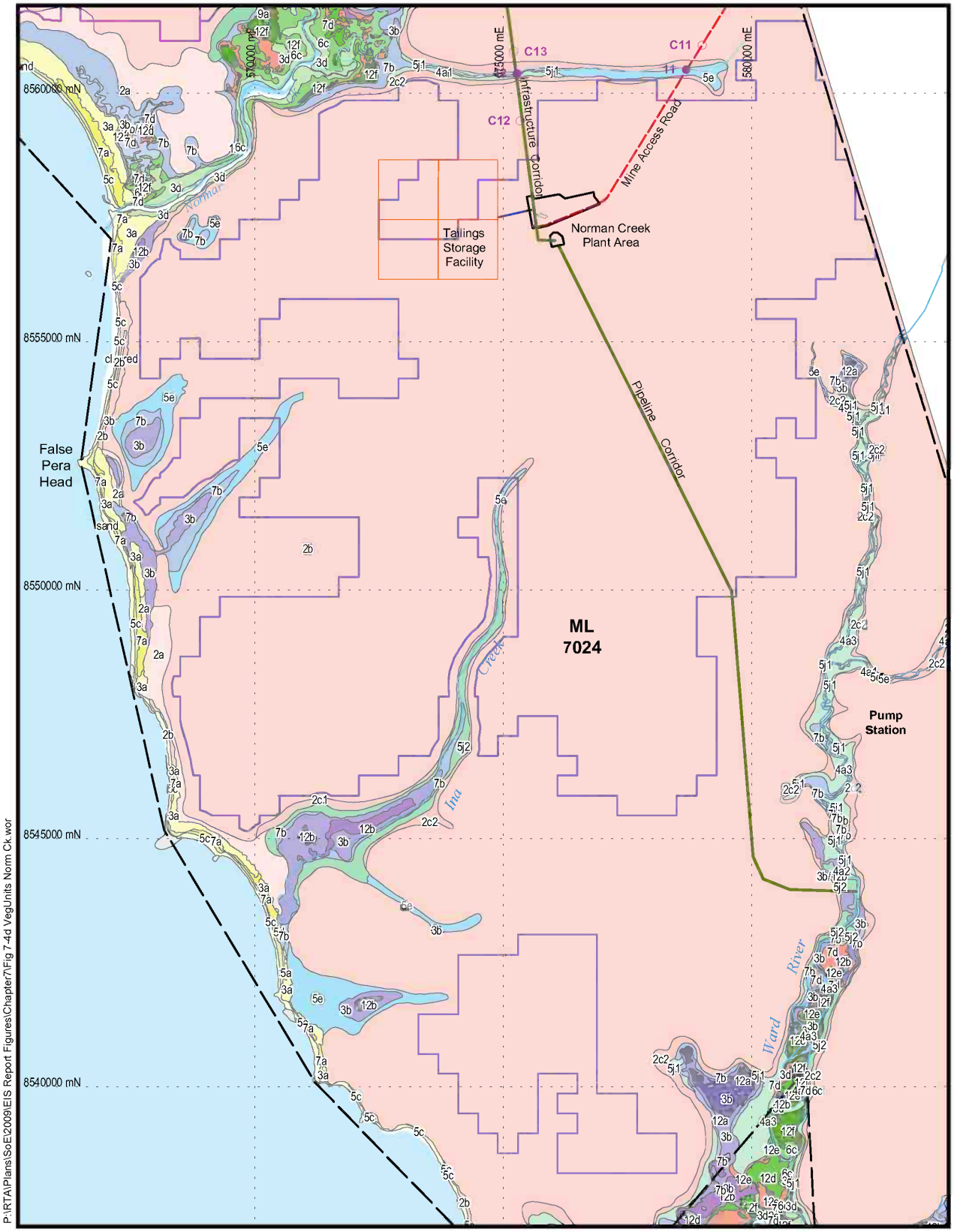
South of Embley Project

Fig. 7-4c: Vegetation Units (Norman Creek East Mining Area)

N

1 0 1km

Datum/Projection: GDA94/MGA Zone 54 Date: 18/01/2011



P:\RTA\Plans\SoE\2009\EIS Report Figures\Chapter7\Fig 7-4d VegUnits Norm Ck.wor

RTA Mining Lease boundary
Freshwater dam
Tailings storage facility
Mining Years 14- 40
Culverts

For Vegetation Unit Descriptions See Fig 7-4

Rio Tinto Alcan

South of Embley Project

Fig. 7-4d Vegetation Units (Norman Creek Mining Area)

N

1 0 1 2km

Datum/Projection: GDA94/MGA Zone 54 Date: 16/07/2010

Table 7-4 Vegetation Units Mapped in the Project Area

Veg. Unit	Description	Key Species	Mapped Area of Vegetation in Project Area (ha)	Proportion of Vegetation[1] in Project Area
Laterite/bauxite plateau and eroding edges				
2a	Tall woodland with Molloy red box on plains – massive sandy loams	Molloy Red Box (*Eucalyptus leptophleba*) Darwin Stringybark (*E. tetrodonta*)	1,039	1%
2b	Tall Darwin Stringybark woodland on lateritic red earths	Darwin Stringybark (*E. tetrodonta*) Melville Island Bloodwood *(Corymbia nesophila)*	85,941	86%
2c	Tall Darwin Stringybark woodland on yellow earths/eroding slopes			
2c1	Tall Darwin Stringybark woodland on yellow earths/eroding slopes (broader gentle sloped areas	Darwin Stringybark (*E. tetrodonta*) Melville Island bloodwood (*C. nesophila*) Long-fruited Bloodwood (*C. polycarpa*) Molly Red Box (*E. leptophleba*)	1,517	1.5%
2c2	Tall Darwin Stringybark woodland on yellow earths/eroding slopes (typically on outer margins of drainage corridors)	Darwin Stringybark (*E. tetrodonta*) Melville Island bloodwood *(C. nesophila* Long-fruited Bloodwood *(C. polycarpa)*	2,239	2.2%
3c	Notophyll vine forest on lateritic or bauxite red earths		56	<0.1%
5b	Grassy woodland on undulating plains and erosional slopes – yellow earths	Cullen's Ironbark (*E. cullenı*) Darwin Stringybark (*E. tetrodonta*) Cape York Ironwood (*Erythrophleum chlorostachys*)	37	<0.1%
5f	Grassy woodland on eroding slopes on colluvium – yellow and gleyed podzolics	Broad-leaved Carbeen (*C. confertiflora*)	209	0.2%
Freshwater drainage lines, wetlands and streams				
3b	*Melaleuca* swamp; zone at the most consistent water level	*Melaleuca* spp. Swamp Mahogany (*Lophostemon suaveolens*)	1,291	1.3%
4a	Riparian gallery forest along permanent and semi-permanent watercourses			
4a1	Narrow mesic gallery along watercourse with Cape York red gum	Cape York Red Gum (*E. brassiana*) Swamp Mahogany (*Lophostemon suaveolens*) Weeping Tea Tree (*Melaleuca leucadendra*) *Acacia aulacocarpa* *Asteromyrtus symphiocarpa*	115	0.1%

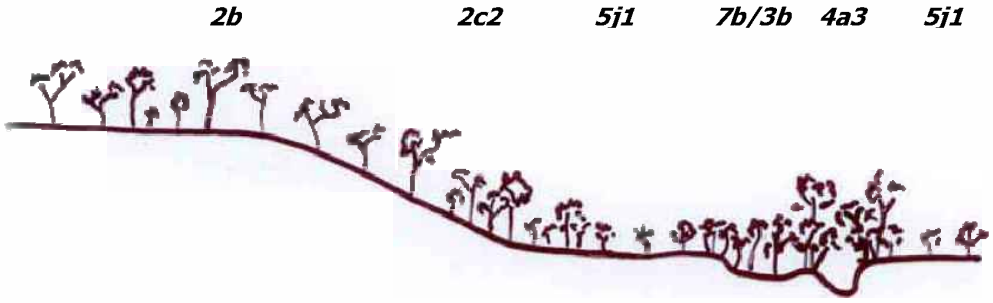
Veg. Unit	Description	Key Species	Mapped Area of Vegetation in Project Area (ha)	Proportion of Vegetation[1] in Project Area
4a2	Riparian gallery rainforest (note: the small areas of closed forest associated with semi-permanent springs/seepages shown in Figure 7-8. These have affinities with Unit 4a2). See below for key species. These closed forest patches are variable and range from rainforest with vines and palms, to riparian gallery forests, to ferny swamp forest with rainforest species.	*Syzygium angophoroides* Swamp Mahogany (*Lophostemon suaveolens*) *Buchanania arborescens* *Gmelina dalrympleana* *Diospyros geminata* *Dillenia alata*	28	<0.1%
	Rainforest / palm forest associated with semi-permanent springs/seepages	Canopy: *Syzygium angophoroides, Lophostemon suaveolens, Deplanchea tetraphylla* Sub canopy: *Carallia brachiata, Dillenia alata, Calophyllum sil, Hydriastele wendlandiana* Ground cover/shrubs/vines: *Melastoma polyanthum* *Blechnum indicum, Flagellaria indica, Lygodium microphyllum*		
4a3	Paperbark dominated riparian gallery with rainforest understorey	Weeping Tea Tree (*M. leucadendra*) *Carallia brachiata*	104	0.1%
4b	Swamp forest / woodland and palm forest on gleyed podzolics close to water table	Weeping Tea Tree (*M. leucadendra*) Swamp Mahogany (Lophostemon suaveolens) *Carallia brachiata* *Diospyros geminata* *Strychnos lucida* *Dillenia alata*	1.6	<0.1%
4c	Sclerophyll fern forest on low lying alluvial terraces, humic gleys.	*Blechnum indicum* *Lygodium microphyllum*	0.4	<0.1%
5e	*C. polycarpa/ E. brassiana* Woodland on colluvial upper reaches of broad drainage basins - yellow podzolics	Clarksons Bloodwood (*C. polycarpa*) Cape York Red Gum (*E. brassiana*)	881	0.9%
5j	Bloodwood–Banksia in upper parts of broad basins – A2 horizon present			
5j1	With Swamp Box (*Lophostemon suaveolens*) and Lily Pily (*Syzygium angophoroides*) – outer fringe of permanent watercourses	Long-fruited Bloodwood (*C polycarpa*) Toothed Banksia (*Banksia dentata*) Swamp Box (*L. suaveolens*) Lily Pily (*Syzygium angophoroides*)	1,596	1.6%
5j2	With Broad-leaved Paperbark (*Melaleuca viridiflora*) on floodplains	Long-fruited Bloodwood (*C polycarpa*) Toothed Banksia (*B. dentata*) Broad-leaved Paperbark (*M. viridiflora*)	315	0.3%

Veg. Unit	Description	Key Species	Mapped Area of Vegetation in Project Area (ha)	Proportion of Vegetation[1] in Project Area
5j3	With Swamp Box (*Lophostemon suaveolens*) and Cabbage Palm (*Livistonia muelleri*) – on gentle low slope (e.g. western boundary of Norman Creek near estuary)	Long-fruited Bloodwood (*C polycarpa*) Toothed Banksia (*B. dentata*) Swamp Box (*L. suaveolens*) Cabbage Palm (*Livistonia muellerii*)	137	0.1%
5j4	With Broad-leaved Paperbark (*Melaleuca viridiflora*), Lineament Tree (*Asteromyrtus lysicarpa*) +/– Hard Tea-tree (*Melaleuca clarksoniana*) on margins of sinkholes	Long-fruited Bloodwood (*C. polycarpa*) Toothed Banksia (*B. dentata*) Broad-leaved Paperbark (*M. viridiflora*) Lineament Tree (*Asteromyrtus lysicarpa*) +/– Hard Tea-tree (*M. clarksoniana*)	17	<0.1%
7b	Melaleuca / Swamp mahogany on the outer margins of drainage depressions	Broad-leaved Tea Tree (*M. viridiflora*) Swamp mahogany (*L. suaveolens*)	1,743	1.7%
7d	Seepage zone along footslopes or outer margins of drainage lines with grassy ground cover and scattered low paperbark	Blady grass (*Imperata cylindrica*) Broad-leaved Tea Tree (*M. viridiflora*)	254	0.3%
12a	Sedgeland in the drainage lines of permanent swamps	*Melaleuca* spp. Sword Grass *(Gahnia sieberiana)*	127	0.1%
12b	Sedgeland in basins of seasonally flooded swamps and drainage depressions	'Bulkuru' spike rush (*Eleocharis dulcis*) *Fimbristylis* sp.	243	0.2%
Coastal and beach ecosystems				
3a	Semi-evergreen notophyll vine forest or thicket on coastal dunes	*Ficus* spp. Indian Beech *(Pongamia pinnata)*	382	0.4%
5a	Layered woodland on plains – massive sandy loams	Clarksons Bloodwood (*C. polycarpa*) Cape York Ironwood (*E. chlorostachys*)	2	<0.1%
5c	Woodland on low beach dunes with horse-tail she oak	Horse-tail She Oak *(Casuarina equisetifolia)*	149	0.1%
5d	Paperbark woodland fringing sandy swales	Silver Paperbark *(M. dealbata)*	6	<0.1%
6a	Semi-evergreen vine thicket on calcareous sand[3]		0	-
7a	Mixed shrubby woodland (Sclerophyll vine woodland) on dunefields	Lancewood *(Acacia crassicarpa)* Scrub Turpentine *(Canarium australianum)* Beach Tamarind *(Cupaniopsis anacardioides)*	174	0.2%
7c	Woodland with Paperbark on sandy swales [2]	Broad-leaved Tea Tree (*M. viridiflora*) Lancewood *(Acacia crassicarpa)*	0	-
12c	Grassland/herbland on dunefield	Sand Spinifex *(Spinifex hirsutus)*	2	<0.1%

Veg. Unit	Description	Key Species	Mapped Area of Vegetation in Project Area (ha)	Proportion of Vegetation[1] in Project Area
Estuary and saltpan ecosystems				
3d	Mangrove; Rhizophora zone	*Rhizophora* spp.	485	0.5%
3e	Mangrove; Landward zone, freshwater conditions (including looking glass mangrove)	Milky Mangrove *(Excoecarya agallocha)* Cajuput *(M. cajuputi)*	72	0.1%
6c	Mangroves; Ceriops zone	Spur Mangroves *(Ceriops* spp.) Grey Mangrove *(Avicennia eucalyptifolia)*	447	0.4%
8c	Closed scrub in saline strips in estuarine plains – yellow podzolics [2]	*M. acacioides*	0	-
9a	Mangrove; highly saline landward zone (mixed species)	Club Mangrove *(Aegialitis annulata)* Milky Mangrove *(Excoecarya agallocha)*	15	<0.1%
12d	Grasslands on low level terraces (narrow bands)	Broad-leaved Tea Tree *(M. viridiflora)* Screw Pine *(Pandanus sp.)* Vetiver Grass *(Vetiveria elongata)*	108	0.1%
12e	Saltpan, sparse herbfield	Samphire (*Arthrocnemum* spp.)	240	0.2%
12f	Seasonally flooded saline marine plains	'Bulkuru' spike rush *(E. dulcis)* Fimbristylis sp.	399	0.4%
		Totals	100,372	100%

Notes:

1. A total of 100,367ha of terrestrial, wetland and estuarine vegetation was mapped within the Project area.



Note: Exaggerated vertical scale

Component Vegetation Units:	2b	Tall Darwin Stringybark woodland on lateritic red earths
	2c2	Tall Darwin Stringybark woodland on yellow earths/eroding slopes (typically on outer margins of drainage corridors)
	5j1	Bloodwood-Banksia in upper parts of broad basins with Swamp Box (*Lophostemon suaveolens*) and Lily Pily (*Syzygium angophoroides*) – outer fringe of permanent watercourses
	7b	Melaleuca/Swamp Mahogany on the outer margins of drainage depressions
	3b	*Melaleuca* swamp; zone at the most consistent water level
	4a3	Paperbark dominated riparian strip with rainforest understorey

Figure 7-5 Typical Vegetation Sequence on Edge of Plateau

A variety of wetland vegetation occurs within the Project area including freshwater, marine and brackish. The most distinctive freshwater wetlands are the typically circular, seasonal tree swamps dominated by *Melaleuca* spp. and *Lophostemon suaveolens* that occur within the bauxite plateau (units 3b, 7b, 12b). These tree swamps are not as numerous in the Project area as in the nearby Weipa area and occur predominantly in the northern part of the Project area (only six tree swamps have been identified in the Project area). More extensive freshwater and brackish treed wetland vegetation occurs along the lower reaches of the main stream systems (unit 3b), again dominated by *Melaleuca* spp. and heavily influenced by post wet season groundwater discharge flows and late dry season tidal penetration. Areas of open sedgeland (unit 12b) also occur behind mangrove systems in estuarine reaches. More detailed analysis of the ecology of these systems is provided in **Section 8**.

An array of vegetation types occur on coastal sand formations from grasslands on unconsolidated dunes (12c), shrubby Acacia dominated woodlands on hind dunes (7a), to semi evergreen notophyll vine forest on old hind dunes (3a). Dune formations do not occur along the entire coastline of the Project area as the bauxite plateau abuts the coast for the majority of the Gulf coastline and also the Hey River coastline. Consequently, vegetation communities on dune systems occur mainly as isolated pockets particularly in the vicinity of rocky headlands such as Boyd Point.

Mangrove communities occur predominantly in association with the three major drainage systems of the Project area (Winda Winda/Triluck Creek, Norman Creek, Ward River) with patches of fringing mangroves also occurring along the Embley–Hey River estuary. Within the Project area, mangrove communities attain greatest complexity and extent along Norman Creek and the Ward River. The mangrove species diversity within the Project area is typical of the tropical location. Upper estuarine areas of the three major drainage systems support a combination of mangrove, salt pan, *Melaleuca* wetland, and sedge swamp developed by topography, stream channel morphology, and highly variable salinity profiles that are determined by wet season freshwater flows and groundwater discharge.

Overall, the vegetation community of the Project area is typical of that occurring elsewhere on the western Cape on the bauxite plateau landform. Godwin (1985) described seven land systems for the Weipa region and mapped them as far south as Pera Head. The Andoom Land System is most applicable to the Project area and the most widespread, being associated with the following landform: low level plateau with sparse drainage and containing swampy sink holes and bordered by low gentle scarps (Godwin 1985). The Tullanaringa Land System of coastal beach ridges and swales is applicable to the coastal areas of the Project area where there is a more gradual topographic sequence to the coast as opposed to the bauxite cliffs. The Wenlock Land System of saline tidal flats and stream banks is apparent on the lower reaches of the Ward River, Norman Creek, Winda Winda Creek and to a lesser extent the Embley and Hey River systems. The Kurracoo Land System is described as moderately dissected undulating plains; it is largely erosional, though depositional surfaces occur along streams. Godwin (1985) mapped this system along the upper reaches of Norman Creek and its tributaries.

In contrast to the Weipa area and further north towards the Jardine River, the broad heathy swamps and drainage lines with insectivorous plants of the Jardine Land System do not occur within the Project area, apart from a small area on the northern branch of Norman Creek. Similarly, the Mapoon Land System of broad marine plains with sequences of palm forest, *Melaleuca* swamp and open sedgeland are not well developed within the Project area due to the tendency for the bauxite plateau to abut the coastline and a consequent lack of a well-developed marine plain landform.

7.5.2 Regional Ecosystems

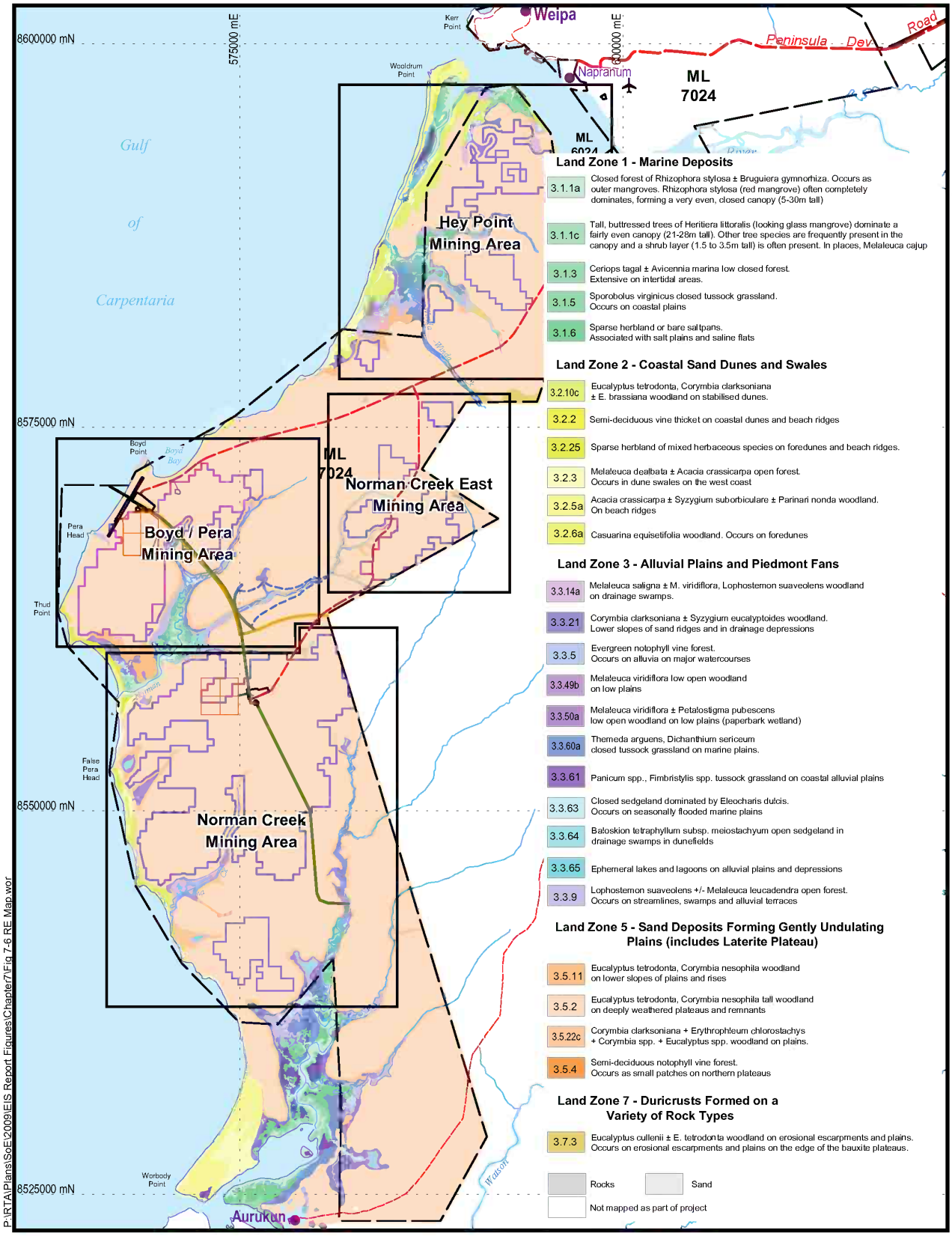
There are a total of 28 REs within five different land zones currently appearing on the *Vegetation Management Act (1999)* (Qld) (VMA) certified mapping for the Project area (refer **Appendix 7C** for Version 6 VMA RE mapping). RE mapping is issued by DERM with caveats over the accuracy of mapping when interpreted at a property scale, and verification of RE mapping is required when used at a larger scale. RE mapping was produced at a scale of 1:100,000 and subsequently represents only broadscale mapping when considering the Project area at a scale of 1:10,000. Comparison of current RE mapping with the more detailed vegetation unit mapping prepared by ground-truthing of vegetation indicates some inaccuracies in the VMA RE mapping with respect to the complexity of REs occurring in the area, and the designation of RE types. The ground-truthed mapping undertaken for the Project identified 27 REs in the Project area. Three of the REs appearing on the VMA RE coverage of the Project area were not located during field surveys (RE 3.5.7x2a, 3.5.22a and 3.5.19x7). One RE appearing on the VMA RE mapping (RE 3.2.2a) is a variation of the main RE type and is represented on the Project RE mapping as the main RE type (i.e. RE 3.2.2). An additional three REs not included on VMA mapping were identified as present through field surveys for the Project (RE 3.1.1c, 3.3.5 and 3.3.21).

RE mapping was undertaken by assigning the existing RE type as defined by DERM that most closely described the vegetation unit identified during field surveys. In most cases, REs were a good fit for vegetation units. However, in some cases assigned REs did not accurately reflect the vegetation unit observed in the field and represent the closest available RE.

Figures 7-6, 7-6a, 7-6b, 7-6c and 7-6d are ground-truthed RE maps for the Project area using the vegetation unit mapping and equivalent REs as outlined in **Table 7-5**. A list of the 27 REs identified as occurring within the Project area is provided in **Table 7-5**. RE 3.5.2 (*Eucalyptus tetrodonta*, *Corymbia nesophila* tall woodland on deeply weathered plateaus and remnants) corresponds with vegetation units 2b and 2c1, and is the most widespread RE within the Project area comprising 87,465ha or approximately 86% of the vegetation in the Project area.

7.5.3 Threatened Vegetation Communities

Of the 27 REs occurring in the Project area, 24 are listed under the VMA as "Least concern", and three are listed under the VMA as "Of concern" (refer **Table 7-5**). There are no "Endangered" REs within the Project area.



RTA Mining Lease boundary
Township
Road/track
Freshwater dam
Tailings storage facility
Mining Years 1- 13
Mining Years 14- 40

Rio Tinto Alcan

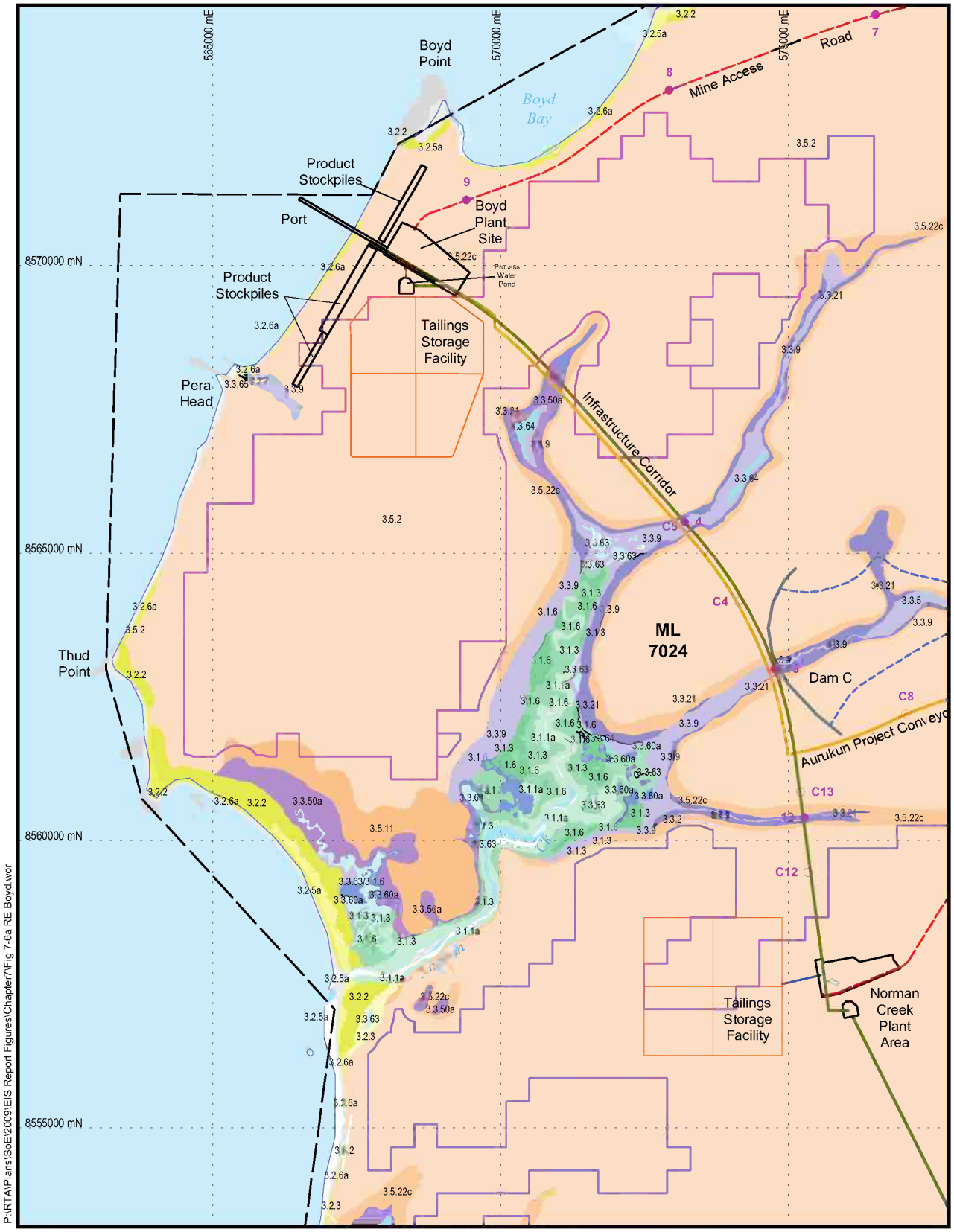
South of Embley Project

Fig. 7-6: Regional Ecosystems (Ground Surveyed)

N

5 0 5km

Datum/Projection: GDA94/MGA Zone 54 Date: 10/11/2010



P:\RTA\Plans\SoE\2009\EIS Report Figures\Chapter7\Fig 7-6a RE Boyd.wor

RTA Mining Lease boundary
Freshwater dam
Tailings storage facility
Mining Years 1- 13
Mining Years 14- 40
Culverts

For RE Descriptions See Fig 7-6

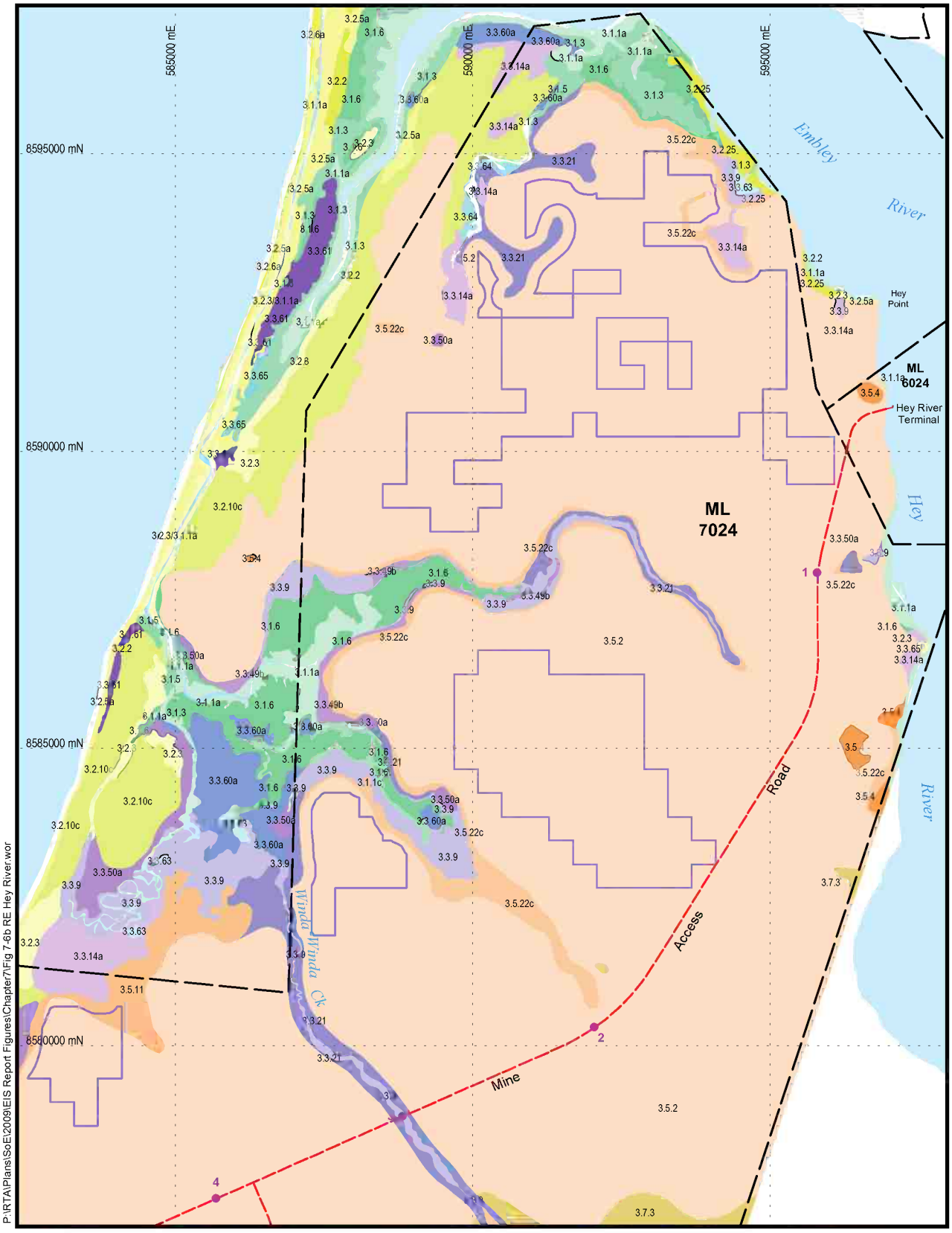
South of Embley Project

Fig. 7-6a: Regional Ecosystems (Boyd/Pera Mining Area)

N

1 0 1 2km

Datum/Projection: GDA94/MGA Zone 54 Date: 08/11/2010



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RTA Mining Lease boundary

Mining Years 14- 40

Culverts

For RE Descriptions See Fig 7-6

Rio Tinto Alcan

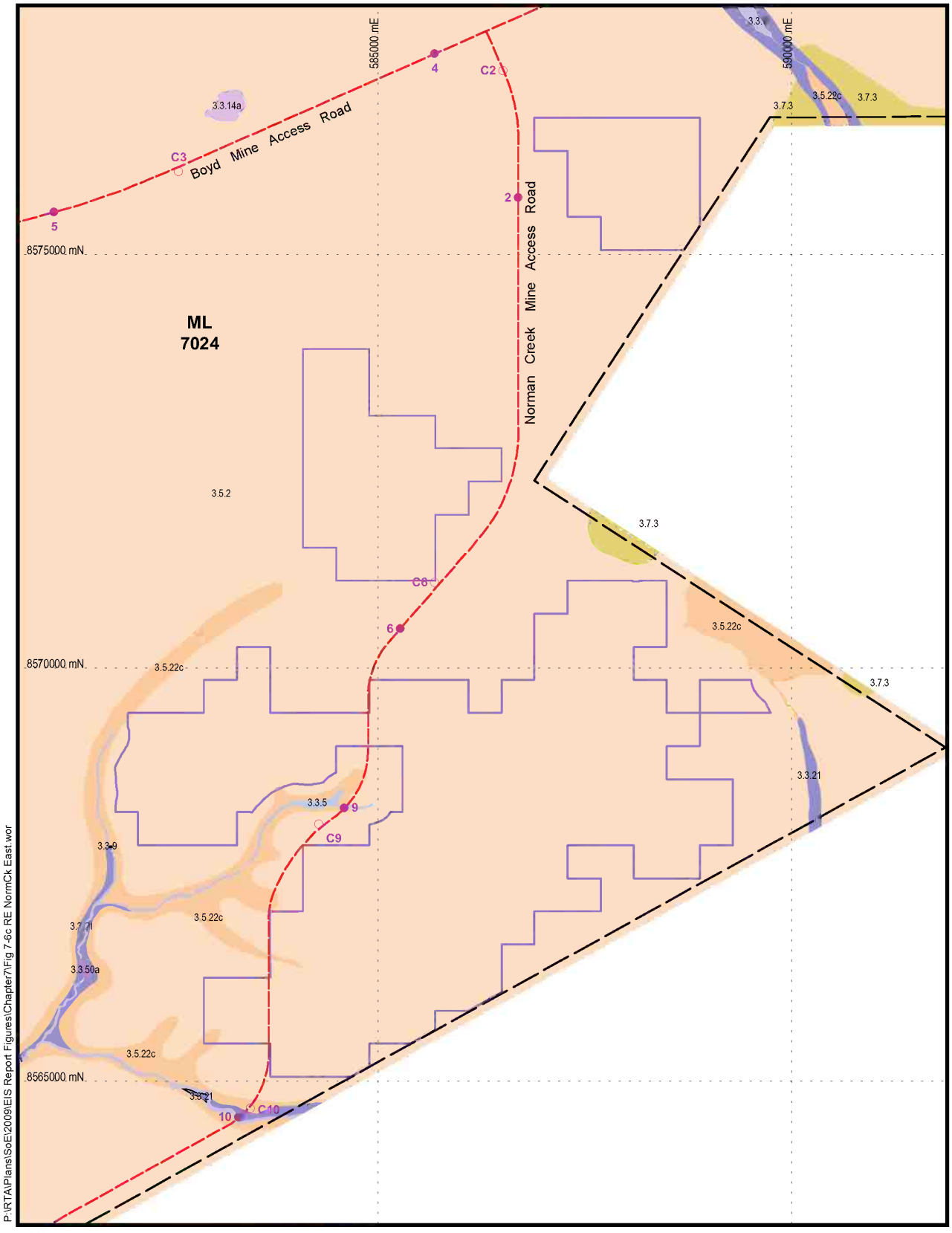
South of Embley Project

Fig. 7-6b: Regional Ecosystems (Hey Point Mining Area)

N

1 0 1 2km

Datum/Projection: GDA94/MGA Zone 54 Date: 08/11/2010



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RTA Mining Lease boundary

Mining Years 14- 40

Culverts

For RE Descriptions See Fig 7-6

Rio Tinto Alcan

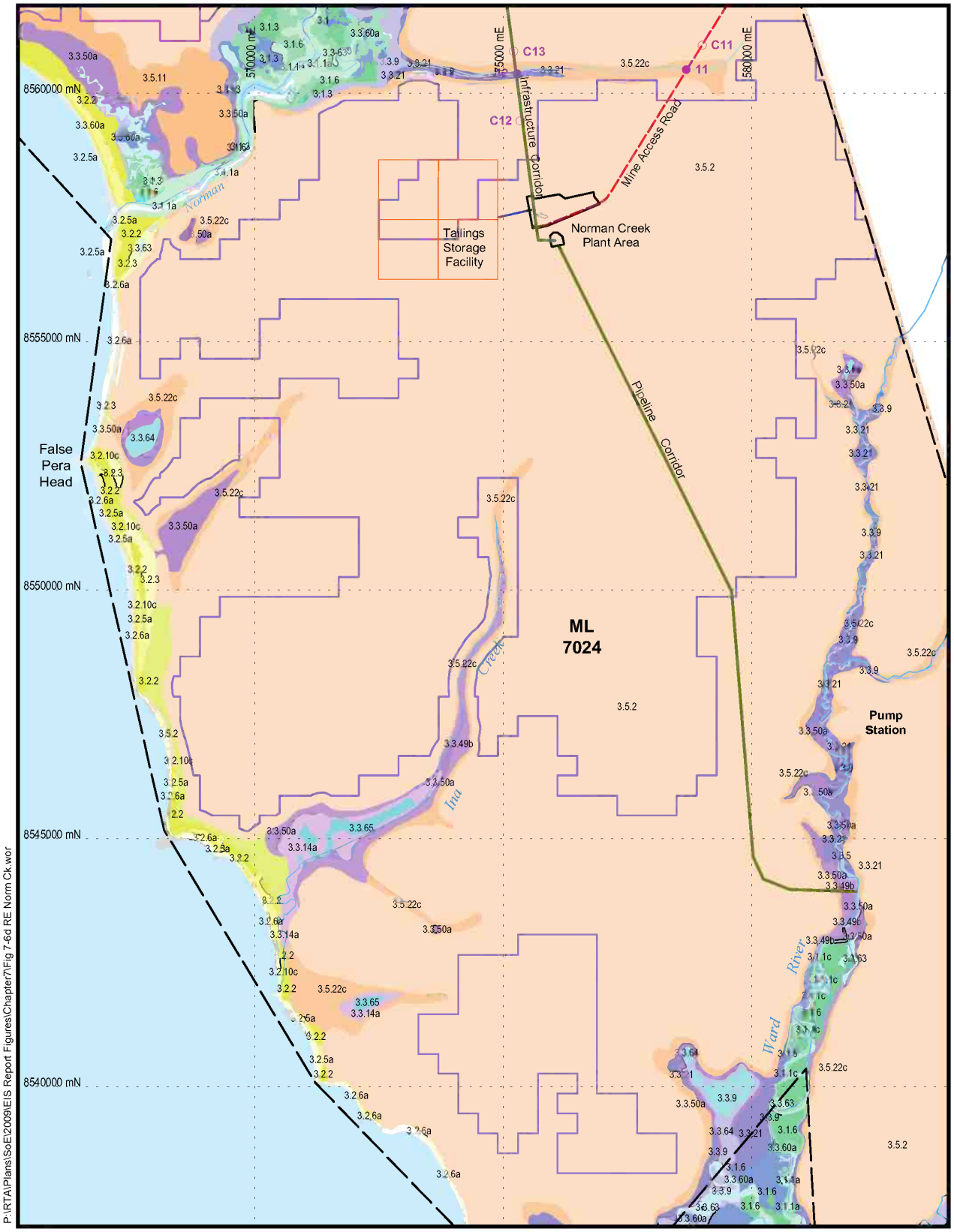
South of Embley Project

Fig. 7-6c: Regional Ecosystems (Norman Creek East Mining Area)

N

1 0 1km

Datum/Projection: GDA94/MGA Zone 54 Date: 08/11/2010



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RTA Mining Lease boundary
Freshwater dam
Tailings storage facility
Mining Years 14- 40
Culverts

For RE Descriptions
See Fig 7-6

Rio Tinto Alcan

South of Embley Project

Fig. 7-6d
Regional Ecosystems
(Norman Creek Mining Area)

N

1 0 1 2km

Datum/Projection: GDA94/MGA Zone 54 Date: 08/11/2010

Table 7-5 Regional Ecosystems Identified within the Project Area

RE	Description	VMA Status	Biodiversity Status	Corresponding Veg. Units		Ecological Values/ Comments	Extent in Reserves or Protected Areas in Cape York Bioregion[1]	Mapped[2] Vegetation Area in Project Area (ha)	Proportion of Vegetation in Project Area
				Main Veg. Unit(s)	Associated Veg. Units[3]				
Land Zone 1 – Marine Deposits									
3.1.1a	Closed forest of *Rhizophora stylosa* ± *Bruguiera gymnorhiza*. Occurs as outer mangroves. *Rhizophora stylosa* (Red Mangrove) often completely dominates, forming a very even, closed canopy (5–30m tall).	Least concern	No concern at present	3d	7d	Estuarine wetland	Medium representation, which includes: Cape Melville NP, Endeavour River NP, Iron Range NP, Jardine River NP, Lakefield NP.	481	0.5%
3.1.1c	Tall, buttressed trees of *Heritiera littoralis* (Looking Glass Mangrove) dominate a fairly even canopy (21–28m tall). Other tree species are frequently present in the canopy and a shrub layer (1.5–3.5m tall) is often present. In places, *Melaleuca cajuputi* (Cajuput Tree) is the most frequent canopy species.	Least concern	No concern at present	3d 3e	3b 7b 7d	Estuarine wetland	Medium representation, which includes: Cape Melville NP, Endeavour River NP, Iron Range NP, Jardine River NP, Lakefield NP.	122	0.1%
3.1.3	*Ceriops tagal* ± *Avicennia marina* low closed forest. Extensive on intertidal areas.	Least concern	No concern at present	6c 9a	7d	Estuarine wetland	Medium representation, which includes: Cape Melville NP, Endeavour River NP, Heathlands RR, Iron Range NP, Iron Range RR, Jardine River NP, Lakefield NP.	472	0.5%
3.1.5	*Sporobolus virginicus* closed tussock grassland. Occurs on coastal plains.	Least concern	No concern at present	12e		Estuarine wetland	Low representation, which includes: Lakefield NP.	4	<0.1%
3.1.6	Sparse herbland or bare saltpans. Associated with salt plains and saline flats.	Least concern	No concern at present	12e 12f 8c		Estuarine wetland	High representation, which includes: Cape Melville NP, Endeavour River NP, Iron Range NP, Jardine River NP, Lakefield NP.	633	0.6%
Land Zone 2 – Coastal sand dunes and swales									
3.2.2	Semi-deciduous vine thicket on coastal dunes and beach ridges	Least concern	Of concern	3a			No representation in protected areas on mainland within bioregion.	380	0.4%

RE	Description	VMA Status	Biodiversity Status	Corresponding Veg. Units		Ecological Values/ Comments	Extent in Reserves or Protected Areas in Cape York Bioregion[1]	Mapped[2] Vegetation Area in Project Area (ha)	Proportion of Vegetation in Project Area
				Main Veg. Unit(s)	Associated Veg. Units[3]				
3.2.3	*Melaleuca dealbata* ± *Acacia crassicarpa* open forest. Occurs in dune swales on the west coast.	Of concern Remnant extent >30% remains <10,000ha	Of concern	5d	3b 7b	Palustrine wetland (e.g. vegetated swamp)	Low representation, which includes: • 22ha in National Parks.	228	0.2%
3.2.5a	*Acacia crassicarpa* ± *Syzygium suborbiculare* ± *Parinari nonda* woodland. On beach ridges.	Least concern	No concern at present	7a	3b 7b 7c		Low representation, which includes: • Cape Melville NP, • Lakefield NP.	174	0.2%
3.2.6a	*Casuarina equisetifolia* woodland. Occurs on foredunes.	Of concern >30% remains Remnant extent <10,000ha	Of concern	5c			Low representation, which includes: • Cape Melville NP, • Iron Range NP.	149	0.1%
3.2.10c	*Eucalyptus tetrodonta, Corymbia darksoniana* ± *E. brassiana* woodland on stabilised dunes.	Least concern	Of concern	2a 5a			High representation, which includes: • 7,213ha in National Parks (including Cape Melville NP) • 611ha in Resource Reserves.	537	0.5%
3.2.25	Sparse herbland of mixed herbaceous species on foredunes and beach ridges.	Of concern >30% remains Remnant extent <10,000ha	Of concern	12c			High representation, which includes: • 1,025ha in National Parks (including Cape Melville and Lakefield NPs).	34	<0.1%
Land Zone 3 – Alluvial plains and piedmont fans									
3.3.5	Evergreen notophyll vine forest. Occurs on alluvia on major watercourses.	Least concern	No concern at present	4a2		Riverine wetland or fringing riverine wetland	High representation, which includes: • Cape Melville NP, • Iron Range NP, • Jardine River NP, • Lakefield NP, • Mungkan Kandju NP, • Starcke NP.	28	<0.1%

RE	Description	VMA Status	Biodiversity Status	Corresponding Veg. Units		Ecological Values/ Comments	Extent in Reserves or Protected Areas in Cape York Bioregion[1]	Mapped[2] Vegetation Area in Project Area (ha)	Proportion of Vegetation in Project Area
				Main Veg. Unit(s)	Associated Veg. Units[3]				
3.3.9	*Lophostemon suaveolens* open forest. Occurs on streamlines, swamps and alluvial terraces.	Least concern	No concern at present	4a1 4a3	3b 7b	Riverine wetland or fringing riverine wetland	High representation, which includes: • Heathlands RR, • Iron Range NP, • Jardine River NP, • Lakefield NP, • Mungkan Kandju NP.	1,623	1.6%
3.3.14a	*Melaleuca saligna* ± *M. viridiflora, Lophostemon suaveolens* woodland on drainage swamps.	Least concern	No concern at present	3b 7b	5j4	Palustrine wetland (e.g. vegetated swamp)	Medium representation, which includes: • Cape Melville NP, • Jardine River NP, • Lakefield NP, • Mungkan Kandju NP.	434	0.4%
3.3.21	*Corymbia clarksoniana* ± *Syzygium eucalyptoides* woodland. Lower slopes of sand ridges and in drainage depressions.	Least concern	No concern at present	5j1		Floodplain (other than floodplain wetlands)	Low representation, which includes: • Mungkan Kandju NP.	1,589	1.6%
3.3.49b	*Melaleuca viridiflora* low open woodland on low plains	Least concern	No concern at present	5j2		Widely distributed on floodplains	High representation, which includes: • Lakefield NP, • Mungkan Kandju NP.	315	0.3%
3.3.50a	*Melaleuca viridiflora* ± *Petalostigma pubescens* low open woodland on low plains.	Least concern	No concern at present	7b	3b	Palustrine wetland (e.g. vegetated swamp)	High representation, which includes: • Iron Range NP, • Jardine River NP, • Lakefield NP, • Mungkan Kandju NP.	986	1.0%
3.3.60a	*Themeda arguens, Dichanthium sericeum* closed tussock grassland on marine plains.	Least concern	No concern at present	7d 12d		Floodplain (other than floodplain wetlands).	High representation, which includes: • Lakefield NP.	188	0.2%
3.3.61	*Panicum spp., Fimbristylis spp.* tussock grassland on coastal alluvial plains.	Least concern	No concern at present	12c	7d 5a	Floodplain (other than floodplain wetlands)	Low representation, which includes: • Lakefield NP.	7	<0.1

RE	Description	VMA Status	Biodiversity Status	Corresponding Veg. Units		Ecological Values/ Comments	Extent in Reserves or Protected Areas in Cape York Bioregion[1]	Mapped[2] Vegetation Area in Project Area (ha)	Proportion of Vegetation in Project Area
				Main Veg. Unit(s)	Associated Veg. Units[3]				
3.3.63	Closed sedgeland dominated by *Eleocharis dulcis*. Occurs on seasonally flooded marine plains.	Least concern	No concern at present	12f 12b		Palustrine wetland (e.g. vegetated swamp).	No representation.	152	0.2%
3.3.64	*Baloskion tetraphyllum subsp. meiostachyum* open sedgeland in drainage swamps in dunefields.	Least concern	No concern at present	12a	7d	Palustrine wetland (e.g. vegetated swamp).	High representation, which includes: • Cape Melville NP, • Heath lands RR, • Iron Range NP, • Jardine River NP, • Mungkan Kandju NP.	185	0.2%
3.3.65	Ephemeral lakes and lagoons on alluvial plains and depressions.	Least concern	No concern at present	12a 12b		Palustrine wetland (e.g. vegetated swamp).	Medium representation, which includes: • Lakefield NP, • Mungkan Kandju NP.	66	0.1%
Land Zone 5 – Sand deposits forming gently undulating plains (includes laterite plateau)									
3.5.2	*Eucalyptus tetrodonta, Corymbia nesophila* tall woodland on deeply weathered plateaus and remnants.	Least concern	No concern at present	2b 2c1		Associated with bauxite plateaus. Significant areas near Weipa cleared for bauxite mining. One of the most widespread REs in the bioregion.	Low representation, which includes: • Jardine River NP, • Mungkan Kandju NP.	87,465	86%
3.5.4	Semi-deciduous notophyll vine forest. Occurs as small patches on northern plateaus.	Least concern	No concern at present	3c		Great variability in species composition between patches.	High representation, which includes: • Heathlands RR, • Iron Range NP, • Jardine River NP, • Mungkan Kandju NP.	56	<0.1%
3.5.11	*Eucalyptus tetrodonta, Corymbia nesophila* woodland on lower slopes of plains and rises.	Least concern	No concern at present	2a			Low representation, which includes: • Lakefield NP, • Mungkan Kandju NP.	599	0.6%

RE	Description	VMA Status	Biodiversity Status	Corresponding Veg. Units		Ecological Values/ Comments	Extent in Reserves or Protected Areas in Cape York Bioregion[1]	Mapped[2] Vegetation Area in Project Area (ha)	Proportion of Vegetation in Project Area
				Main Veg. Unit(s)	Associated Veg. Units[3]				
3.5.22c	*Corymbia clarksoniana* + *Erythrophleum chlorostachys* + *Corymbia spp.* + *Eucalyptus spp.* woodland on plains.	Least concern	No concern at present	5e 2c2			High representation, which includes: • Lakefield NP, • Cape Melville NP. • Starcke NP, • Mungkan Kandju NP.	3,120	3.1%
Land Zone 7 – Duricrusts formed on a variety of rock types									
3.7.3	*Eucalyptus cullenii* ± *E. tetrodonta* woodland on erosional escarpments and plains. Occurs on erosional escarpments and plains on the edge of the bauxite plateaus.	Least concern	No concern at present	5b 5f			Medium representation, which includes: • Mungkan Kandju NP.	245	0.2%
							Total	100,272[4]	100%

Abbreviations: RE = Regional Ecosystem; VMA = *Vegetation Management Act 1999* (Qld); NP = National Park; RR = Resources Reserve

Notes:

1. Reserved extent based on data from RE Description Database and data from Accad *et al.* (2008), which relies on 2005 remnant mapping. Note that RE mapping is incomplete for Cape York Bioregion and thus actual hectare values are not available for all REs.
2. According to revised mapping prepared for this Project (refer Figure 7-6).
3. Associated Veg. Units comprise vegetation units that can occur within more than one land zone and therefore may be attributed to more than one RE.
4. Area discrepancy from mapped vegetation within Project area due to rounding up area totals.

A RE is regarded as "Of concern" under the VMA if between 10 and 30% of its pre-clearing extent remains within the bioregion (i.e. if the majority of the RE has been cleared); or more than 30% of its pre-clearing extent remains but the remaining extent is less than 10,000ha (i.e. naturally limited distribution). Each of the "Of concern" REs occurring within the Project area has been assessed as such due to a natural limited distribution, and none have experienced significant reduction in their pre-clear extent within the Project area or elsewhere in the Cape York Bioregion. The extent to which each of the "Of concern" REs occurring in the Project area is represented in Bioregional conservation reserves is indicated in **Table 7-5**. There are no conservation reserves occurring in the main catchments making up the Project area and therefore the five "Of concern" REs are not represented in conservation reserves at the catchment level.

The Biodiversity Status of REs is also indicated in **Table 7-5**. All the REs present have a similar "No concern at present (Least concern)" or "Of concern" status to the VMA status apart from RE 3.2.2 and RE 3.2.10c which have an 'Of concern' Biodiversity Status. The Biodiversity Status scheme was developed by the DERM (formerly the Environment Protection Agency) as an alternative conservation status scheme to the VMA.

The Biodiversity Status has no regulatory power but provides an indication of conservation value of individual REs from a more ecological perspective compared to the VMA status which relies substantially on proportions of pre-disturbance and remnant areas. The three Biodiversity Status classes mirror those of the VMA and comprise:

- No concern at present (similar to "Least concern" under the VMA);
- Of concern; and
- Endangered.

The EPBC search did not identify any EECs as likely to occur within the Project area, and none were identified during the field surveys.

7.6 Flora

7.6.1 Overview of Flora

A total of 519 plant taxa has been recorded from all vegetation types within the Project area based on results of preliminary and EIS surveys. This constitutes approximately 58% of the 887 species of vascular plant taxa currently known to occur over all of RTA's Weipa mining leases. It is likely that numerous additional species known to occur within RTA's mining leases would be identified within the Project area if additional surveys were to be carried out during the wet season.

A list of the flora species recorded from the Project area is provided in **Appendix 7D**. **Table 7-6** summarises the floristic diversity at different taxonomic levels and indicates there is considerable floristic diversity within the Project area, reflecting the diversity of vegetation types and habitats present including closed forest, woodland, and a range of stream and wetland habitats. A total of 184 (or approximately 36% of the total compliment of species from the Project area) has been identified from *Eucalyptus tetrodonta* dominated vegetation (unit 2b), which is the vegetation type occurring where mining is proposed. This vegetation type comprises approximately 85% of the Project area.

The composition of plant families present reflects the variety of habitats with Lauraceae, Annonaceae, Sapindaceae, Moraceae and Clusiaceae especially indicative of vine forest and moist riparian gallery forest; Myrtaceae indicative of sclerophyllous vegetation types including eucalypt woodland, but especially boosted by a substantial diversity of Melaleuca occurring predominantly in wetland habitats; Cyperaceaea and Restionacaeae indicative of wetland habitats; Rhizophoraceae indicative of mangroves; and, Poaceae well represented across all habitats.

Table 7-6 Floristic Diversity of the Project Area at Different Taxonomic Levels

Taxonomic Level	All Vegetation Types	*Eucalyptus tetrodonta* Vegetation Types	*Eucalyptus tetrodonta* Vegetation Types as Proportion of Total
Family	110	57	52%
Genus	343	132	39%
Species	519	184	36%

Particularly well represented families comprised Poaceae (51 species), Fabaceae (38), Cyperaceae (22), Euphorbiaceae (22), and Rubiaceae (20). Particularly well represented genera comprised Melaleuca (12), Acacia (9), Ficus (7), Corymbia (5), Dianella (5), and Cryptocarya (5).

The most widespread species within the Project area were the key species associated with *Eucalyptus tetrodonta* woodland (vegetation unit 2b/2c1, RE 3.5.2), as this is by the far the most abundant vegetation type. The most widespread species comprised the trees *Eucalyptus tetrodonta*, *Corymbia nesophila*, *Erythrophleum chlorostachys* and *Parinari nonda*; the tall shrubs *Planchonia careya*, and *Acacia rothii*; and the ground cover species *Heteropogon triticeus*, *Coelospermum reticulatum*, *Spermacoce brachystema* and *Smilax australis*.

7.6.2 Threatened Flora – EPBC Act

The Commonwealth EPBC Act provides for the listing and protection of threatened flora in Australia. The threatened status categories for flora under the EPBC Act in order of increasing conservation significance are vulnerable, endangered, critically endangered or conservation dependant. **Table 7-7** lists the threatened flora species that:

- have been previously recorded from within or in close proximity to the Project area (DERM 2009c, Queensland Herbarium 2009);
- have been found during surveys for the EIS;
- could potentially occur within the Project area based on EPBC database search; and
- could potentially occur within the Project area based on previous surveys in the Weipa area for RTA.

An assessment is provided of each species' potential occurrence in the Project area based on their habitat requirements and the condition and array of habitats available. The source of records for each species is indicated in **Table 7-7** along with the preferred habitat and known occurrence in the Weipa region. **Figure 7-7, Figure 7-7a** and **Figure 7-7b** detail the location of threatened flora recorded during field surveys.

Of the 6 species identified as potential inhabitants of the Project area, all are listed as vulnerable, and:

- 2 species have been confirmed as present in the Project area;
- 1 species is likely to occur in the Project area; and
- 3 species possibly occur in the Project area.

The REs that represent potential habitat for each species are provided in **Table 7-7**. Refer to **Figure 7-6, Figure 7-6a, Figure 7-6b, Figure 7-6c** and **Figure 7-6d** for the location and distribution of these REs within the Project area. Refer to **Table 7-10** for data on the area of proposed disturbance of REs compared to the total area within the Project area, the Weipa Plateau subregion, and the Cape York Bioregion.

Table 7-7 Threatened Flora Listed Under the EPBC Act

Species **Common Name [Family] (Source of Record)**	**EPBC Status**	**Growth Form and Habitat**	**Likelihood of Occurrence within Project Area and Areas of Proposed Disturbance within the Project Area (Site)**
Calophyllum bicolor No common name [Clusiaceae] (Wild, epbc)	V	A small fire sensitive tree known to be associated with permanent groundwater seepage zones, particularly in evergreen vine forest. Potential habitats comprise RE 3.3.5 (Refer to **Figures 7-6** to **7-6d** for the locations of RE's within the Project area).	**Project Area** **Possible**: not detected during field surveys of five semi-permanent groundwater seepage rainforest patches, close to proposed mining areas, that provide suitable habitat for the species, but may occur in the Project area in groundwater-fed riparian gallery forest or seepage zones nearer the coast. Only limited areas of suitable fire retardant habitat occur within the Project area. Six other semi-permanent seepage areas surveyed outside the infrastructure footprint did not have suitable habitat present. **Mining Area** **Unlikely:** No suitable habitat exists in Darwin Stringybark woodland. **Dam C on Norman Creek and infrastructure footprint** **Unlikely:** targeted surveys of the dam area and infrastructure crossings of riparian areas indicated with a high reliability that this species is not present in these locations.
Dendrobium bigibbum (also known as *Vappodes bigibba)* Cooktown Orchid [Orchidaceae] (Wild, epbc)	V	An epiphyte that grows on trees and rocks in situations with moderate light intensity. Occurs in a range of fire sensitive habitats including coastal scrub, streambank vegetation, monsoon thickets, and gullies in open forest and woodland where fire cannot penetrate. In the Weipa area grows as an epiphyte on trees (rocks absent) and commonly encountered in coastal vine forest and vine forest on bauxite. Potential habitats comprise REs 3.1.1a, 3.1.1c, 3.2.2, 3.3.5, 3.5.4 (Refer to **Figures 7-6** to **7-6d** for the locations of RE's within the Project area).	**Project Area**: **Confirmed:** located in coastal and non-coastal vine forest, and mangrove edges at several locations within the Project area that would not be affected by mining or infrastructure. **Mining Area** **Unlikely:** no suitable habitat exists in Darwin Stringybark woodland. **Dam C on Norman Creek and infrastructure footprint** **Confirmed**: identified in pockets of riparian rainforest within the footprint of Dam C, in the vicinity of the infrastructure corridor crossings on Norman Creek, and vicinity of road crossings of Norman Creek and Winda Winda Creek.

Species **Common Name [Family] (Source of Record)**	**EPBC Status**	**Growth Form and Habitat**	**Likelihood of Occurrence within Project Area and Areas of Proposed Disturbance within the Project Area (Site)**
Dendrobium johannis (also known as *Cepobaculum johannis)* Chocolate Tea tree Orchid [Orchidaceae] (+)	V	An epiphyte that grows in open humid habitats, on slopes in open woodland, close to swamps and in pockets of monsoon forests. It has been recorded growing on Tea-tree in Melaleuca woodland and in coastal semi-evergreen vine thicket. In the Weipa area commonly encountered growing on Melaleuca and Syzygium suborbiculare on the margin of Melaleuca swamps and riparian gallery forest. Potential habitats comprise REs 3.2.3, 3.3.5, 3.3.9, 3.3.14a, 3.3.21 (Refer to **Figures 7-6** to **7-6d** for the locations of RE's within the Project area).	**Project Area** **Confirmed:** located in riparian gallery forest and Melaleuca dominated swamps particularly along major drainage lines and associated tributaries throughout the Project area, in areas not to be disturbed. **Mining Area** **Unlikely:** no suitable habitat exists in Darwin Stringybark woodland. **Dam C on Norman Creek and infrastructure footprint** **Confirmed**: occurs within the infrastructure corridor where it crosses Norman Creek.
Myrmecodia beccarii Ant Plant [Rubiaceae] (+)	V	A tuberous epiphyte known to grow in *Melaleuca* woodland and mangrove areas. Recently recorded from the Weipa area in a small groundwater seepage forest. Potential habitats comprise REs 3.1.1a, 3.1.1c, 3.1.3, 3.3.14a, 3.3.5 (Refer to **Figures 7-6** to **7-6d** for the locations of RE's within the Project area).	**Project Area** **Possible**: this species is of very restricted distribution in the Weipa area. If a permanent groundwater seepage zone was identified within the Project area, this species may occur within this zone. At present only semi-permanent groundwater seepage zones have been identified within the Project area. The species may also occur within or on the landward margin of mangroves within the Project area. **Mining Area** **Unlikely:** no suitable habitat exists in Darwin Stringybark woodland. **Dam C on Norman Creek and infrastructure footprint** **Unlikely:** targeted surveys of the dam area and infrastructure crossings of riparian areas indicated with a high reliability that this species is not present in these locations.
Solanum dunalianum Beach Nightshade [Solanaceae] (Wild, epbc)	V	An herbaceous shrub growing to 2–4m and found in or at the edge of semi deciduous vine forest. Potential habitats comprise REs 3.2.2, 3.5.2 (Refer to **Figures 7-6** to **7-6d** for the locations of RE's within the Project area).	**Project Area** **Likely**: not detected during field surveys but suitable coastal vine forest and vine forest on bauxite habitat occurs in the Project area in areas not to be disturbed. **Mining Area** **Unlikely:** no suitable habitat exists in Darwin Stringybark woodland. **Dam C on Norman Creek and infrastructure footprint** **Unlikely:** within the Project area the species is expected to be restricted to more mesic habitats, particularly coastal vine forest and vine forest on bauxite,

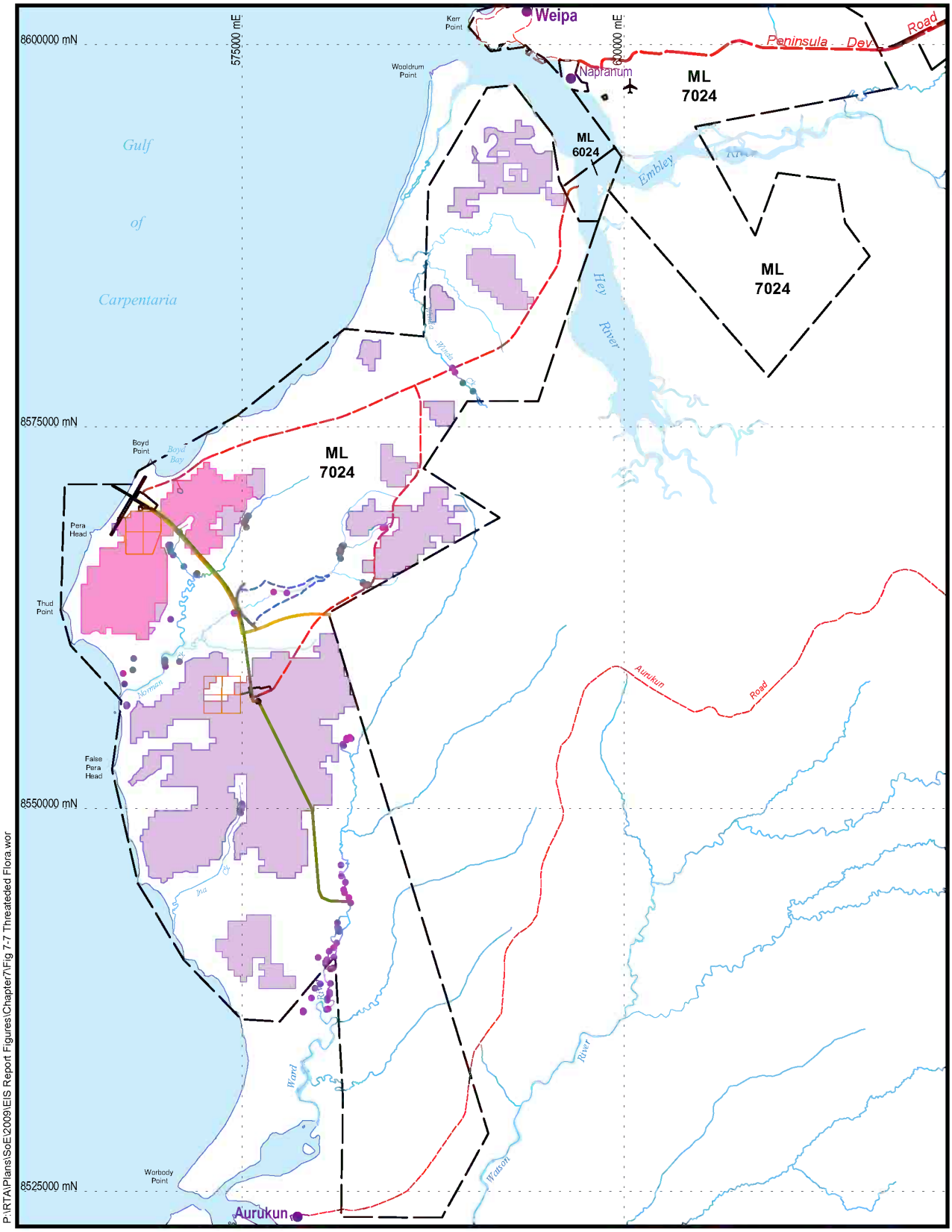
Species **Common Name** **[Family]** **(Source of Record)**	**EPBC Status**	**Growth Form and Habitat**	**Likelihood of Occurrence within Project Area and Areas of Proposed Disturbance within the Project Area (Site)**
Spathoglottis plicata No common name [Orchidaceae] (epbc)	V	A terrestrial orchid with flower stems to 1m that grows in or close to swamps, in seasonally inundated areas and in moist, grassy patches close to streams, in Melaleuca swamp forest and riparian gallery closed forest. Flowers during wet season, difficult to detect when not flowering. Potential habitats comprise REs 3.2.3, 3.3.5, 3.3.9, 3.3.14a, 3.3.21 (Refer to **Figures 7-6** to **7-6d** for the locations of RE's within the Project area).	**Project area** **Possible**: not detected during field surveys anywhere within the Project area but suitable stream, wetland and seepage habitat occurs extensively in the Project area in areas that would not be directly disturbed by the Project. **Mining Area** **Unlikely:** No suitable habitat exists in Darwin Stringybark woodland. **Dam C on Norman Creek and infrastructure footprint** **Possible:** potential habitat for the species occurs within the proposed footprint of Dam C and the infrastructure corridor crossing of Norman Creek, although targeted surveys did not locate the species within these areas.

Key to Source of Record codes:

epbc	Potential species from the EPBC database
Wild	Records from the WildNet database
herb	Specimen records from Queensland Herbarium HERBRECS
+	Additional potential threatened species added to assessment

Key to Status:

V	Vulnerable



P:\RTA\Plans\SoE\2009\EIS Report Figures\Chapter7\Fig 7-7 Threateded Flora.wor

RTA Mining Lease boundary
Township
Road/track
Freshwater dam
Tailings storage facility
Mining Years 1 -13
Mining Years 14 - 40

Threatened Flora

- Cooktown Orchid [Dendrobium bigibbum] (69 locations)
- Chocolate Tea Tree Orchid [Dendrobium johannis] (76 locations)

South of Embley Project

Fig. 7-7: Threatened Flora

N

5 0 5km

Datum/Projection: GDA94/MGA Zone 54 Date: 10/11/2010

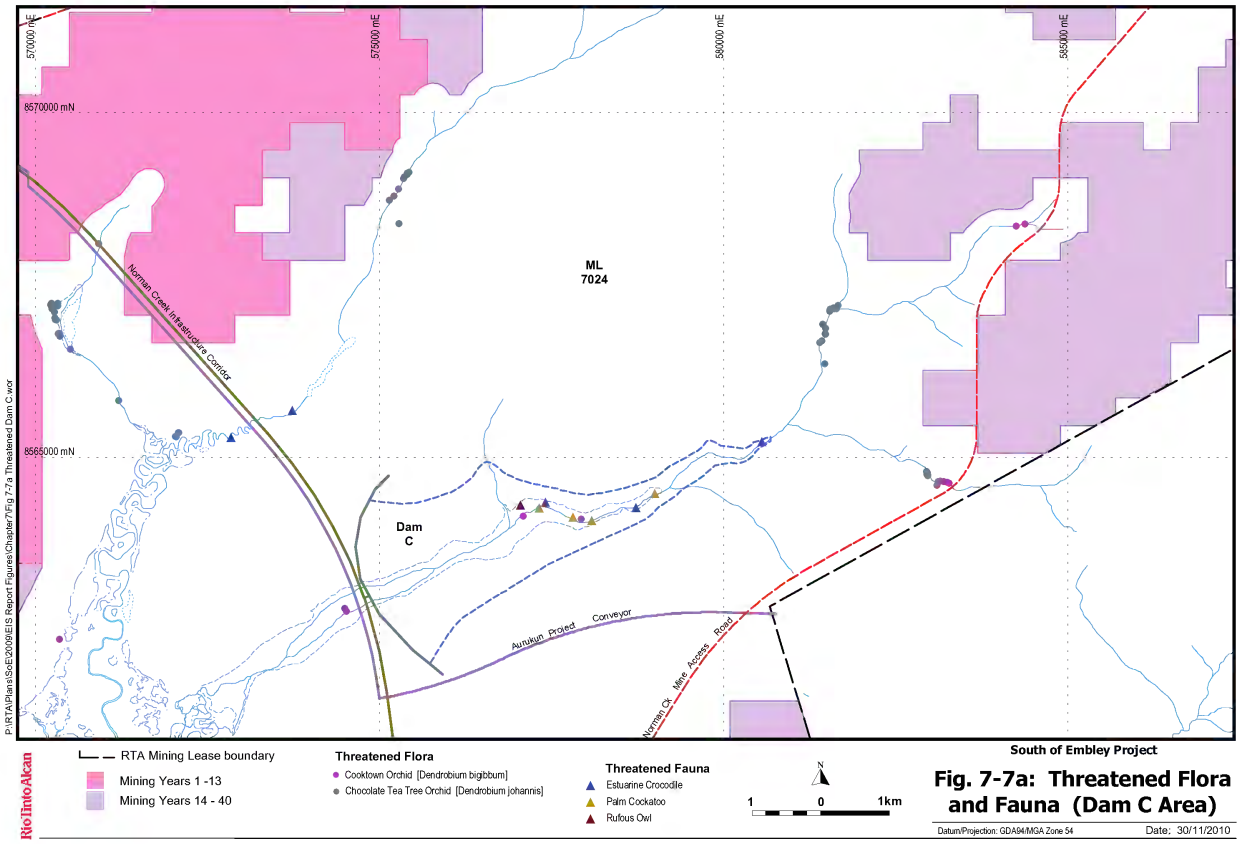
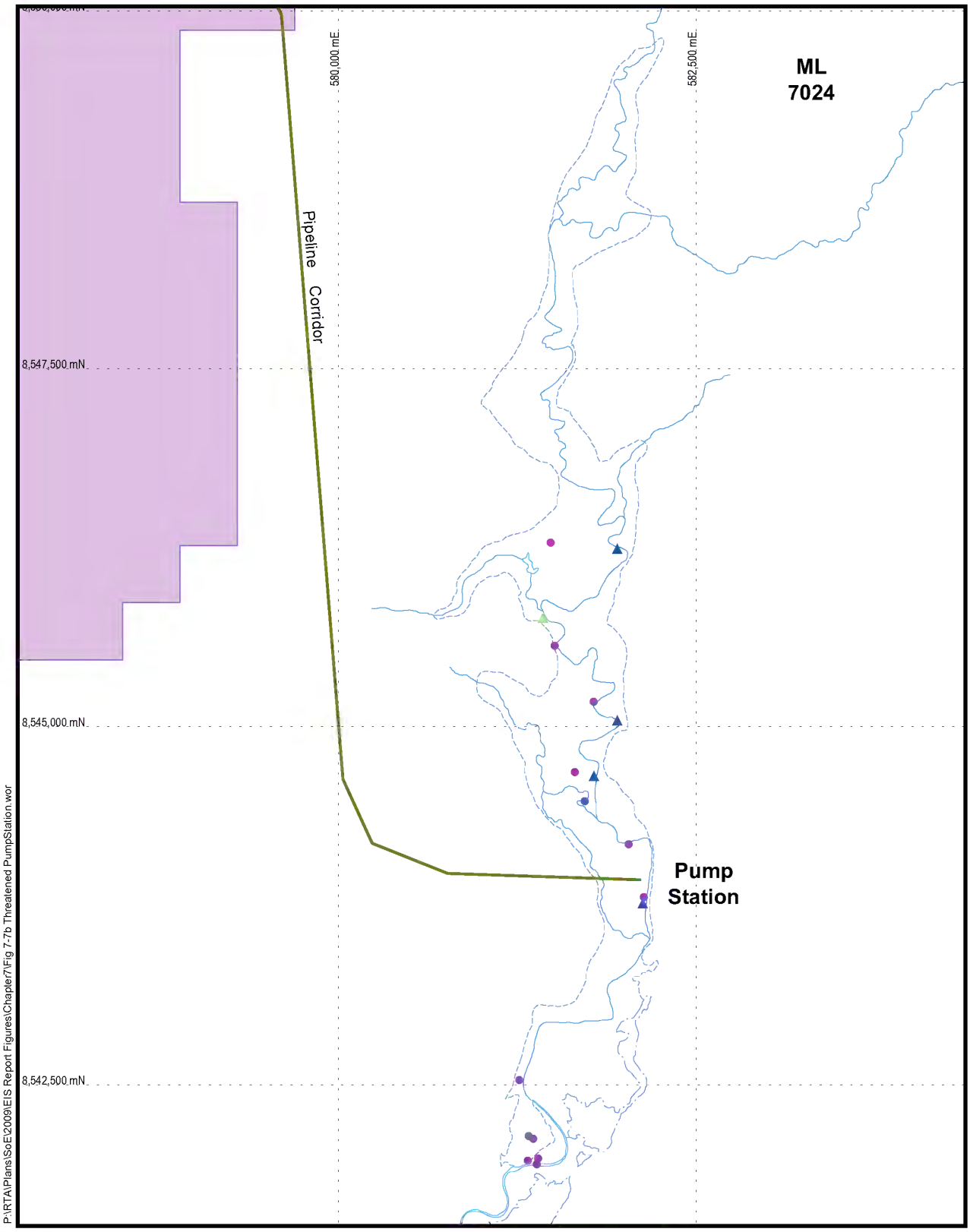


Fig. 7-7a: Threatened Flora and Fauna (Dam C Area)



South of Embley Project

RTA Mining Lease boundary

Mining Years 14 - 40

Threatened Flora

- Cooktown Orchid [Dendrobium bigibbum]
- Chocolate Tea Tree Orchid [Dendrobium johannis]

Threatened Fauna

- Estuarine Crocodile
- Palm Cockatoo

Fig. 7-7b: Threatened Flora and Fauna (Pump Station)

N

500 0 500m

Datum/Projection: GDA94/MGA Zone 54 Date: 30/11/2010

Profiles of each of the 6 species are provided below.

Calophyllum bicolor

Calophyllum bicolor is currently known only from 17 populations on Cape York Peninsula (DERM 2010). It occurs on spring-fed areas that form a distinct habitat with evergreen rainforest and permanently wet substrates, but does not occur on stream banks away from the spring heads. There are four specimen records of the species from the Weipa area, but the species has not been recorded from the Project area. Permanently wet spring heads supporting vine forest have not been identified within the Project area and are therefore considered not as common within the Project area as in the Weipa area. However, five semi-permanent springs/seepage zones with suitable habitat were located and surveyed for the species close to proposed mining areas, but the species was not present. Six other seepage zones lacking suitable habitat were surveyed and the species was not present. Unsurveyed isolated habitats with these characteristics may occur at the margin of wetlands in the lower freshwater sections of drainages (Norman Creek, Ward River, Winda Winda Creek) and may support the species. Potential habitats for the species comprise:

- vegetation units 4a2, 4b; and
- RE 3.3.5.

Vegetation unit 4a2 occurs within the proposed footprint of Dam C on a freshwater tributary of Norman Creek; however, *Calophyllum bicolor* was not located in this area during targeted surveys. The species was not recorded during other surveys of the 4a2 and 4b vegetation communities.

Cooktown Orchid (Dendrobium bigibbum)

The Cooktown Orchid has been recorded from several locations in the Weipa region, particularly in notophyll vine forest on coastal dunes and on lateritic red earths. The habitat preference of this species in the Weipa region is well known, and the Cooktown Orchid is restricted to closed forest, typically as an epiphyte in rainforest or vine thicket habitats. The species is sensitive to fire and therefore is found only in situations where frequent fires do not occur. Vine forest patches on bauxite provide the required fire protection but with respect to riparian gallery forest the species is more commonly encountered inside broad occurrences of the vegetation, or where lateral seepage zones and mesic ground vegetation suppress fire frequency and scorch height.

The Cooktown Orchid was recorded within the Project area in coastal vine forest and mangroves near the mouth of Norman Creek, in mangroves on the Ward River and in areas of riparian rainforest and riparian gallery forest throughout the Project area. The species was not located in other vine forest areas on bauxite, although it may occur in these areas which occur in the Hey Point area. It is likely the Cooktown Orchid also occurs in other coastal vine forest areas that were not surveyed to the north of Norman Creek and in the Hey Point area.

Potential habitats for the species comprise:

- vegetation units 3a, 3c, 3d, 3e, 4a1; and
- REs 3.1.1a, 3.1.1c, 3.2.2, 3.3.5, 3.5.4.

The Cooktown Orchid occurs within the proposed footprint of Dam C, and in the vicinity of a proposed Mine Access Road crossing of an upper Norman Creek tributary.

Chocolate Tea Tree Orchid (Dendrobium johannis)

The Chocolate Tea Tree Orchid has been recorded from several locations in the Weipa region, including the Andoom, Weipa and Ely mining lease areas. The habitat preferences of this species are well known and the Chocolate Tea Tree Orchid is restricted to mesic habitats, typically as an epiphyte on mature *Syzygium* spp. and *Melaleuca* spp. trees in riparian gallery forest and on the margins of swamp habitats and their associated ecotones.

In the Project area the species has been located in riparian gallery forest and Melaleuca dominated swamps particularly along major drainage lines and associated tributaries. It is anticipated that the species occurs in these habitats throughout the Project area.

Potential habitats for the species comprise:

- vegetation units 3b, 4a2, 4a3, 4b, 5j1, 5j4, 5d, 7b, 7d; and
- REs 3.2.3, 3.3.5, 3.3.9, 3.3.14a, 3.3.21.

Chocolate Tea Tree Orchid occurs within the infrastructure corridor downstream of Dam C, and in the vicinity of proposed Mine Access Road crossings of Winda Winda Creek and an upper Norman Creek tributary.

Ant Plant (Myrmecodia beccarii)

The Ant Plant is known from a variety of denser canopy habitats on Cape York including mangroves, *Melaleuca* dominated wetlands, coastal scrubs, and groundwater seepage zones with swamp vine forest. The Ant Plant was recently recorded from the Weipa area in a small groundwater seepage forest but is apparently of very restricted distribution in the Weipa area. The Ant Plant was not located during extensive targeted surveys in suitable habitat but may occur within the Project area if any permanent groundwater seepage zones are present (currently only semi-permanent groundwater seepage zones have been identified within the Project area) or mangrove areas that were not inspected during surveys.

Potential habitats for the species comprise:

- vegetation units 3b, 3d, 3e, 4a2, 6c, 7b, 7c, 7d; and
- REs 3.1.1a, 3.1.1c, 3.1.3, 3.3.14a, 3.3.5.

Potential habitat for the species does not occur within proposed mining areas, and surveys of suitable habitat within the footprint of proposed infrastructure areas did not locate the species.

Beach Nightshade (Solanum dunalianum)

Beach Nightshade is known from a few records near Weipa and on Torres Strait islands, although recent surveys for known populations in the Weipa area failed to relocate the species despite targeted searching (Landsberg and Clarkson 2004). The species has generally been recorded from semi-deciduous notophyll vine forest and the edges of this community, and in the Weipa area has been recorded from vine thicket vegetation on coastal dunes between Pennefather and Duyfken areas north of Weipa and vine forest on bauxite on the north shore of the Embley River near Napranum (Jason Searle pers. comm.). The distribution of this species in the region is poorly known with only a few specimens collected, but it appears likely to be more prevalent in closed forest vegetation.

The species was not recorded during surveys for the Project. Within the Project area it is expected to be restricted to more mesic habitats, particularly coastal vine forest and vine forest on bauxite, and consequently it is highly unlikely populations of this plant would occur in areas subject to mining operations or infrastructure development within the Project area.

Potential habitat for the species comprises:

- vegetation units 3a 3c, 6a and ecotones; and
- REs 3.2.2, 3.5.2 (margins) and ecotones.

Spathoglottis plicata

Spathoglottis plicata is known from Cape York between Cooktown and the Jardine River and has been recorded from the Weipa region (DEWHA 2008e). The species was not recorded during targeted surveys in the Project area. *Spathoglottis plicata* typically occurs in or close to swamps, in seasonally inundated areas and in moist, grassy patches close to streams, in Melaleuca swamp forest and riparian gallery rainforest (Jones 1988; Dockrill 1992, Landsberg and Clarkson 2004). The species may be difficult to detect in the field if not flowering and when

aerial shoots are absent, and the potential presence of this species in suitable habitat within the Project area cannot be discounted.

Potential habitat for the species comprises:

- vegetation units 3b, 4a1, 4a3, 4b, 5j1, 5j4, 5d, 7b, 7d; and
- REs 3.2.3, 3.3.5, 3.3.9, 3.3.14a, 3.3.21.

Potential habitat for the species occurs within the proposed footprint of Dam C and the infrastructure corridor crossing of Norman Creek, although targeted surveys did not locate the species within these areas or elsewhere within the Project area.

7.6.3 Threatened Flora – NC Act

The Queensland *Nature Conservation Act 1992* (NCA) provides for the listing and protection of threatened flora in Queensland. The main threatened status categories for flora under the NCA in order of increasing conservation significance are "near threatened", "vulnerable" and "endangered. **Table 7-8** lists the threatened flora species that:

- have been previously recorded from within or in close proximity to the Project area (DERM 2009c, Queensland Herbarium 2009);
- have been found during surveys for the EIS;
- could potentially occur within the Project area based on EPBC database search; and
- could potentially occur within the Project area based on previous surveys in the Weipa area for RTA.

An assessment is provided of each species' potential occurrence in the Project area based on their habitat requirements and the condition and array of habitats available. The source of records for each species is indicated in **Table 7-8** along with the preferred habitat and known occurrence in the Weipa region.

Of the 16 NCA listed species identified as potential inhabitants of the Project area:

- 2 species have been confirmed as present in the Project area;
- 2 species are likely to occur in the Project area;
- 11 species possibly occur in the Project area; and
- 1 species is unlikely to occur in the Project area.

Profiles for these species are set out below, but also refer to profiles in **Section 7.6.2** for those species that are also listed under the EPBC Act.

Acacia fleckeri

Acacia fleckeri has been recorded from several locations in the Weipa region, including the riparian corridor of the Hey River. *Acacia fleckeri* is known from sandy creek or river banks or on shell mounds in fringing woodland with species of *Melaleuca*, *Leptospermum*, *Eucalyptus* and other *Acacia* species. In the Weipa area the species is known primarily from riparian gallery forest. This species was not recorded in the Project area; however, suitable habitats for the species are well represented within the Project area, and it is likely that the species occurs within the Project area, at least in the Hey River area.

Potential habitats for the species comprise:

- vegetation units 4a1, 4a3, 5e, 5j1; and
- REs 3.3.9, 3.3.21, 3.5.22c.

Potential habitat for *Acacia fleckeri* occurs within the proposed footprint of Dam C and the infrastructure corridor crossing of Norman Creek; however, the species was not observed in these areas during targeted surveys and is not expected to occur in these areas.

Table 7-8 Threatened Flora Listed Under the NC Act

Species **Common Name [Family] (Source of Record)**	**NCA Status**	**Growth Form and Habitat**	**Likelihood of Occurrence within Project Area**
Acacia fleckeri No common name [Mimosaceae] (Wild)	NT	A small to medium tree restricted to Cape York Peninsula. Known from sandy creek or river banks or on shell mounds in fringing woodland with species of *Melaleuca, Leptospermum*, *Eucalyptus* and other *Acacia* species. Occurs in riparian gallery forest in the Weipa area.	**Likely**: not located during field surveys but specimen record from the Hey River area. Likely to occur in the Hey Point area and possibly in other areas of fringing vegetation.
Acacia ommatosperma No common name [Mimosaceae] (Wild)	NT	A shrub or small tree known from ironstone ridges and erosional edges of the bauxite plateau in *Eucalyptus tetrodonta* open forest habitats, and also *Corymbia clarksoniana* woodland on alluvium/colluvium. Restricted to the Weipa area of Cape York Peninsula.	**Possible**: not detected during field surveys but may occur in association with ironstone outcrops within the Project area.
Albizia retusa No common name [Mimosaceae] (Wild)	NT	A small to medium tree found in *Eucalyptus tetrodonta* open forest habitats particularly near vine forest. Known from the Weipa area.	**Possible**: not detected during field surveys but may occur in *Eucalyptus tetrodonta* habitats within the Project area.
Calophyllum bicolor No common name [Clusiaceae] (Wild, epbc)	V	A small fire sensitive tree known to be associated with groundwater seepage zones particularly in evergreen vine forest.	**Possible**: not detected during field surveys but may occur in the Project area in more robust groundwater-fed riparian gallery forest or seepage zones near the coast. Only limited areas of suitable fire retardant habitat occur within the Project area.
Combretum trifoliatum Sepang [Combretaceae] (herb)	NT	A small to medium tree known from riparian gallery forest in the western Cape York area. Little known in the Weipa area.	**Unlikely**: few records in the vicinity of the Project area despite substantial survey effort, and not located in the Project area during EIS field surveys.
Dendrobium bigibbum (also known as *Vappodes bigibba*) Cooktown Orchid [Orchidaceae] (Wild, epbc)	V	An epiphyte that grows on trees and rocks in situations with moderate light intensity. Occurs in a range of fire sensitive habitats including coastal scrub, streambank vegetation, monsoon thickets, and gullies in open forest and woodland where fire cannot penetrate. In the Weipa area grows as an epiphyte on trees (rocks absent) and commonly encountered in coastal vine forest and vine forest on bauxite.	**Confirmed**: located in coastal and non-coastal vine forest, and mangrove edges at several locations within the Project area.
Dendrobium johannis (also known as *Cepobaculum johannis*) Chocolate Tea Tree Orchid [Orchidaceae] (+)	V	An epiphyte that grows in open humid habitats, on slopes in open woodland, close to swamps and in pockets of monsoon forests. It has been recorded growing on Tea-tree in Melaleuca woodland and in coastal semi-evergreen vine thicket. In the Weipa area commonly encountered growing on Melaleuca and *Syzygium suborbiculare* on the margin of Melaleuca swamps and riparian gallery forest.	**Confirmed**: located in riparian gallery forest and Melaleuca dominated swamps particularly along major drainage lines and associated tributaries.
Habenaria hymenophylla Rainforest Habenaria [Orchidaceae] (Wild)	NT	Little known species with records from the Weipa area. Occurs in vine forest.	**Possible**: difficult to predict occurrence but may occur in the Project area in vine forest habitats.
Heterachne baileyi No common name [Poaceae] (Wild, herb)	NT	A tussock grass known from *Eucalyptus tetrodonta* dominated woodlands on lower slopes of the plateau, and *Melaleuca viridiflora* woodland on floodplains.	**Possible**: not detected during field surveys but may occur in *E. tetrodonta* woodlands within the Project area.

Species **Common Name** **[Family]** **(Source of Record)**	**NCA Status**	**Growth Form and Habitat**	**Likelihood of Occurrence within Project Area**
Hoya revoluta No common name [Ascleiadaceae] (Wild, herb)	NT	A climbing or scrambling vine recorded from vine forest on coastal dunes and lateritic red earths. Record from Pennefather area north of Weipa.	**Possible**: not detected during field surveys but may occur in coastal and bauxite vine forest habitats within the Project area.
Lepturus geminatus No common name [Poaceae] (Wild)	NT	Tussock grass. Record from the Weipa area.	**Possible**: difficult to predict occurrence but may occur in the Project area.
Lindsaea walkerae No common name [Lindsaeaceae] (Wild)	NT	A terrestrial fern found near streams and in swamps. Record from the Weipa area.	**Possible**: not detected during field surveys but may occur in wetland and riparian gallery forest in the Project area.
Myrmecodia beccarii Ant Plant [Rubiaceae] (+)	V	A tuberous epiphyte known to grow in *Melaleuca* woodland and mangrove areas. Recently recorded from the Weipa area in a small groundwater seepage forest.	**Possible**: this species is of very restricted distribution in the Weipa area. If a permanent groundwater seepage zone was identified within the Project area, this species may occur within this zone. At present only semi-permanent groundwater seepage zones have been identified within the Project area. The species may also occur within mangroves within the Project area.
Sarcolobus vittatus No common name [Apocynaceae] (Wild)	V	Record from Unigan Nature Reserve at Weipa. Little known species.	**Possible**: not detected during field surveys but may occur in riparian gallery forest in lower sections of drainage lines.
Solanum dunalianum Beach Nightshade [Solanaceae] (Wild, epbc)	V	An herbaceous shrub growing to 2–4m and found in or at the edge of semi deciduous vine forest.	**Likely**: not detected during field surveys but suitable coastal vine forest and vine forest on bauxite habitat occurs in the Project area.
Spathoglottis plicata No common name [Orchidaceae] (epbc)	V	A terrestrial orchid with flower stems to 1m that grows in or close to swamps, in seasonally inundated areas and in moist, grassy patches close to streams, in Melaleuca swamp forest and riparian gallery rainforest	**Possible**: not detected during field surveys but suitable stream, wetland and seepage habitat present within Project area.

Key to Source of Record codes:

epbc	Potential species from the EPBC database
Wild	Records from the WildNet database
herb	Specimen records from Queensland Herbarium HERBRECS
+	Additional potential threatened species added to assessment

Key to Status:

V	Vulnerable
NT	Near threatened

Acacia ommatosperma

The small tree *Acacia ommatosperma* was recently recorded in Darwin Stringybark (*Eucalyptus tetrodonta)* open forest habitat near Weipa. This tree has not been recorded elsewhere in the Weipa region, despite targeted survey effort in parts of the Weipa mining leases and in the SoE Project area. Other records for *Acacia ommatosperma* for the Cape York Peninsula bioregion indicate this species favours ironstone outcrops within Darwin Stringybark open forest. Given the occurrence of similar ironstone ridge habitat within the Darwin Stringybark woodlands of the Project area, it is considered possible that *Acacia ommatosperma* occurs in the Project area within Darwin Stringybark open forest where it grades locally into ironstone outcrops.

Potential habitat for the species comprises:

- vegetation unit 2b (small pockets where ironstone outcrops occur); and
- RE 3.5.2.

Vegetation unit 2b occurs within the proposed mining areas. The species was not recorded during the surveys of the 2b vegetation community but may occur in isolated pockets within this vegetation unit.

Albizia retusa

Records of the small tree *Albizia retusa* in the broader Cape York Bioregion indicate the species as occurring in Darwin Stringybark woodland, typically within the ecotone with adjoining notophyll vine forest. The distribution of *Albizia retusa* in the Weipa region is insufficiently known, being recorded in Darwin Stringybark open forest only in the Ely mining lease north east of Weipa (Dames and Moore 1996). Recent targeted flora surveys in this area failed to identify the tree; however, the related small tree *Albizia procera* was recorded with some regularity, and previous records for *Albizia retusa* may have been a result of taxonomic misidentification. *Albizia retusa* was not recorded during targeted surveys in the Project area. Nevertheless, ecotonal habitat between Darwin Stringybark woodland and vine forest occurs within the Project area and it is possible the species occurs in these areas.

Potential habitats for the species comprise:

- vegetation unit 2b adjoining 3c; and
- RE 3.5.2 adjoining 3.5.4.

Potential habitat for this species occurs in close proximity to vine forest on bauxite within the general mining area; however, it is likely the ecotonal area typically occupied by the species would fall within the environmental buffer area to be established around vine forest areas. The species was not recorded within these areas during targeted surveys.

Sepang *(Combretum trifoliatum)*

The distribution of this species is known from a few specimens and not well known in the Weipa region generally. Within the Weipa area Sepang is a tree of riparian gallery forest and is expected to be restricted to these types of riparian mesic habitat areas. The closest record to the Project area comes from the more substantial riparian gallery forests of the Wenlock River. Riparian gallery forest occurs throughout the Project area on the main drainages; however, this habitat type was subject to considerable survey effort and together with the lack of records of the species from the nearby Weipa Peninsula it is regarded as unlikely that Sepang occurs within the Project area.

Potential habitats for the species comprise:

- vegetation units 3a, 3c, 4a2; and
- REs 3.2.2, 3.3.5, 3.5.4.

Habenaria Hymenophylla

This is a little known terrestrial orchid species from Cape York and Torres Strait islands with a record from Weipa (Gunness *et al.* 1987). The species apparently occurs in vine forest but little

detail is available on the preferred habitats. The species was not observed during surveys of the Project area but is considered to possibly occur within vine forests in the area. It is likely that the species may be difficult to locate during field surveys at different times of the year.

Potential habitats for the species comprise:

- vegetation unit 3c, 4a2; and
- REs 3.2.2, 3.5.4.

None of the potential habitats of *Habenaria hymenophylla* occur within proposed mining or infrastructure areas.

Heterachne baileyi

Heterachne baileyi is known to occur on the lower slopes of the bauxite plateau in Darwin Stringybark woodland and on adjoining low lying areas dominated by *Melaleuca viridiflora*. The species has been recorded from the vicinity of the Aurukun Road near the eastern boundary of the Project area and possibly occurs within the Project area, although not recorded during field surveys.

Potential habitats for the species comprise:

- vegetation units 2c1, 2c2, 5e, 5j2, 5j4; and
- REs 3.3.14a, 3.3.49a, 3.3.50a, 3.5.2, 3.5.22c.

Potential habitat for *Heterachne baileyi* is located within the proposed footprint of Dam C and within the proposed infrastructure corridor crossing of Norman Creek, although the species was not recorded during targeted surveys of these areas.

Hoya *(Hoya revoluta)*

Hoya has been recorded from several locations in the Weipa region, particularly in notophyll vine forest on coastal dunes and on lateritic red earths. Hoya typically occurs as a climbing or scrambling vine and may be difficult to detect under certain seasonal conditions. The species was not recorded during targeted surveys of favoured habitat types but may occur within the Project area.

Potential habitats for the species comprise:

- vegetation units 3a, 3c; and
- REs 3.2.2, 3.5.4.

None of the potential habitats of *Hoya revoluta* occur within proposed mining or infrastructure areas.

Lepturus geminatus

Lepturus geminatus is a grass species known only to occur in northern Queensland and the Northern Territory. It is typically found growing on sand within and at the edges of evergreen vine forests and also on the inland faces of sand dunes; however, the habitat preferences of the species on Cape York are not well known. This species has not been recorded from the Project area but may occur in areas of suitable habitat.

Potential habitats for the species comprise:

- vegetation units 3a, 5c, 12c; and
- REs 3.2.2, 3.2.6a, 3.2.25.

None of the potential habitats of *Lepturus geminatus* occur within proposed mining or infrastructure areas.

Lindsaea walkerae

Lindsaea walkerae is a terrestrial creeping fern found near streams and within swamps. It has been recorded from a number of locations on northern Cape York and elsewhere in northern

Australia with a record from Weipa. This species has not been recorded from the Project area but may occur in areas of suitable habitat. Potential habitats for the species comprise:

- vegetation units 4a1, 4a2, 4a3, 4b, 4c, 7b, 12a; and
- REs 3.3.5, 3.3.9, 3.3.14a, 3.3.64, 3.3.65.

Potential habitat for *Lindsaea walkerae* occurs within the proposed footprint of Dam C and the infrastructure corridor crossing of Norman Creek, although the species was not recorded during targeted surveys of these areas.

Sarcolobus vittatus

This is a little known plant recorded from Unigan Nature Reserve near Weipa. Based on the occurrence of the species at Unigan potential habitats for the species include riparian gallery forest, coastal vine forest and possibly landward mangrove communities. The species was not recorded from the Project area but may occur in these habitats within the Project area.

Potential habitats for the species comprise:

- vegetation units 3a, 3c, 3d, 3e, 4a2; and
- REs 3.1.1c, 3.2.2, 3.3.5.

None of the potential habitats of *Sarcolobus vittatus* occur within proposed mining or infrastructure areas.

7.6.4 Introduced Flora and Weeds

No weeds or introduced flora species have been confirmed as occurring within the Project area, although there was an unverified sighting of the invasive scrambler Rubber Vine (*Cryptostegia grandiflora*) on the lower reaches of Norman Creek. The lack of weeds in the Project area is due predominantly to the limited amount of disturbance within the area, and relatively minimal visitation by vehicles potentially carrying weed propagules.

There are a number of weeds in the Weipa region that occur in similar habitats to those present within the Project area and these species could become established in the Project area if weed propagules entered the Project area. Species from the Weipa region that pose the greatest risk to the Project area in terms of alteration of natural habitat include:

- Gamba Grass (*Andropogon gayanus*);
- Rubber Vine (*Cryptostegia grandiflora*);
- Noogoora Burr (*Xanthium occidentale*)
- Guinea Grass (*Panicum maximum*);
- Stinky Passionfruit (*Passiflora foetida*);
- Parkinsonia (*Parkinsonia aculeate*);
- Hyptis (*Hyptis suaveolens*);
- Para Grass (*Urochloa mutica*); and
- Caltrop (*Tribulus terrestris*).

In Aurukun, cultivated and disturbance exotics that are known to be environmental weeds elsewhere in Australia include:

- Coral vine (*Antiogonon leptopus*);
- Neem tree (*Azadirachta indica*);
- Butterfly tree (*Bauhina monandra*);
- Golden shower tree (*Cassida fistula*);
- Centra (*Centrosema molle*);

- Poinciana (*Delonix regia*);
- Cupid's flower (*Ipomoea quamoclit*);
- Rangoon Creeper (*Quisqualis indica*); and
- Sicklepod (*Senna obtusifolia*) (Cook Shire 2007).

Other significant weed species known from northern Cape York Peninsula that may become established in the Project area include:

- Leucaena (*Leucaena leucocephala*);
- Grader Grass (*Themeda quadrivalvis*);
- Lion's Tail (*Leonitis nepetaefolia*);
- Pond Apple (*Annona glabra*); and
- Lantana (*Lantana* spp.) (CYWAFAP 2009).

Management measures to prevent the spread of weeds into the Project area are discussed in **Section 7.10.2**

7.6.5 Culturally Important Flora

Large individuals of pandanus (*Pandanus spiralis*) suitable for weaving occur most frequently in coastal areas associated with dune systems (vegetation units 5c, 5d, 7a, 7c) and sporadically in association with paperbark wetlands in lower catchment reaches (vegetation units 3b, 7b) and on high sandy bends in estuaries (small areas not mapped out). Another species known to be used for weaving, known as matrush or wallum (*Lomandra longifolia*) occurs fairly consistently in association with fringing riparian vegetation and adjacent colluvial/alluvial habitats along the freshwater reaches of larger streams (vegetation units 4a2, 4a3, 5j, 5e).

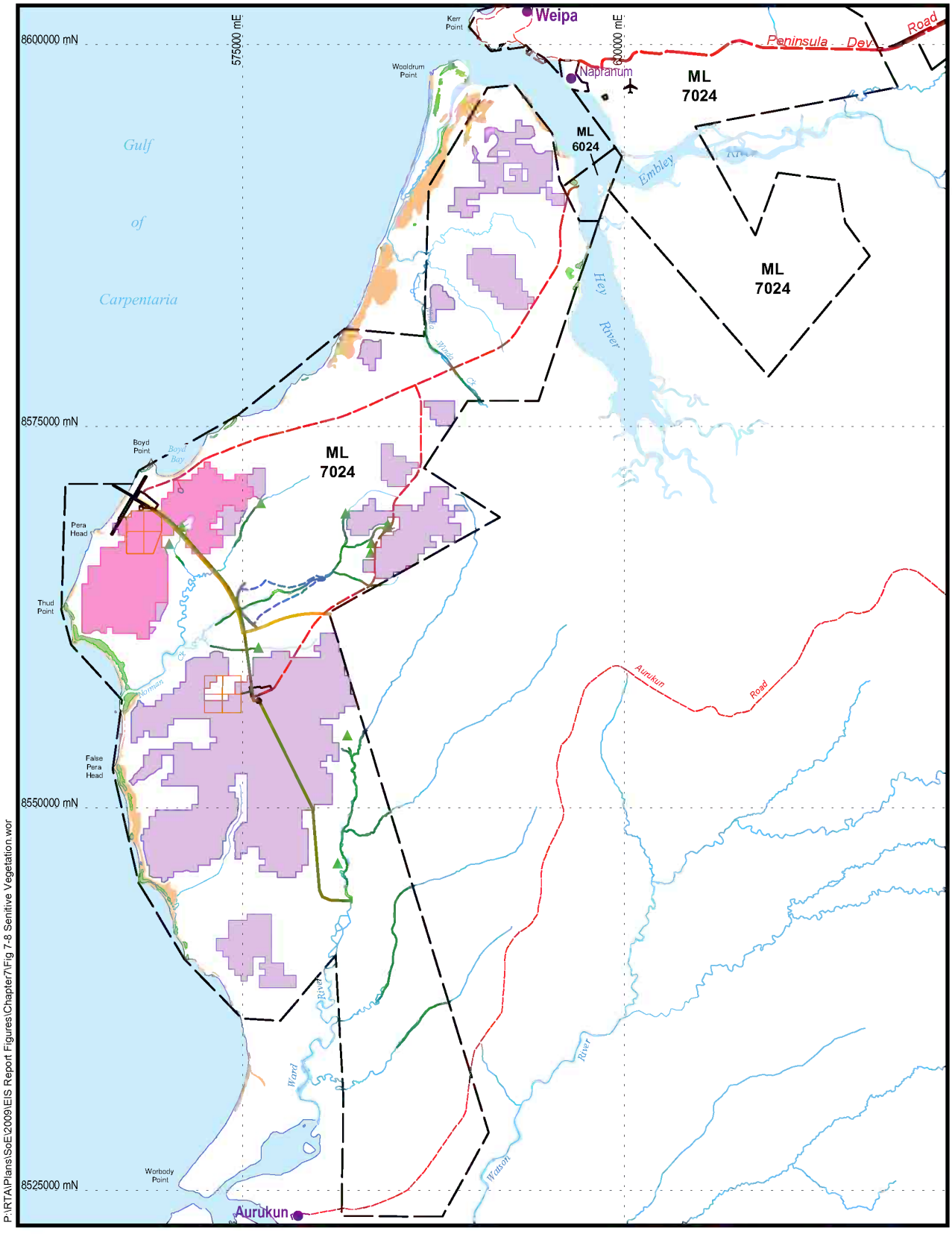
Further discussion of impacts to and mitigation measures for culturally important flora is provided in **Section 11.1.4.**

7.7 Summary of Sensitive Environmental Areas for Flora

A number of sensitive environmental areas for flora have been identified through the previous sub-sections. These comprise areas of particular local, regional or national significance with respect to habitat values, biodiversity, presence of threatened species, conservation status, refugial function, or landscape connectivity function. Sensitive environmental areas for flora within the Project area are summarised in **Table 7-9**, and mapped in **Figure 7-8**.

Table 7-9 Sensitive Environmental Areas for Flora

Flora Attribute/Area	Description
"Of concern" REs	"Of concern" REs occupy approximately 411ha (0.4%) of the Project area comprising 3.2.3, 3.2.6a, and 3.2.25. All these REs are located within Land Zone 2 which comprises coastal sand dunes and swales. Land Zone 2 would not be disturbed for mining.
Riparian gallery forest and adjoining alluvial/colluvial flats along groundwater-fed sections of freshwater streams (i.e. veg. units 4a1, 4a3, 5e, 5j1, 5j2)	This vegetation community is associated with shallow aquifer discharge at the periphery of drainage corridors (base of the bauxite plateau) and directly into streams. The floristic diversity of these areas is very high relative to their spatial extent and dependent on continued groundwater discharge. The vegetation types within these areas are also confirmed and potential habitat for a high number of threatened flora species.
Closed forest associated with semi-permanent groundwater spring/seepage areas.	These areas are of very limited spatial extent (associated springs typically 20-50m in diameter) and often provide refugia for rainforest flora and contain flora species not occurring in other vegetation units. These areas are dependent on groundwater discharges extending into the dry season. The vegetation has affinities for unit 4a2.
Vine forest on coastal sands and the bauxite plateau	Vine forest patches provide a refugial function for flora and supports threatened flora. Vine forest on the bauxite plateau is most likely indicative of an historic vegetation community where closed forest vegetation was more widespread than currently distributed.


8600000 mN
8575000 mN
8550000 mN
8525000 mN
575000 mE
600000 mE
Weipa
Kerr Point
Napranum
Peninsula Dev. Road
Wooldrum Point
Gulf of Carpentaria
ML 7024
ML 6024
ML 7024
ML 7024
Embley River
Hey River
Boyd Point
Boyd Bay
Pera Head
Thud Point
False Pera Head
Aurukun Road
Ward River
Watson River
Worbody Point
Aurukun
P:\RTA\Plans\SoE\2009\EIS Report Figures\Chapter7\Fig 7-8 Senitive Vegetation.wor
RTA Mining Lease boundary
Township
Road/track
Freshwater dam
Tailings storage facility
Mining Years 1 -13
Mining Years 14 - 40
Of concern Regional Ecosystems
Riparian corridor of spring fed freshwater stream reaches
Groundwater seepage/spring with rainforest/palm forest
Vine Forest
South of Embley Project
Fig. 7-8:
Sensitive Vegetation
N
5 0 5km
Datum/Projection: GDA94/MGA Zone 54
Date: 16/07/2010

7.8 Overview of Potential Impacts on Terrestrial Flora

Any impacts on flora would occur at the construction and operational phases of the Project. Direct impacts on vegetation would occur as a result of development clearing of vegetation within the proposed mining areas, and a much smaller area of clearing for construction of Project infrastructure. Clearing for mining would be restricted to the bauxite plateau and would affect only Darwin Stringybark woodland, while disturbance of vegetation for infrastructure would affect a variety of vegetation types including woodland, riparian and wetland vegetation types, and also some regrowth vegetation.

Secondary impacts on vegetation may occur during the operational phase of the Project, linked primarily to potential effects from altered hydrological regime due to mining activity, operation of the water supply dam on Norman Creek, and water extraction from the Ward River. The potential introduction of exotic and weed flora, and fire regimes also pose a potential mechanism for impacts on native vegetation within the Project area.

Specifically, direct impacts on vegetation and flora would occur as a result of:

- removal of Darwin Stringybark woodland within the mining area for mining and haul roads; and
- removal or disturbance of vegetation for construction of infrastructure comprising:
    - Boyd beneficiation plant, stockpiles and ship loading facility at the proposed port;
    - Boyd tailings storage facility;
    - water supply dam on a freshwater tributary of Norman Creek (Dam C);
    - infrastructure corridor from Boyd infrastructure area to Dam C on a freshwater tributary of Norman Creek;
    - pumping station on Ward River and associated pipeline corridor to Dam C;
    - Hey River barge/ferry terminal;
    - Mine Access Roads; and
    - Norman Creek beneficiation plant and tailings storage facility.

In some instances infrastructure would be located within the disturbance footprint of previously mined areas (e.g. tailings storage facilities) and would not require additional clearing of vegetation; however, the majority of Project infrastructure would be located in unmined areas. Prior to construction of each tailings storage facility cell, the bauxite from within each cell would be mined and fed into the plant if it is operating, or stockpiled for later processing if not. This approach would avoid sterilisation of economic bauxite reserves and reduce the extent of clearing of vegetation.

Potential secondary effects on vegetation may occur as a result of:

- localised effects on substrate moisture regime and vegetation community in wetland and riparian areas due to alterations to surface and shallow groundwater regimes as a result of bauxite mining;
- localised effects on wetland and riparian vegetation downstream of Dam C due to altered streamflow and any seepage, should it occur;
- localised effects on wetland and riparian vegetation downstream of the water extraction point on the Ward River;
- displacement of native vegetation and changes to vegetation communities by introduced flora or weeds;
- damage to native vegetation communities from feral pig activity; and,
- alteration to native vegetation communities due to altered fire regime, including controlled asset protection fires that burn less intensively.

7.9 Potential Impacts and Mitigation Measures – Direct Impacts on Vegetation Communities

7.9.1 Potential Impacts

The conceptual 40-year mine plan, proposed infrastructure, and vegetation mapping of the Project area are shown in **Figures 7-6, 7-6a, 7-6b, 7-6c and 7-6d**. The proposed mining areas would avoid riparian and other sensitive habitats by establishment of an environmental buffer system. **Table 7-10** summarises the areas of different REs to be directly disturbed by the Project based on interaction with the 40-year mine plan, proposed Dam C, and the location of Project infrastructure. The table also indicates the areas of each RE to be removed relative to the overall Project area, the Weipa Plateau subregion, and the wider Cape York Bioregion.

Note that version 6 of the RE mapping was used for this analysis, although the official spatial analysis of RE extents for the Version 6 RE data produced by the Queensland Herbarium is not currently available. The version 6 data has been adjusted with RTA's ground surveyed data in the vicinity of the Project area. RE mapping remains incomplete for four subregions within the Cape York bioregion. The percentage of Cape York subregions partially covered by Version 6 RE mapping is as follows:

- Weipa Plateau 85% mapped;
- Coen-Yambo Inlier 66% mapped;
- Jardine–Pascoe Sandstones 94% mapped; and
- Laura Lowlands 95% mapped.

Pre-clearing extent data are not yet available for version 6 . The pre-clearing extent data used for this analysis are based on 2006 imagery and therefore do not reflect any recent losses of REs elsewhere in the bioregion nor increased mapping areas. Consequently, the figures for areas of REs to be disturbed relative to their overall bioregional distribution that are presented in **Table 7-10** may have inaccuracies but nonetheless provide a robust indication of the spatial extent of impact of mining and Project infrastructure on vegetation.

696ha within the footprint of Dam C; and 1,360ha within the footprint of Project infrastructure established on non-mining areas (including an estimate for haul roads). The total 29,339ha of remnant vegetation to be disturbed is comprised entirely of "Least concern" REs, apart from approximately 0.3ha of RE 3.2.6a (*Casuarina equisetifolia* woodland on foredunes) to be disturbed for the ship loading facility.

Disturbance to RE 3.2.6a would occur to facilitate construction access for support structures for the approach jetty of the ship loading facility, and a support structure (bent) may also be located within the RE. A 20m construction corridor would be required through the approximately 30m wide band of RE 3.2.6a that occurs at the base of the bauxite cliff (hence the approximately 0.3ha disturbance area). Following construction, vegetation within the 20m corridor would be allowed to regenerate (subject to fire risk assessment) beneath the 12m wide deck of the approach jetty which would be approximately 12–15m above the ground surface. It is envisaged that, provided the original dune surface is reinstated, the area below the structure would still be suitable to support RE 3.2.6a.

Disturbance to REs within the Project area would comprise 27,283ha within mining areas;

RE 3.5.2 (Darwin Stringybark woodland) would be the most extensively disturbed vegetation type within the Project area as it occurs on the bauxite plateau where mining occurs. Approximately 28,967ha, or 33%, of the area of this vegetation type within the Project area would be disturbed, representing 4.3% and 3.7% of its subregional and bioregional distribution respectively. Small areas of RE 3.5.11 and RE 3.5.22c are also mapped within the mining area but occur on the lower slopes of the plateau edge and would most likely be avoided during mining.

Table 7-10 Regional Ecosystem Disturbance

RE	Description	VMA Status	Approx. area to be disturbed (ha)				Total mapped area in Project area (ha)	Proportion to be disturbed in Project area	Area in Weipa Plateau subregion# (ha)	Proportion of area in subregion to be disturbed#	Area in Cape York Bioregion# (ha)	Proportion of area in bioregion to be disturbed#	Projected remnant extent in bioregion as proportion of current extent#
			Mining area	Dam C	Infra-structure	Total							
Land Zone 1 – Marine Deposits													
3.1.1a	Closed forest of *Rhizophora stylosa* ± *Bruguiera gymnorhiza*. Occurs as outer mangroves.	L	0	0	0.04	**0.04**	481	<0.01%	30,293	<0.01%	68,381	<0.01%	>99.99%
Land Zone 2 – Coastal sand dunes and swales													
3.2.6a	*Casuarina equisetifolia* woodland. Occurs on foredunes	O	0	0	0.3	**0.3**	149	0.2%	492	0.1%	1,731	<0.1%	>99.9%
Land Zone 3 – Alluvial plains and piedmont fans													
3.3.5	Evergreen notophyll vine forest. Occurs on alluvia on major watercourses	L	0	7.9	0.3	**8.2**	29	28.8%	22,498	<0.1%	54,065	<0.1%	>99.9%
3.3.9	*Lophostemon suaveolens* open forest. Occurs on streamlines, swamps and alluvial terraces	L	0	52.6	3.6	**56.2**	2,164	3.4%	24,750	0.2%	47,167	0.1%	99.9%
3.3.21	*Corymbia clarksoniana* ± *Syzygium eucalyptoides* woodland. Lower slopes of sand ridges and in drainage depressions	L	0	115.3	5	**120.3**	1,596	7.5%	11,629	1.0%	38,214	0.3%	99.7%
3.3.49b	*Melaleuca viridiflora* low open woodland on low plains	L	0	0	0.5	**0.5**	315	0.2%	120,899	<0.1%	722,201	<0.1%	>99.9%

RE	Description	VMA Status	Approx. area to be disturbed (ha)				Total mapped area in Project area (ha)	Proportion to be disturbed in Project area	Area in Weipa Plateau subregion# (ha)	Proportion of area in subregion to be disturbed#	Area in Cape York Bioregion# (ha)	Proportion of area in bioregion to be disturbed#	Projected remnant extent in bioregion as proportion of current extent#
			Mining area	Dam C	Infra-structure	Total							
3.3.50a	*Melaleuca viridiflora* ± *Petalostigma pubescens* low open woodland on low plains	L	0	0	3.1	**3.1**	986	0.3%	2,276	<0.1%	186,034	<0.1%	>99.9%
Land Zone 5 – Sand deposits forming gently undulating plains (includes laterite plateau)													
3.5.2	*Eucalyptus tetrodonta, Corymbia nesophila* tall woodland on deeply weathered plateaus and remnants	L	27,198	434	1,336	**28,967**	87,465	33.1%	668,673	4.3%	791,008	3.7%	96.3%
3.5.11	*Eucalyptus tetrodonta, Corymbia nesophila* woodland on lower slopes of plains and rises	L	28.2	0	0	**28.2**	602	4.7%	101,356	<0.1%	179,280	<0.1%	>99.9%
3.5.22c	*Corymbia clarksoniana* + *Erythrophleum chlorostachys* + *Corymbia* spp. + *Eucalyptus* spp. woodland on plains.	L	57.4	85.9	11.7	**155**	3,120	5.0%	166,592	0.1%	291,098	<0.1%	>99.9%
Total area to be disturbed for all zones			27,283	696	1,360	**29,339**							

Key to VMA Status Codes:

L Least concern

O Of concern

Note: Only REs likely to be disturbed are listed

All RE spatial data based on analysis of V6 RE data and adjusted with ground-surveyed mapping by RTA within and adjacent to the Project area.

With the exception of RE 3.5.2, the disturbance to most REs would be much less than 10% (0.2% to 7.5%) of their total extent in the Project area apart from RE 3.3.5 (28.8%). The total area of RE 3.3.5 within the Project area is small (28ha) but a relatively substantial proportion (8.2ha) occurs within the footprint of Dam C and associated infrastructure; however, in a subregional and bioregional context, the disturbance to RE 3.3.5 would be negligible.

While there are uncertainties as to whether the Pisolite Hills Project and Aurukun Bauxite Project will proceed, the cumulative impact of vegetation loss associated with the SoE Project together with these two projects has been considered. In the absence of publicly stated clearing rates, estimations of disturbance within RE 3.5.2 associated with the Pisolite Hills Project and the Aurukun Project were calculated using publicly available information on bauxite reserves. It is estimated that clearing of RE 3.5.2 associated with the Pisolite Hills Project and the Aurukun Bauxite Project would be approximately 2,600ha and 9,300ha respectively. In addition, total clearing (past and future) associated with the current Weipa operations is projected to total approximately 33,300ha at end of mine life.

Considering clearing associated with these current and possible future projects, total clearing within RE 3.5.2 would be approximately 74,200ha within the Weipa Plateau Subregion. If the Pisolite Hills Project and Aurukun Bauxite Project were to fully develop, the subregional extent of RE 3.5.2 would be reduced to approximately 89% of its former known distribution (2006 imagery). The Cape York Bioregional extent of RE 3.5.2 would be reduced to approximately 91% of its former known distribution (2006 imagery). The total clearing associated with current operations and proposed projects in the Weipa Plateau Subregion would not cause RE 3.5.2 to become regarded as "Of concern" or "Endangered" under the *Vegetation Management Act 1999*.

Of the remaining vegetation types to be directly disturbed by Project infrastructure only very minimal areas would be affected representing negligible reductions in subregional and bioregional extent. The reduction in spatial extent of these vegetation types within the SoE Project area as a component of a likely larger cumulative reduction across the Cape York Bioregion (from other projects) is anticipated to be minimal.

7.9.2 Mitigation Measures

The disturbance of sensitive environmental areas by mining would be avoided by the development of an environmental buffer system. The system would comprise a methodology for determining set-back distances from sensitive vegetation types and the preclusion of mining from within the designated buffers.

The sensitive vegetation to be buffered by Darwin Stringybark woodland would comprise the following vegetation types: riparian, wetland, estuarine, vine forest and coastal vegetation on sand. The relevant vegetation units and equivalent REs are listed in **Table 7-11**.

The buffer system would exceed the minimum requirements of the Queensland Government's *Regional Vegetation Management Code* as they relate to clearing set-back distances from watercourses and wetlands (DERM 2009b). In Cape York, the recommended minimum buffer distances from watercourses vary depending on stream order; from wetlands, they depend on the significance of the wetland. These buffer distances are:

- 50m buffer from each high bank of a watercourse with stream order one or two;
- 100m buffer from each high bank of a watercourse with stream order three or four;
- 200m buffer from each high bank of a watercourse with stream order five and above;
- 100m buffer from a natural wetland; and
- 200m buffer from a natural significant wetland.

A variable environmental buffer system would be implemented that takes into account factors such as sensitive vegetation type, important locations of threatened flora and fauna, stream order and hydrology when determining buffer distances. In all cases the above Code requirements would be met or exceeded.

Table 7-11 Vegetation Units to be Buffered

Veg. Unit	Description	Equivalent RE
Laterite/bauxite plateau and slopes		
3c	Notophyll vine forest on lateritic or bauxite red earths	3.5.4
Freshwater drainage lines, wetlands and streams		
3b	*Melaleuca* swamp; zone at the most consistent water level	3.3.14a 3.3.9
4a	Riparian gallery forest along permanent and semi-permanent watercourses	
4a1	Narrow mesic fringe along watercourse with Cape York red gum	3.3.9
4a2	Riparian rainforest	3.3.5
4a3	Paperbark dominated riparian strip with rainforest understorey	3.3.9
5e	*C. polycarpa/ E. brassiana* Woodland on colluvial upper reaches of broad drainage basins - yellow podzolics	3.5.22c
5j	Bloodwood-Banksia in upper parts of broad basins – A2 horizon present	
5j1	With Swamp Box (*Lophostemon suaveolens*) and Lily Pily (*Syzygium angophoroides*) – outer fringe of permanent watercourses	3.3.21
5j2	With Broad-leaved Paperbark (*Melaleuca viridiflora*) on floodplains	3.3.49a
5j3	With Swamp Box (*Lophostemon suaveolens*) and Cabbage Palm (*Livistonia muelleri*i) – on gentle low slope (e.g. western boundary of Norman Creek near estuary)	3.3.9
5j4	With Broad-leaved Paperbark (*Melaleuca viridiflora*), Lineament Tree (*Asteromyrtus lysicarpa*) +/- Hard Tea-tree (*Melaleuca clarksoniana*) on margins of sinkholes	3.3.14a
7b	Melaleuca/Swamp mahogany on the outer margins of drainage depressions	3.3.14a 3.3.50a 3.3.9
12a	Sedgeland in the drainage lines of permanent swamps	3.3.64
12b	Sedgeland in basins of seasonally flooded swamps and drainage depressions	3.3.63 3.3.65
Coastal and beach ecosystems		
3a	Semi-evergreen notophyll vine forest or thicket on coastal dunes	3.2.2
5a	Layered woodland on plains – massive sandy loams	3.2.10c
5c	Woodland on low beach dunes with horse-tail she oak	3.2.6a
5d	Paperbark woodland fringing sandy swales	3.2.3
7a	Mixed shrubby woodland (Sclerophyll vine woodland) on dunefields	3.2.5a
7c	Woodland with Paperbark on sandy swales	3.2.5a
12c	Grassland/herbland on dunefield	3.2.25
Estuary and saltpan ecosystems		
3d	Mangrove; Rhizophora zone	3.1.1a
3e	Mangrove; Landward zone, freshwater conditions (including looking glass mangrove)	3.1.1c
6c	Mangroves; Ceriops zone	3.1.3
8c	Closed scrub in saline strips in estuarine plains – yellow podzolics	3.1.6
9a	Mangrove; highly saline landward zone (mixed species)	3.1.3
12d	Grasslands on low level terraces (narrow bands)	3.2.25
12e	Saltpan, sparse herbfield	3.1.5 3.1.6
12f	Seasonally flooded saline marine plains	3.1.6

Typically, a buffer distance up to 200m would be adopted for vine forest, wetlands, estuaries, coastal vegetation on sand and riparian vegetation along watercourses of stream order three and above. Narrower buffer distances to a minimum of about 100m may be adopted for riparian vegetation along watercourses of stream order one and two, or where significant ecological attributes are absent and physical characteristics are such that a narrower buffer would still provide edge effect protection and filtering of surface runoff flows from disturbed areas.

Surveys would be carried out to define the boundaries of mapped sensitive vegetation types in the field. The field surveys would be carried out prior to clearing for drill lines (which are typically established for detailed orebody definition) and prior to clearing ahead of mining. The surveys would also assess the stream order of any watercourses and the presence or absence of significant ecological features such as springs, aquatic refugia and threatened flora and fauna in and around the sensitive vegetation types.

Buffer distances would then be set based on the findings of the surveys and, where relevant, stream order. Establishment of the buffer distance and authorisation for clearing non-buffered areas would be managed through a ground disturbance approval.

Buffer mapping would be developed using vegetation units as these provide the more detailed delineation of vegetation types compared to REs; however, in **Table 7-11** equivalent REs to the vegetation units to be buffered are provided for reference. Note that some vegetation units can be mapped into multiple RE types depending on the prevailing land zone.

The mitigation measures described above would effectively minimise the potential direct impacts of the Project on vegetation communities as outlined in **Section 7.9.1**.

7.10 Potential Impacts and Mitigation Measures – Indirect Impacts on Vegetation Communities

7.10.1 Potential Impacts

Altered hydrological regime due to removal of bauxite

Discussion of the potential interaction of mining operations on surface and sub-surface hydrology is provided in **Section 5.2.4** and **Section 5.4** respectively. From a vegetation perspective, changes to hydrological regimes have the potential to significantly affect the condition and composition of vegetation and alter the distribution of the overall vegetation community at a local scale.

No dedicated surveys or research have addressed the linkages between groundwater hydrology and vegetation communities on the laterite plateau. It is believed that at least some of the vegetation communities and groundwater hydrology are linked as the existence of 30–35m high eucalypt forest in an area of seasonally variable rainfall indicates that relatively high substrate moisture availability persists after the cessation of wet season rains. In particular the role of the shallow aquifer, which comprises kaolinitic layer and paleochannels overlain by porous bauxite (refer **Section 5.3.2**), is of significance. As a result of the capacity of the mine floor to store surface flow which ponds on the mine floor and slowly infiltrates into the adjoining soil profile of undisturbed areas, the potential effects of mine areas on interflow and vegetation in adjoining areas are likely to be minimal. Qualitative observations of the condition of Darwin Stringybark woodland and vine forest on bauxite adjacent to mine pits in the nearby Weipa mining area show no obvious adverse effects on vegetation in most instances. Isolated occurrences of canopy dieback in Darwin Stringybark woodland are evident in the Weipa mining area and may be related to hydrological change, edge effects or natural dieback. Similar isolated effects could potentially occur in close proximity to the final mine pits in the Project area.

The rainforest and palm forest associated with semi-permanent groundwater springs/seepage areas (see **Figure 7-8**) would be protected by environmental buffers. The shallow aquifer is typically hosted in the kaolinitic layer below the bauxite, apart from the peak of the wet season (see **Section 5.3.2**) where occasionally the water table rises into the bauxite. The semi-permanent seepage areas are not fed from bauxite-hosted groundwater during the dry season

and hence removal of the bauxite would be very unlikely to affect the groundwater supply to these areas.

Discussion of the potential effects of hydrological changes on riparian and wetland ecosystems is provided in **Section 8.14.** In summary, while it is not anticipated that there would be significant changes to riparian and wetland vegetation at a catchment scale, there is the potential for patchy local effects including minor adjustments to the boundaries and extent of different vegetation types in response to new surface and sub-surface hydrological regimes. Localised effects may be experienced by riparian, wetland, and estuary vegetation types.

Altered hydrological regime downstream of the water supply dam

Changes to surface and sub-surface hydrology may occur downstream of the water supply dam (Dam C) due to changes to streamflow regime below the impoundment, and potential changes to groundwater discharge rates and quality. Elevated groundwater discharge may occur immediately below the dam wall and result in elevated substrate moisture and sustained saturation of riparian, alluvial and colluvial areas, and possibly persistent low volume flows in the naturally seasonal flowing receiving streams (Norman Creek). If groundwater discharge did occur, adverse effects on vegetation may be experienced within 1–2 km downstream of the dam wall and potentially comprise:

- dieback of existing canopy vegetation (vegetation unit 4a; REs 3.3.9, 3.3.5) on stream banks due to permanent waterlogging, and development of a new equilibrium vegetation;
- lateral expansion of moisture-dependent fringing vegetation types such as *Melaleuca* swamps with sedge understorey (vegetation unit 7b; RE 3.3.12, 3.3.14a) and swamp Banksia (vegetation unit 5j; RE 3.3.54); and
- reduction in peripheral drainage line communities situated adjacent to the foot of the bauxite plateau (vegetation unit 5e; RE 3.5.22c) that are squeezed out by expansion of inner fringing communities (as per dot point above).

Altered hydrological regime downstream of the pumping point on the Ward River

The potential effects of the proposed pumping from the Ward River on stream hydrology are discussed in **Section 8.14.1**. Modelling shows that mean monthly flow to the Ward estuary is not reduced by more than 5.3% in any month except July (16.6%) as a result of pumping. Pumping would not affect downstream flows beyond that of normal seasonal variation. Wet season inundation of alluvial and colluvial vegetation areas adjacent to the stream is a key determinant of the composition of this vegetation community, which is also substantially driven by groundwater seepage at the base of the bauxite plateau which would not be affected by the pumping. Consequently, given the minimal impact on streamflows during the wet season when inundation occurs, impacts on peripheral vegetation types are not anticipated due to the pumping program.

Reduced flows may affect salinity levels and tidal penetration up the system from the estuary and result in an upstream shift in the freshwater–mangrove riparian vegetation community ecotone. As described in **Section 8.14.1**, there is the potential for upstream retraction of the freshwater–mangrove ecotonal boundary. If this occurs there may be a concomitant shift of the upper distribution of mangrove vegetation elements, such as greater colonisation by mangrove plants upstream within the new ecotone and decline of freshwater riparian vegetation such as fringing paperbarks (*Melaleuca* spp.). Overall, these changes to the ecotonal area are not anticipated to represent significant impacts on the vegetation communities involved and indeed are unlikely to be much different from natural decline and enhancement of freshwater and estuary vegetation within the ecotone due to inter-decadal streamflow and climate variation. RTA would monitor river flow at the pump station using flow meter as described in **Section 5.5.1** and the position of the freshwater–mangrove ecotonal boundary by using aerial photography as described in **Section 8.14.2.1**. .

Introduction of weeds and exotic plant species

Weeds that are known from the Weipa region pose a significant threat to vegetation within the Project area. Weeds such as Gamba Grass (*Andropogon gayanus*), Guinea Grass (*Panicum maximum*), Grader Grass (*Themeda quadrivalvis*), Rubber vine (*Cryptostegia grandiflora*), Leucaena (*Leucaena leucocephala*), Stinky Passionfruit (*Passiflora foetida*) and Hyptis (*Hyptis suaveolens*) can exclude native ground cover vegetation and significantly reduce ground cover floristic and structural diversity and affect recruitment of upper strata. Rubber Vine and Stinky Passionfruit can kill off midstorey and canopy trees with Rubber Vine most active in riparian and floodplain situations (refer also to **Section 8.9** for introduced aquatic species). Vegetation types most at risk from weed invasion include riparian, wetland, estuarine and coastal communities.

Weed invasion typically follows disturbance and it is anticipated that in the Project area, any potential weeds would most likely occur in rehabilitation areas and edges of mined areas. Based on observations of undisturbed habitat immediately adjacent to mining blocks in the Weipa mining area, it is not anticipated that weed invasion of undisturbed vegetation would occur as a result of the Project provided that appropriate weed control measures are implemented.

Altered fire regime

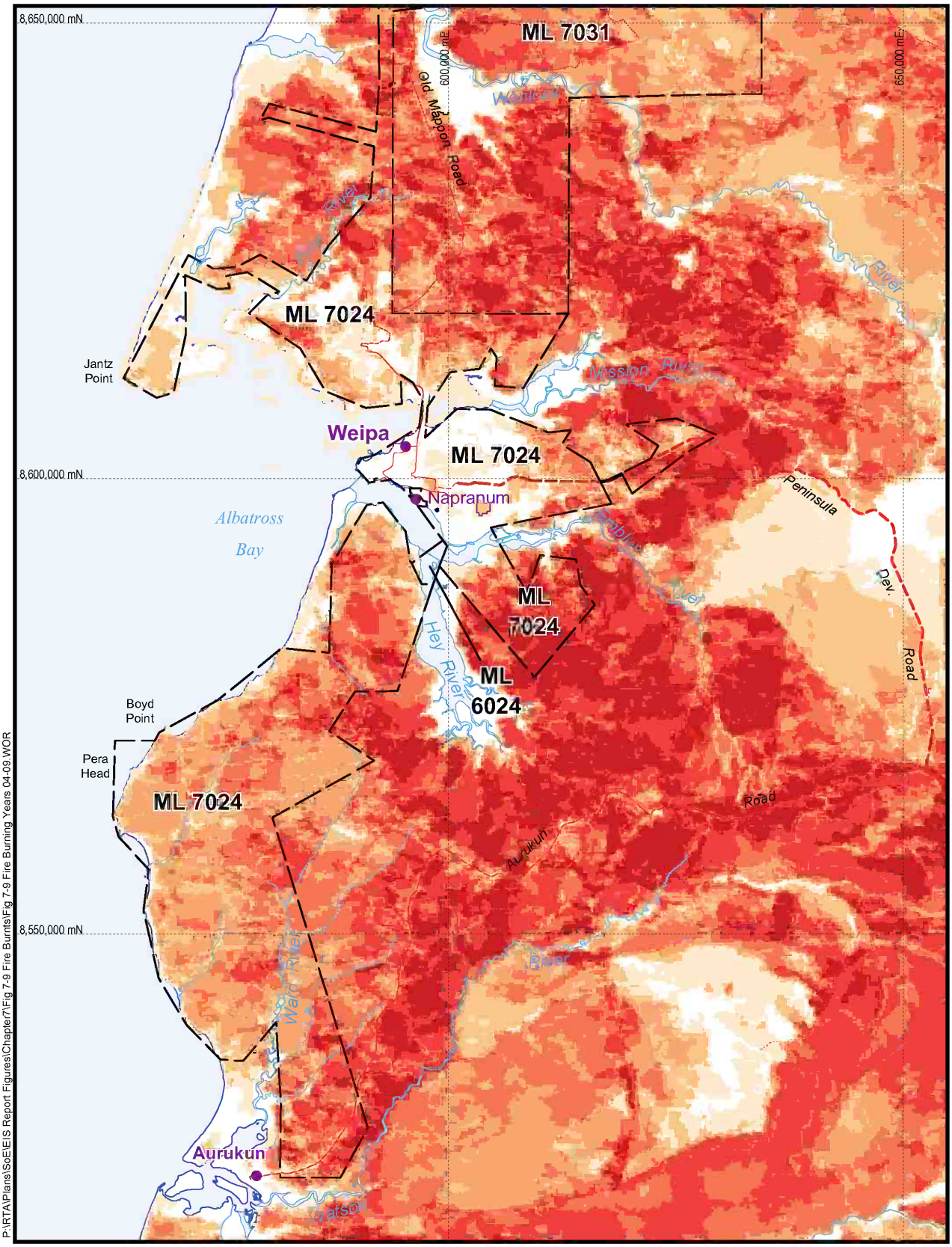
Fire regime is a critical determinant of vegetation condition and overall vegetation community composition, with the intensity, frequency and timing of fire important for both fire-adapted and fire-sensitive vegetation types. The current fire regime within the Project area is one of extensive, high intensity, late dry season fires with areas close to access tracks and high recreational visitation areas being intentionally burned on an annual basis (refer **Figure 7-9**).

Between 2004 and 2009 all of the Project area was burnt, with fires generally occurring three or four years out of the six-year period and some areas being burnt every year (NAFI 2010).

Fires in the Cape York region start through: maintenance of fire regimes by Traditional Owners; fire management for the purposes of biodiversity conservation and protection of the community by DERM in the National Parks; maintenance of native pastures by the pastoral industry; as well as through storms and accidental or deliberate means. This fire regime is regarded as inappropriate for both fire-adapted vegetation such as Darwin Stringybark woodland and fire-sensitive vegetation such as vine forest and riparian gallery forest. Observations of vegetation patterns and fire damage within the Project area (and consideration of faunal communities) indicate that the current fire regime is promoting a simplified woodland vegetation community with premature loss of woodland canopy trees and suppression and retreat of fire-sensitive flora and vegetation types.

Disturbance to vegetation by feral pigs

Disturbance of vegetation by feral pigs is evident throughout the Project area in all vegetation types, but with particularly extensive damage in coastal wetland areas – especially the 'Bulkuru' spike rush (*Eleocharis dulcis*) swamps (vegetation unit 12f; RE 3.3.63) that occur adjacent to the estuaries of the main stream systems (Norman Creek, Winda Winda Creek, Ward River). Pig activity also provides a potential pathway for weed establishment via the resultant disturbed ground surface and the potential for pigs to translocate weed propagules into these areas. By the end of most dry seasons many 'Bulkuru' spike rush swamps have been entirely ploughed up by pigs foraging for 'Bulkuru' spike rush tubers and invertebrates. This disturbance is likely to have a deleterious effect on the resilience of this community particularly with respect to the response of the 'Bulkuru' spike rush to re-establish in the following wet season and provide habitat opportunities for many wetland dependant species of aquatic and terrestrial fauna. Other vegetation types that suffer appreciable pig damage are *Melaleuca* wetlands, saltpan and coastal grasslands, riparian gallery forest and groundwater seepage areas. Pig damage in Darwin Stringybark woodland is usually minimal and does not have a significant impact on vegetation and flora.



P:\RTA\Plans\SoE\EIS Report Figures\Chapter7\Fig 7-9 Fire Burning Years 04-09.WOR

RTA Mining Lease boundary
Township
Drainage
Road/track

Number of Years Burnt
0
1
2
3
4
5
6

Source: www.firenorth.org.au/nafi2

South of Embley Project

Fig. 7-9: Fire History 2004 - 2009

N

10 0 10km

Datum/Projection: GDA94/MGA Zone 54 Date: 17/02/2011

The implementation of the Project would provide an opportunity to implement a pig control program in targeted locations within the Project area, which would lead to improved conditions of wetland and riparian habitats.

7.10.2 Mitigation Measures

Altered hydrological regime due to removal of bauxite

Proposed mitigation measures for changes to vegetation communities resulting from the altered post-mining hydrological regime would follow the recommendations for mitigation of hydrological effects detailed in **Section 8.14.2**. In summary, these measures comprise designing post-mining drainage to emulate as far as possible the pre-mining regime of surface and subsurface flows. This would be achieved by a combination of surface drainage features and detention basins that recharge the shallow aquifer.

The environmental buffer system as described in **Section 7.9.2** would also be a primary mitigation measure for edge effects and hydrological effects on sensitive vegetation. The retained tract of undisturbed land within the buffer between mined bauxite areas and nearby riparian and wetland ecosystems would minimise changes to the groundwater hydrology and limit effects on nearby vegetation.

These mitigation measures would be supported by a selective vegetation monitoring program. Results of the monitoring program would be used to identify any effects on vegetation from edge effects and altered hydrological regime (and any other causes) and investigate measures to minimise similar future impacts.

The vegetation monitoring program would have the following attributes:

- Monitoring sites would be established in representative areas of sensitive vegetation units occurring adjacent to mining areas and in downstream areas (both in terms of surface and groundwater hydrology). The monitoring sites would include seasonally stratified sampling data prior to mining or development (i.e. one late wet / early dry season and one pre wet season survey event);
- Specimens would be collected for herbarium identification if a plant cannot be identified;
- Control sites for each vegetation unit would be established within the Project area in areas well away from proposed mining or infrastructure that are unlikely to experience surface or groundwater modification; and
- Monitoring would be undertaken periodically at an interval that would allow effective remediation should significant adverse impacts become evident.

The mitigation measures described above would effectively minimise the potential impacts as outlined in **Section 7.10.1** associated with the alteration of the hydrological regime due to bauxite removal.

Altered hydrological regime downstream of the water supply dam

Mitigation of the effects of water supply dam seepage on downstream riparian and fringing vegetation can be addressed at both the design and operational phases of the Project. With respect to possible elevated surface flow and groundwater inputs downstream of Dam C, further detailed geotechnical investigations and engineering design would be undertaken to select the wall position and structural format for a low seepage dam structure (within other design constraints and specifications).

Secondly, an environmental flow program with appropriate water release structures would be implemented to provide a streamflow regime that maximises similarities with the natural regime of streamflow duration throughout the year. Of greatest significance for riparian and wetland vegetation would be the similarity of the released flow regime to the natural seasonality of vegetation communities. The stream reach immediately downstream of proposed Dam C does not typically support late dry season flows and conversion of this reach to permanent flow could bring about significant ecosystem changes to the vegetation units currently occurring there.

The mitigation measures described above would effectively minimise the potential impacts as outlined in **Section 7.10.2** associated with the construction and operation of the water supply dam and any subsequent alteration to the hydrological regime downstream of the water supply dam.

Altered hydrological regime downstream of the pumping point on the Ward River

Significant impacts on vegetation communities are not anticipated to occur as a result of the proposed pumping program and no specific mitigation measures are proposed; however, the environmental buffer system would serve to maintain natural groundwater discharge at the periphery of the Ward River system downstream of the pump location and help minimise changes to instream flows below the pump location, and maintain wet season inundation of peripheral alluvial/colluvial vegetation.

The mitigation measures described above would effectively minimise the potential impacts as outlined in **Section 7.10.3** associated with the operation of the pumping point on the Ward River and any subsequent alteration to the hydrological regime downstream of the pumping point.

Weed Management

With respect to potential weed impacts, a weed management program comprising monitoring and control components would be developed and implemented to prevent impacts on undisturbed vegetation. The main focus of the weed management program would be early detection and early control of any weed invasions. The weed management program would have the following attributes:

- The weed management program would be developed and implemented in the early stages of the Project.
- Prior to the establishment of the Mine Access Road, any vehicles travelling to the Project area would be required to be washed down for weeds.
- Washdown facilities would be provided at the Humbug barge terminal and all vehicles thoroughly washed before transfer to the Hey River barge/ferry terminal and site access road.
- Washdown facilities would be constructed, positioned and managed such that wash water and soil is contained and not released to the surrounding ecosystems.
- Annual weed surveys would be conducted post wet season, targeting:
    - all operational areas (mining and infrastructure) and immediately adjacent ecosystems; and
    - site access roads.
- Periodic weed surveys would be conducted at least every three years, targeting:
    - habitats where key weed species are most likely to become established; and
    - areas within the mining lease where there is high recreational visitation (especially riparian and wetland areas).
- Detailed mapping of the above areas would form the basis of the weed management program and guide annual weed surveys.
- Training courses would be conducted regularly for relevant mine personnel, highlighting significant weed species and basic identification features for weeds likely to be encountered on the site, to ensure staff have been provided with enough information to accurately identify weed species. Commonly this includes a combination of posters, a herbarium, newsletters and training packages.
- Protocols would be established for easy reporting of weed occurrence by any personnel working on site and be of a format that encourages reporting.

- Results of the weed survey and any weed reporting would be uploaded to the site GIS in a timely manner so that weed mapping is maintained as a live database.
- Any weed infestation areas would have controlled access until appropriate treatment and suppression is complete and there is no risk of propagules being translocated.

The mitigation measures described above would effectively manage the potential weed related impacts associated with the Project as outlined in **Section 7.10.4**.

Fire Management

A fire management program would be developed in cooperation with Traditional Owners and the relevant Western Cape Communities Coordinating Committee (WCCCC) sub-committee to address the adverse aspects of the current fire regime within the Project area. The fire management program would aim to conserve fire-sensitive flora and vegetation communities and promote overall vegetation diversity by reducing fire intensity and frequency and promoting a regime of early to mid dry season lower intensity burns with a lower frequency. This would be achieved by promoting a regime of planned early to mid dry season lower intensity burning, and suppression (where practicable) of inappropriate fires. These activities would be underpinned by establishment and maintenance of a network of fire breaks to facilitate effective control burns and provide opportunities for combating inappropriate fires.

Public access would be restricted to the Project area, which would help control the prevalence of unwanted fires, although unauthorised access to non-active sections of the Project area may see the persistence of unauthorised fires, for which strategic fire suppression may be required. While these fire management principles would be applied across undisturbed areas of the Project area, specific controlled burning at a greater frequency would be required to protect infrastructure and rehabilitated areas from fire damage, but would be restricted to the vicinity of such assets.

The mitigation measures described above would effectively manage the potential fire management related impacts associated with the Project as outlined in **Section 7.10.5**.

The mitigation of the risk of damage caused by bushfires is also discussed in **Section 19.3.3**.

Feral animal management

A feral animal management program would be developed with the following attributes:

- The program would focus on feral pigs, which are the main pest in the Project area.
- The feral animal management program would be developed and implemented in the early stages of the Project.
- The program would focus on reducing pig numbers in sensitive environmental areas where pig populations are concentrated.
- Control measures would be compatible with accepted animal welfare outcomes.
- The control program would include appropriate monitoring for measuring program performance and guiding subsequent control effort.

The mitigation measures described above would effectively manage the potential impacts related to feral animals as outlined in **Section 7.10.6**.

7.11 Potential Impacts and Mitigation Measures – Threatened Flora

7.11.1 Potential Impacts

Of the 15 threatened plant species either confirmed as present or assessed as possible or likely to occur in the Project area, three are known to occur in Darwin Stringybark woodland on the bauxite plateau, comprising:

- *Acacia ommatosperma*

- *Albizia retusa; and*
- *Heterachne baileyi.*

None of these species were confirmed as present during field surveys.

Heterachne baileyi is known to occur on the lower slopes of the Weipa bauxite plateau and adjoining alluvial plains and probably colluvial plains. This habitat generally lies within the environmental buffer areas and hence outside of the mining footprint; consequently, *Heterachne baileyi* is unlikely to be directly affected by mining activity. However, the proposed water supply dam on a freshwater tributary of Norman Creek (Dam C) occupies lower bauxite slopes and adjoining colluvial/alluvial flats with *Melaleuca viridflora* and the species may occur in these areas, although it was not observed during targeted surveys. The potential habitat area for this species, within the dam footprint, would comprise approximately 3% of this habitat type within the Project area, so the majority of potential preferred habitat would not be affected. It is unlikely that indirect effects on any potentially occurring populations would occur as a result of alterations to hydrology or edge effects. The proposed fire management plan is likely to favour this species.

Acacia ommatosperma was not observed during surveys of the Project area but is known to occur on ironstone ridges and the slope of the bauxite plateau, as well as colluvial/alluvial plains adjacent to the lower plateau. The species thus has a similar potential distribution to *Heterachne baileyi* and consequently most of the potential habitat for the species is likely to occur within environmental buffer areas. Furthermore, ironstone ridges are unlikely to be included in mining areas as they do not yield commercial bauxite. The proposed water supply dam and other infrastructure would disturb less than 5% of the potential habitat for the species within the Project area, and it is unlikely that indirect effects on any potentially occurring populations would occur as a result of alterations to hydrology or edge effects.

Albizia retusa is known to occur in Darwin Stringybark woodland, predominantly in the vicinity of vine forest. The proposed environmental buffer system would prevent mining in the vicinity of vine forest and avoid disturbance of this area. Furthermore, no infrastructure is proposed in close proximity to vine forests. *Albizia retusa* may occur within notophyll vine forests in the Project area, although targeted surveys of vine forests did not locate the species. Indirect effects due to altered hydrology and edge effects are unlikely to affect any potential populations, and the proposed fire management plan is likely to favour this species.

The remaining threatened species confirmed as present or assessed as possible or likely to occur in the Project area do not occur in Darwin Stringybark woodland and would not be affected by clearing for mining. Eight of the threatened species are associated with freshwater riparian or wetland habitats that may be affected by construction of infrastructure, especially the water supply dam (Dam C) on a freshwater tributary of Norman Creek. These species comprise:

- Acacia fleckeri;
- Calophyllum bicolor;
- Cooktown Orchid (Dendrobium bigibbum);
- Chocolate Tea Tree Orchid *(Dendrobium johannis);*
- Lindsaea walkerae;
- Ant Plant (Myrmecodia beccarii);
- Sarcolobus vittatus; and
- Spathoglottis plicata.

Of these species, Chocolate Tea Tree Orchid is confirmed as occurring within the infrastructure corridor where it crosses Norman Creek. Cooktown Orchid is confirmed in pockets of riparian rainforest within the footprint of Dam C, in the vicinity of the infrastructure corridor crossings on Norman Creek and vicinity of road crossings of Norman Creek and Winda Winda Creek.

Consequently, these two species would be impacted by construction of the dam and/or linear infrastructure. Both Chocolate Tea Tree Orchid and Cooktown Orchid are relatively widely distributed within the Project area in suitable habitat that would not be adversely affected by the Project. Specifically, Chocolate Tea Tree Orchid is ubiquitous within riparian gallery forest and Melaleuca wetlands throughout the Project area. Cooktown Orchid is commonly encountered within riparian rainforest, the edge of mangrove forests, and coastal vine forests. Disturbance associated with the water supply dam and infrastructure for these two species represents a minor proportion of their overall occurrence in the Project area.

Targeted surveys of the dam area and infrastructure crossings of riparian areas indicated with a relatively high reliability that the more detectable species listed above (*Acacia fleckeri, Calophyllum bicolor,* Ant Plant) are not present in these locations and would not be directly affected by the dam and linear infrastructure.

Although not recorded during targeted field surveys, the potential presence of the more diminutive species (*Lindsaea walkerae, Sarcolobus vittatus, Spathoglottis plicata*) within the dam footprint cannot be discounted; however, potential habitat for all of these species occurs extensively elsewhere in the Project area in areas that would not be directly disturbed by the Project. Consequently, the potential impact on these species, should they be present within the infrastructure areas, is not regarded as significant.

The 8 riparian species listed above may also be locally affected to some degree by changes to surface and groundwater hydrology as described in **Section 7.10.1.** Potential impacts from alterations to hydrology on habitats supporting these species would be localised and would not change the catchment-wide occurrence of different riparian, wetland and mangrove habitats, or the overall availability of potential habitat for most of these species. One species, *Calophyllum bicolor,* would be potentially more susceptible to alterations to groundwater discharge rates as it grows only in association with permanent groundwater seepage areas (which have not been identified within the Project area) within rainforest. However, this species was not detected at five semi-permanent spring heads with suitable habitat located close to proposed mining areas that were visited during targeted surveys. Nor was it present at six other seepage areas which lacked suitable habitat. The species may occur in other unsurveyed isolated patches of suitable habitat at wetland margins closer to the coast on the lower reaches of the main drainage systems. The proposed environmental buffer system would minimise hydrological impacts on groundwater seepage zones particularly in lower catchment areas where the species may occur.

All the threatened flora species occurring in riparian and wetland situations would be favoured by the proposed fire management program, which would provide a more suitable fire regime for fire-sensitive species.

The remaining four threatened species occur predominantly in vine forest, which would not be affected by clearing for mining or infrastructure. Cooktown Orchid also occurs in this habitat. The vine forest species comprise:

- Cooktown Orchid (Dendrobium bigibbum);
- Habenaria hymenophylla;
- Hoya (Hoya revoluta);
- Lepturus geminatus; and
- Beach Nightshade (Solanum dunalianum).

One of these species, Cooktown Orchid, has been confirmed in the Project area within coastal vine forest areas on sand, and Beach Nightshade, *Hoya revoluta* and *Lepturus geminatus* also potentially occur in this habitat. Vine forest patches on coastal dunes are unlikely to be affected by changes to groundwater as the coastal dune complexes are not influenced by shallow aquifers or groundwater discharge. Consequently, impacts on threatened flora occurring in coastal vine forest are not anticipated.

Cooktown Orchid*, Habenaria hymenophylla* and Hoya all potentially occur in vine forest on bauxite. Vine forest areas on bauxite may be susceptible to effects related to changes in

groundwater hydrology following mining; however, any effects would be minimised by the proposed environmental buffer system which would prevent mining in close proximity to vine forest areas. Observations over a number of years of similar vine forest areas within other mining areas near Weipa suggest deleterious effects on vine forest communities have not occurred where appropriate environmental buffers have been implemented. It is anticipated there would not be any adverse impacts on threatened flora occurring within vine forest patches from Project-related disturbance.

Cooktown Orchid also occurs in mangrove areas predominantly along the landward edge of mangrove forest. These mangrove areas would not be directly affected by clearing and are not anticipated to experience any indirect effects via changes to hydrology.

All the above vine forest species are likely to benefit from the proposed fire management plan, which would promote a fire regime more favourable for fire-sensitive species.

7.11.2 Mitigation Measures

Species of riparian and wetland habitats

The environmental buffer system would mitigate impacts on riparian threatened flora by avoiding direct disturbance (apart from the water supply dam site and infrastructure corridors) and minimising potential hydrological effects and edge effects on the vegetation communities supporting these species. The potential for groundwater changes and impacts are further discussed in **Section 5.4.1** and **Section 8.14**.

All the fire-sensitive species would be favoured by improvements to riparian habitat condition in undisturbed areas as a result of the fire management program. The target regime of less frequent and less intense fires (via early – mid dry season burns) would reduce suppression of the moister riparian and wetland vegetation and maximise the spatial extent of these communities. Ground cover and shrub species that potentially occur in the Project area such as *Lindsaea walkerae, Sarcolobus vittatus*, and *Spathoglottis plicata* would especially benefit, with the epiphytic *Dendrobium bigibbum* and *Dendrobium johannis* also benefiting from the lower scorch height which should accompany the new fire regime. The proposed fire regime, which would result in a habitat mosaic of mixed fire age, would also promote the establishment of fire refugia where robust populations of threatened flora may develop and provide source populations for recolonisation of adjoining areas following natural disturbance events.

The terrestrial rooted species would also benefit from the feral pig control program. The riparian gallery forest of freshwater streams and adjoining colluvial areas is currently heavily utilised and disturbed by feral pigs throughout the year causing extensive damage to native vegetation within these habitats. The proposed feral animal management program would reduce damage to vegetation in general and to any of the threatened flora species that may be present.

The mitigation measures described above would effectively minimise the potential impacts of the Project on threatened flora associated with riparian and wetland habitats as outlined in **Section 7.11.1**.

Species of vine forest habitats

The environmental buffer system provides the primary mitigation measure for vine forest threatened species by controlling potential hydrological induced effects and habitat edge effects on the vine forest community. In addition, the fire management plan would provide positive outcomes for these species by mitigating existing non mining related fire impacts.

The mitigation measures described above would effectively minimise the potential impacts of the Project on threatened flora associated with vine forest habitats as outlined in **Section 7.11.1**.

7.11.3 Impact on EPBC Act Threatened Flora

This assessment is based on the *Significant impact guidelines* (DEWHA 2009a) provided by the Commonwealth Government. Individual "significant impact" assessments are provided for each

of the EPBC listed flora species that were assessed as possible, likely or confirmed inhabitants of the Project area. Key definitions from the guidelines that apply to this assessment are as follows:

An "important population" is a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are:

- key source populations either for breeding or dispersal;
- populations that are necessary for maintaining genetic diversity; and/or
- populations that are near the limit of the species range.

"Habitat critical to the survival of a species" refers to areas that are necessary:

- for activities such as foraging, breeding, roosting, or dispersal;
- for the long-term maintenance of the species (including the maintenance of species essential to the survival of the other species, such as pollinators);
- to maintain genetic diversity and long-term evolutionary development; or
- for the reintroduction of populations or recovery of the species.

Such habitat may be, but is not limited to: habitat identified in a recovery plan for the species or ecological community as habitat critical for that species or ecological community; and/or habitat listed on the Register of Critical Habitat maintained by the Minister under the EPBC Act.

An "invasive species" is an introduced species, including an introduced (translocated) native species, which out-competes native species for space and resources or which is a predator of native species. Introducing an invasive species into an area may result in that species becoming established. An invasive species may harm listed threatened species by direct competition, modification of habitat or predation.

The following EPBC Act listed species were confirmed to occur within the Project area:

- Cooktown Orchid (*Dendrobium bigibbum*); and
- Chocolate Tea Tree Orchid (*Dendrobium johannis*).
- The following EPBC Act listed species were not recorded during targeted surveys of the Project area, although suitable habitat was identified:
- Calophyllum bicolor;
- Spathoglottis plicata;
- Myrmecodia beccarii; and
- Beach Nightshade (*Solanum dunalianum*).

The EPBC Act listed species listed above have been assessed against the DEWHA (2009a) criteria for assessing significant impacts.

Calophyllum bicolor

Calophyllum bicolor was not recorded within the Project area. However, as the regional population size of this species is relatively small, if *Calophyllum bicolor* was to occur within the disturbance footprint of the Project area, this would be regarded as an important population. However, if a population was to be disturbed, this disturbance would be unlikely to lead to a long term decrease in the region of *Calophyllum bicolor*.

There are no threats specifically listed for *Calophyllum bicolor* (DSEWPaC 2010).

Will the proposed works ...	***Calophyllum bicolor*: Vulnerable**
... lead to a long-term decrease in the size of an important population of a species?	*Calophyllum bicolor* is currently known only from 17 populations on Cape York Peninsula (DERM 2010). It occurs on spring-fed areas that form a distinct habitat with evergreen rainforest and permanently wet substrates, but does not occur on stream banks away from the spring heads. There are four specimen records of the

Will the proposed works ...	***Calophyllum bicolor*: Vulnerable**
	species from the Weipa area, but the species has not been recorded from the Project area. *Calophyllum bicolor* was not recorded within the Project area despite the location and survey of five semi-permanent groundwater seepage zones that provided suitable habitat for the species. These sites were located in close proximity to proposed mining areas and no other potential habitat areas appear to occur close to mining or infrastructure areas. The species was absent from six other seepage zones surveyed where the habitat was unsuitable. However, unsurveyed isolated patches of suitable habitat may occur at the margin of wetlands in the lower freshwater sections of the main drainages (Norman Creek, Ward River, Winda Winda Creek) and may support the species. Any population of *Calophyllum bicolor* that may be present within the Project area would be regarded as an important population as the location would represent the southern distribution limit for the species. The groundwater seepage habitats on the lower sections of the main drainages where the species may occur are well removed from the proposed mining area and infrastructure and would not be directly disturbed. These habitats would be susceptible to impacts from altered groundwater hydrology; however, their location well away from mining areas and implementation of the proposed environmental buffer system and post-mining rehabilitation measures, which would seek to protect hydrological regimes, are anticipated to minimise impacts on groundwater discharge areas effectively. As such, it is unlikely that the species, if present, would be adversely affected. It is not anticipated that the Project would lead to a long-term decrease in any population of *Calophyllum bicolor* that may be present.
... reduce the area of occupancy of an important population?	As per the discussion above, if *Calophyllum bicolor* is present within the Project area its habitat would not be directly affected by mining and it is not anticipated there would be sufficient hydrological impacts on the groundwater dependent habitats it occupies to lead to a reduction of the area of occupancy of an important population.
... fragment an existing important population into two or more populations?	*Calophyllum bicolor* has a naturally patchy and restricted distribution associated with the isolated occurrence of permanent groundwater seepage zones. Populations of *Calophyllum bicolor* on Cape York are therefore naturally fragmented and not sensitive to disturbance of sub-optimal habitat between patches of preferred habitat. The Project would not lead to fragmentation of any potentially occurring *Calophyllum bicolor* populations.
... adversely affect habitat critical to the survival of a species?	The Project area does not include any critical habitat areas for *Calophyllum bicolor* that are listed under the EPBC Act or identified in Recovery Plans.
... disrupt the breeding cycle of an important population?	If *Calophyllum bicolor* is present within the Project area, it is not anticipated that its preferred habitat would be adversely affected by the Project and consequently the breeding cycle of the species would not be disrupted.
... modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?	If *Calophyllum bicolor* is present within the Project area its habitat would not be directly affected by mining and it is not anticipated there would be sufficient hydrological impacts on the groundwater dependent habitats it occupies to lead to a decline in the species.
... result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?	The Project area is currently predominantly free of serious weeds and invasive species; however, a number of significant environmental weeds occur in the surrounding region. The preferred habitat of *Calophyllum bicolor* is often favoured by invasive species due to the moist nature of the habitat. Should *Calophyllum bicolor* be present, the potential introduction of Rubber Vine (*Cryptostegia grandiflora*) would be of particular concern. Proposed mitigation measures for invasive species include a rigorous weed management program, which includes preventative measures and control measures for weeds within the Project area. Riparian areas including groundwater discharge areas would be one of the habitats targeted by the program. These mitigation measures would be effective in managing the impacts of weeds on *Calophyllum bicolor*. The Project is not anticipated to lead to the introduction or spread of invasive weeds within any potential habitat of *Calophyllum bicolor*.
... introduce disease that may cause the species to decline?	Disease is not known as a threat to this species. It is not anticipated that the Project would represent a threat with respect to the introduction of disease.
... interfere substantially with the recovery of the species?	It is not anticipated that the Project would adversely affect *Calophyllum bicolor* (if present). The Project would not interfere with the recovery of *Calophyllum bicolor*.

Cooktown Orchid *Dendrobium bigibbum*

The population of Cooktown Orchid within the Project area is not considered an important population under the EPBC Act.

Known threats to the Cooktown Orchid include pressure from localised settlement and visitor pressures, changed fire regimes and illegal collection. It has also been suggested that the Cooktown Orchid may also be detrimentally affected by an increase in the incidence of severe cyclones (DEWHA, 2008a).

Will the proposed works ...	**Cooktown Orchid (*Dendrobium bigibbum*): Vulnerable**
... lead to a long-term decrease in the size of an important population of a species?	The Cooktown Orchid occurs on Cape York Peninsula north from Princess Charlotte Bay and Kowanyama to the tip and into southern Asia. It has been recorded from several locations in the Weipa region, particularly in notophyll vine forest on coastal dunes and on lateritic red earths. The habitat preference of this species in the Weipa region is well known: it is restricted to closed forest, typically as an epiphyte in rainforest or vine thicket habitats. The species is sensitive to fire and therefore is found only in situations where frequent fires do not occur. The Cooktown Orchid was recorded from a number of locations throughout the Project area in coastal and Weipa plateau vine forest, mangrove communities and in areas of riparian rainforest and riparian gallery forest and is expected to be widespread within the entire Project area and adjoining areas in suitable habitat. Cooktown Orchid was confirmed in two pockets of riparian rainforest within the footprint of Dam C. The population of Cooktown Orchid within the Project area is not considered an important population under the EPBC Act.
....reduce the area of occupancy of an important population?	As per the discussion above, the population within the Project area is not regarded as an important population.
....fragment an existing important population into two or more populations?	As per the discussion above, the population within the Project area is not regarded as an important population.
....adversely affect habitat critical to the survival of a species?	The Project area does not include any critical habitat areas for *Dendrobium bigibbum* that are listed under the EPBC Act or identified in Recovery Plans. The species is widespread through central and northern Cape York.
....disrupt the breeding cycle of an important population?	As per the discussion above, the population within the Project area is not regarded as an important population.
....modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?	The two pockets of rainforest with Cooktown Orchids within the footprint of Dam C would be inundated. The orchid was found in the vicinity of the infrastructure corridor crossings on Norman Creek and vicinity of road crossings of Norman Creek and Winda Winda Creek. None of the vine forest or mangrove habitat types supporting Cooktown Orchid within the Project area would be directly affected by clearing for mining. No significant modifications of these habitats due to changes in hydrology are anticipated. Overall, the reduction of habitats supporting the species would be very minor. The proposed fire management program would favour the species by effectively reducing the impacts of the current fire regime on fire-sensitive habitats such as vine forest (refer **Section 7.10.2**)
....result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?	The Project area is currently predominantly free of serious weeds and invasive species; however, a number of significant environmental weeds occur in the surrounding region. The vine forest habitat of Cooktown Orchid is not considered at risk of weed invasion as most of the significant weeds in the region do not colonise closed forest. The mangrove habitat of the species is threatened by the introduction of Rubber Vine (*Cryptostegia grandiflora*). Proposed mitigation measures include a rigorous weed management program, which includes preventative measures and control measures for weeds within the Project area. Riparian areas including mangroves would be one of the habitats targeted by the program. These mitigation measures would be effective in managing the impact of weeds on the Cooktown Orchid. The Project is not anticipated to lead to the establishment of invasive weeds within the habitat of the Cooktown Orchid.
.....introduce disease that may cause the species to decline?	Disease is not known as a threat to this species. It is not anticipated that the Project would represent a threat with respect to the introduction of disease.
....interfere substantially with the recovery of the species?	The Project would lead to a minor reduction of the extent of habitats supporting the species due to the inundation of riparian habitat by the water supply dam and linear infrastructure, but given the extensive occurrence of the species elsewhere within the Project area and surrounding areas it is not anticipated that the Project would interfere substantially with the recovery of the species.

Chocolate Tea Tree Orchid *Dendrobium johannis*

As the Chocolate Tea Tree Orchid is widely distributed throughout the region, the population within the Project area is not regarded as an important population and any impact to the regional population as a result of disturbance associated with the Project would be negligible.

The key known potential threats to the Chocolate Tea Tree orchid include over-collection by orchid enthusiasts and habitat degradation from settlement and visitor pressures (DEWHA 2008b).

Will the proposed works ...	**Chocolate Tea Tree Orchid (*Dendrobium johannis*): Vulnerable**
....lead to a long-term decrease in the size of an important population of a species?	The Chocolate Tea Tree Orchid occurs from the Coen area north to the tip of Cape York and in Torres Strait and New Guinea, and has been recorded from several locations in the Weipa region, including the Andoom, Weipa and Ely mining lease areas. The habitat preferences of this species are well known: the Chocolate Tea Tree Orchid is restricted to mesic habitats, typically as an epiphyte on mature *Syzygium* spp. and *Melaleuca* spp. trees in riparian gallery forest and on the margins of swamp habitats and their associated ecotones. The Chocolate Tea Tree Orchid was recorded from a number of locations throughout the Project area in riparian gallery forest and *Melaleuca* dominated wetlands and is expected to be widespread within the entire Project area and adjoining areas in these habitats. The population of the Chocolate Tea Tree Orchid within the Project area is not considered an important population under the intent of the EPBC Act. The Chocolate Tea Tree Orchid occurs within riparian and wetland habitats throughout the Project area. The population within the Project area is not a discrete population, as the species occurs throughout the Weipa Plateau subregion and within the wider Cape York Bioregion.
....reduce the area of occupancy of an important population?	As per the discussion above, the population within the Project area is not regarded as an important population.
....fragment an existing important population into two or more populations?	As per the discussion above, the population within the Project area is not regarded as an important population.
....adversely affect habitat critical to the survival of a species?	The Project area does not include any critical habitat areas for the Chocolate Tea Tree Orchid that are listed under the EPBC Act or identified in Recovery Plans. The species is widespread through central and northern Cape York.
....disrupt the breeding cycle of an important population?	As per the discussion above, the population within the Project area is not regarded as an important population.
....modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?	Areas of riparian gallery forest and fringing *Melaleuca* wetland supporting the Chocolate Tea Tree Orchid would be disturbed by the infrastructure corridor crossing of Norman Creek. While not found within the footprint of the water supply dam, there is suitable habitat present in this location. Elsewhere the habitats of the species would be avoided by the mine plan and buffered by the proposed environmental buffer system. Significant modification of these habitats due to changes to hydrology is not anticipated. Overall, there would be a minor reduction of the extent of habitats supporting the species but, given the extensive occurrence of the species outside of these impact areas, it is not anticipated that the species would be caused to decline. The proposed fire management program would favour the species by effectively reducing the impacts of the current fire regime on fire-sensitive habitats such as riparian gallery forest and melaleuca wetlands (refer **Section 7.10.2**).
....result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?	The Project area is currently predominantly free of serious weeds and invasive species; however, a number of significant environmental weeds occur in the surrounding region. The habitats of the Chocolate Tea Tree Orchid are often favoured by weed invasion, as the moist nature of the habitats supports weed establishment. Of particular threat is the introduction of Rubber Vine (*Cryptostegia grandiflora*) which can thrive and displace native vegetation in riparian and wetland situations. Proposed mitigation measures include a weed management program, which involves preventative measures and control measures for weeds within the Project area. Riparian areas would be one of the habitats targeted by the program. These mitigation measures would be effective in managing the impacts of weeds on the Chocolate Tea Tree Orchid. The Project is not anticipated to lead to the establishment of invasive weeds within the habitat of the Chocolate Tea Tree Orchid.
.....introduce disease that may cause the species to decline?	Disease is not known as a threat to this species. It is not anticipated that the Project would represent a threat with respect to the introduction of disease.
....interfere substantially with the recovery of the species?	The Project would lead to a minor reduction of the extent of habitats supporting the species due to the infrastructure corridor crossing of Norman Creek, but given the extensive occurrence of the species elsewhere within the Project area and surrounding areas it is not anticipated that the Project would interfere substantially with the recovery of the species.

Ant Plant *Myrmecodia beccarii*

Although the Ant Plant has not been identified within the Project area, a population of *Myrmecodia beccarii* within the Project area (if present) would be considered an important population under the intent of the EPBC Act since the species is little known with no specimen records from western Cape York. It is not anticipated that any important population of *Myrmecodia beccarii* that may be present would be adversely effected by the Project

Known threats the Ant Plant include clearing of lowland paperbark woodlands, localised settlement pressures and the removal or destruction of plants by plant and butterfly collectors (DEWHA 2008c).

Will the proposed works ...	***Myrmecodia beccarii*: Vulnerable**
....lead to a long-term decrease in the size of an important population of a species?	*Myrmecodia beccarii* is known from coastal woodlands between Cooktown and Ingham and northern Cape York Peninsula between Weipa and the tip of Cape York. *Myrmecodia beccarii* was not located within the Project area and distribution within adjoining areas is not well known, although the species was recently located in a permanent groundwater seepage area near Weipa (pers. obs.). *Myrmecodia beccarii* is known from a variety of habitats on Cape York including *Melaleuca* wetlands, coastal closed forest, mangroves and swamp forest on permanent groundwater seepages. A potential population of *Myrmecodia beccarii* within the Project area (if found) would be considered an important population under the intent of the EPBC Act since the species is little known with no specimen records from western Cape York. The closest record for the species is from Weipa, with apparently no records of the species south of the Project area. The Project area would represent a distributional limit for the species. Any isolated population in this area would be regarded as an important population as it would represent: • key source populations either for breeding or dispersal; • population that is necessary for maintaining genetic diversity; and/or • population that is near the limit of the species range. (i.e. there are no other records of the species on the west coast of Cape York south of Weipa). Significant areas of potential wetland, mangrove and coastal vine forest habitat occur within the Project area. Targeted threatened surveys were undertaken in a number of *Melaleuca* wetland, coastal vine forest, and groundwater seepage forest habitats within the Project area but the species was not located and it is not anticipated that the species occurs in these habitats within the Project area. Mangrove areas were less intensively surveyed and may be a host to the species. Mangrove habitats within the Project area would not be directly affected by clearing and it is also highly unlikely that these areas would be significantly affected by changes to surface and groundwater hydrology. It is not anticipated that a long-term decrease in the size of any important population of *Myrmecodia beccarii* present within the Project area would occur.
....reduce the area of occupancy of an important population?	It is not anticipated that the area of any important population of *Myrmecodia beccarii* that may be present within the Project area would be reduced.
....fragment an existing important population into two or more populations?	*Myrmecodia beccarii* has a naturally patchy and restricted distribution associated with the restricted habitats it occupies. Populations of *Myrmecodia beccarii* on Cape York are therefore naturally fragmented and not sensitive to disturbance of sub-optimal habitat between patches of preferred habitat. The Project would not lead to fragmentation of important populations of *Myrmecodia beccarii*.
....adversely affect habitat critical to the survival of a species?	The Project area does not include any critical habitat areas for *Myrmecodia beccarii* that are listed under the EPBC Act or identified in Recovery Plans. The species is known from a number of other locations on Cape York.
....disrupt the breeding cycle of an important population?	It is not anticipated that any important population of *Myrmecodia beccarii* that may be present would be adversely effected by the Project; consequently, disruption of any important populations of *Myrmecodia beccarii* present is not expected to occur.
....modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?	Potential mangrove habitat for *Myrmecodia beccarii* within the Project area would not be adversely affected by the Project. The Project would not affect numerous other populations of the species reported from elsewhere on Cape York. A decline in the species as a result of the Project is not expected.
....result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?	The Project area is currently predominantly free of serious weeds and invasive species; however, a number of significant environmental weeds occur in the surrounding region. The preferred habitat of *Myrmecodia beccarii* is susceptible to weed invasion due to the moist nature which is often favoured by invasive species. Of particular concern is the potential introduction of Rubber Vine (*Cryptostegia grandiflora*). Proposed mitigation measures include a weed management program, which includes preventative measures and control measures for weeds within the Project area. Riparian areas including groundwater discharge areas would be one of

Will the proposed works ...	***Myrmecodia beccarii*: Vulnerable**
	the habitats targeted by the program. These mitigation measures would be effective in managing the impacts of weeds on *Myrmecodia beccarii* (if present). The Project is not anticipated to lead to the spread of invasive weeds within the habitat of *Myrmecodia beccarii*.
.....introduce disease that may cause the species to decline?	Disease is not known as a threat to this species. It is not anticipated that the Project would represent a threat with respect to the introduction of disease.
....interfere substantially with the recovery of the species?	Potential mangrove habitat for *Myrmecodia beccarii* within the Project area would not be adversely affected by the Project. The Project would not affect numerous other populations of the species reported from elsewhere on Cape York. It is not anticipated that the Project would interfere with the recovery of the species.

Beach Nightshade *Solanum dunalianum*

Although there are limited records of Beach Nightshade in the Weipa area and the species has not been identified within the Project area, it is expected to be widespread on Cape York (Landsberg and Clarkson 2004) and is therefore likely to occur in the Project area. If this species was disturbed as a result of the Project, the disturbance would have a minor impact on the regional population of the species.

DEWHA (2008d) identify the key known threats to some populations of Beach Nightshade as localised settlement pressures including land clearing, exotic animals such as feral pigs, weeds and altered fire regimes. DEWHA (2008d) also noted that a potential threat to the Beach Nightshade may be habitat destruction associated with mining activities.

Will the proposed works ...	**Beach Nightshade (*Solanum dunalianum*): Vulnerable**
....lead to a long-term decrease in the size of an important population of a species?	The Beach Nightshade is known from two Torres Strait islands and between Weipa and Mapoon on western Cape York Peninsula, however it is expected to be more widespread on Cape York (Landsberg and Clarkson 2004). The species was not found in the Project area during targeted surveys, however for the purposes of the impact assessment it is assumed that it is likely to occur in the Project area in the vicinity of coastal vine forest and possibly vine forest on bauxite. Any occurrence of the species is considered an important population under the intent of the EPBC Act since the species is little known with few existing records for the mainland, and any known occurrence of the species is regarded as: • key source populations either for breeding or dispersal; • populations that are necessary for maintaining genetic diversity; and/or • populations that are near the limit of the species range. The Beach Nightshade is expected to be restricted to the margins of vine forest – these habitats would not be disturbed by mining or development of infrastructure. Furthermore, indirect effects on these communities from changes to surface and sub-surface hydrology are not expected to lead to significant impacts as effective mitigation would occur via the proposed environmental buffer system and measures to emulate pre-disturbance drainage characteristics in the post-mining landscape. The Project would not lead to a long-term decrease in the size of the Beach Nightshade population.
....reduce the area of occupancy of an important population?	As discussed above, habitats supporting the Beach Nightshade would not be adversely affected by the Project; consequently, the area of occupancy of the Beach Nightshade within the Project area would not be reduced.
....fragment an existing important population into two or more populations?	Reduction in the area of the Beach Nightshade would not occur as a result of the Project and the population of this species would not be fragmented.
....adversely affect habitat critical to the survival of a species?	The Project area does not include any critical habitat areas for the Beach Nightshade that are listed under the EPBC Act or identified in Recovery Plans. The species is probably widespread on Cape York.
....disrupt the breeding cycle of an important population?	Vine forest habitat would not be affected by the Project and there would be no effect on the breeding cycle of the species.
....modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?	The vine forest habitat that supports the species would not be adversely affected by the Project, thus a decline in the species is not anticipated. The proposed fire management plan would favour the species by effectively reducing the impacts of the current fire regime on the fire-sensitive vine forest habitats.
....result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species'	The Project area is currently predominantly free of serious weeds and invasive species; however, a number of significant environmental weeds occur in the surrounding region. The peripheral vine forest habitats of the Beach Nightshade are

Will the proposed works ...	**Beach Nightshade (*Solanum dunalianum*): Vulnerable**
habitat?	favoured by weed invasion as the moist nature of the vine forest edge supports weed establishment. A number of smothering and ground cover weed species pose a threat, including Rubber Vine (*Cryptostegia grandiflora*) Hyptis (*Hyptis suaveolens*) and Stylo (*Stylosanthes* spp.). Proposed mitigation measures include a weed management program which includes preventative measures and control measures for weeds within the Project area. These mitigation measures would be effective in managing the impacts of weeds on the Beach Nightshade. The Project is not anticipated to lead to the establishment of invasive weeds within the habitat of the Beach Nightshade.
.....introduce disease that may cause the species to decline?	Disease is not known as a threat to this species. It is not anticipated that the Project would represent a threat with respect to the introduction of disease.
....interfere substantially with the recovery of the species?	The Project would not lead to impacts on the Beach Nightshade and would consequently not interfere with the recovery of the species.

Spathoglottis plicata

As the regional population size of *Spathoglottis plicata* is relatively small, if this species was to occur within the disturbance footprint of the Project area, this would be regarded as an important population. However, if a population was present, it is unlikely the Project would interfere substantially with recovery of the species.

The key known potential threats to *Spathoglottis plicata* include over-collection and illegal collection by orchid enthusiasts, disturbance and foraging by feral pigs and altered hydrology (DEWHA 2008e).

Will the proposed works ...	***Spathoglottis plicata*: Vulnerable**
....lead to a long-term decrease in the size of an important population of a species?	*Spathoglottis plicata* is known from Cape York peninsula between Cooktown and the Jardine River and in the Asia Pacific region. *Spathoglottis plicata* has not been recorded from surveys within the Project area but suitable habitat occurs in the Project area, including riparian gallery forest, Melaleuca wetlands, and seasonally inundated grassy areas. A potential population of *Spathoglottis plicata* within the Project area (if found) would be considered an important population under the intent of the EPBC Act since the species is little known with only one record from western Cape York (near Weipa). Any additional known occurrence of the species would be regarded as significant because it would represent: • key source populations either for breeding or dispersal; • populations that are necessary for maintaining genetic diversity; and/or • populations that are near the limit of the species' range. *Spathoglottis plicata* may occur within the footprint of the proposed water supply dam (Dam C), although targeted surveys within the dam footprint did not locate the species. Suitable habitat for the species also occurs elsewhere in the Project area in areas to be undisturbed by mining and infrastructure. Habitat areas adjacent to mining areas may experience isolated localised minor effects due to changes in hydrology associated with removal of bauxite. However, these effects would be limited by effective mitigation measures including spatial buffering of riparian and wetland areas and use of reconstructed surface drainage and detention areas in mine pits to recharge shallow groundwater aquifers. Significant indirect impacts on the species due to hydrological change are not anticipated. Should *Spathoglottis plicata* occur within the footprint of the water supply dam, a long-term decrease in the size of the population may occur; however, there is no current evidence to suggest the species is present in this area.
....reduce the area of occupancy of an important population?	Should *Spathoglottis plicata* occur within the footprint of the water supply dam then the area of occupancy of the species within the Project area would be reduced; however, there is no current evidence to suggest the species is present in this area.
....fragment an existing important population into two or more populations?	It is not anticipated that *Spathoglottis plicata* would occur as discrete populations within the Project area. Disturbance of *Spathoglottis plicata* within the footprint of the water supply dam is not expected to fragment any population that may be present within the Project area.
....adversely affect habitat critical to the survival of a species?	The Project area does not include any critical habitat areas for *Spathoglottis plicata* that are listed under the EPBC Act or identified in Recovery Plans.
....disrupt the breeding cycle of an important population?	Should *Spathogolottis plicata* occur within the footprint of the water supply dam then the breeding cycle of the species would be disrupted within that area; however, there is no current evidence to suggest the species is present in this area.
....modify, destroy, remove, isolate or	The Project would disturb potential habitat for this species within the water supply dam

Will the proposed works ...	***Spathoglottis plicata*: Vulnerable**
decrease the availability or quality of habitat to the extent that the species is likely to decline?	footprint; however, more extensive areas of similar suitable habitat occur elsewhere throughout the Project area. The proposed feral animal control program would effectively reduce pig numbers in the Project area and would most likely reduce damage levels to potentially occurring populations of *Spathoglottis plicata* during the dry season. Furthermore, the fire management program would effectively reduce the impacts of fire to potential habitat areas. If the species occurrence is restricted to the Dam C footprint area then the species would experience a decline; however, if present within the Project area it is regarded as unlikely that the species would be restricted to the Dam C area given the availability of more extensive areas of similar suitable habitat associated with the main drainage systems of Norman Creek, Ward River and Winda Winda Creek.
....result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?	The Project area is currently predominantly free of significant weeds and invasive species; however, a number of significant environmental weeds occur in the surrounding region. The moist nature of wetland and seasonally inundated habitats favoured by *Spathoglottis plicata* puts them at risk of invasion by weed species. Of particular concern is Rubber Vine (*Cryptostegia grandiflora*). Proposed mitigation measures include a rigorous weed management program, which includes preventative measures and control measures for weeds within the Project area. These mitigation measures would be effective in managing the impacts of weeds on *Spathoglottis plicata*. The Project is not anticipated to lead to the establishment of invasive weeds within any potential habitat of *Spathoglottis plicata*.
8.....introduce disease that may cause the species to decline?	Disease is not known as a threat to this species. It is not anticipated that the Project would represent a threat with respect to the introduction of disease.
9....interfere substantially with the recovery of the species?	It is not anticipated that the species, if present in the Project area, would be restricted to the Dam C site only given the occurrence of more extensive areas of similar suitable habitat throughout the Project area, and consequently it is unlikely the Project would interfere substantially with recovery of the species.

7.12 Environmental Offsets

Under the Queensland offset matters specified in the Terms of Reference (ToR) (i.e. Queensland Government-specific issues environmental offsets policies and the *Policy for Vegetation Management Offsets* (NRW 2007) (refer to the *Regional Vegetation Management Code for Western Bioregions*)), no vegetation offsets are required under either of these Policies for clearing associated with the Project. The Project would not have a significant impact on the terrestrial MNES; therefore, offsets for terrestrial impacts are not required under the EPBC Act.

A condition of approval under the *Fisheries Act 1994* for removal of mangroves in the area of the Hey River barge/ferry terminal may include a requirement to provide a compensatory measure as an offset (refer **Section 6.9.3.2** for further discussion).

7.13 Overview of Terrestrial Fauna Survey Methods

Surveys were undertaken of the terrestrial fauna and habitats within the Project area. The main objectives of the fauna survey program were to characterise the fauna communities within the terrestrial habitats present and to provide substantial coverage of threatened and migratory species listed under the EPBC Act as these are the primary matters of national environmental significance relevant for the Project area (i.e. in the absence of threatened communities or populations). Survey techniques were used that were specifically suited to the species and habitats likely to be present as well as providing an optimal balance of intensive site based data and more extensive data on threatened and migratory species. A detailed description of the survey methodology used for threatened and migratory terrestrial fauna species is provided in **Appendix 7E**.Preliminary surveys were undertaken in July 2006 and May 2007 with dedicated surveys for the EIS undertaken in December 2007, May 2008, December 2008 and May 2009. The spread of survey events provided survey effort over key seasons for detecting fauna variability within the Project area, namely late dry season (December) and late wet season (May). Extensive survey during the wet season was not possible due to the difficulty of access to and within the Project area with the presence of seasonal inundation. Nevertheless, the main late wet season survey in May 2008 and subsequent targeted surveys in May 2009 were

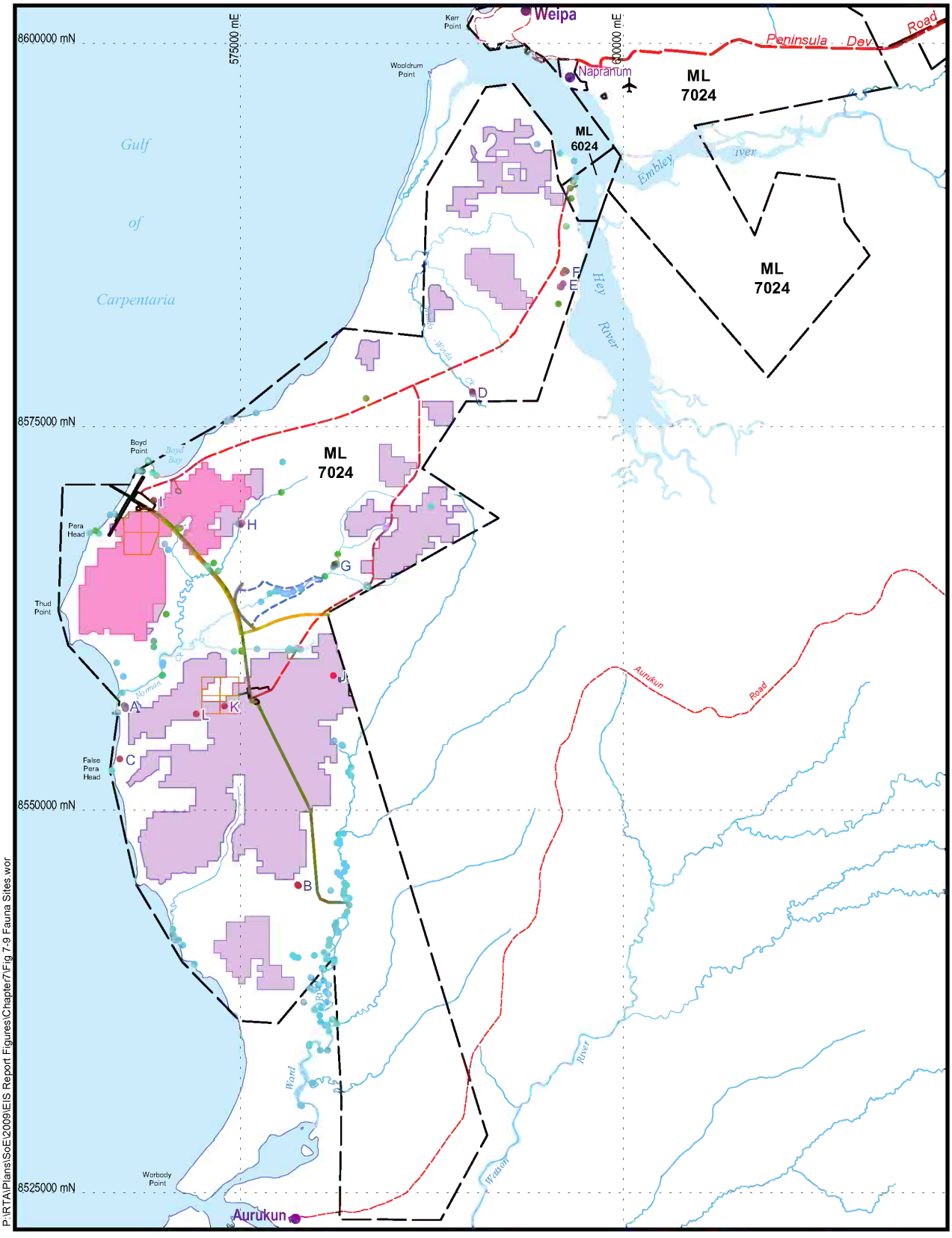
conducted as soon as vehicle access to the Project area was possible, ensuring there was still a significant level of fauna activity.

The two preliminary fauna surveys in 2006 and May 2007 focussed on Darwin Stringybark (*Eucalyptus tetrodonta*) dominated communities on the bauxite plateau. These are the communities that occur within the mining path. Prior to the dedicated EIS surveys, a gap analysis was undertaken to identify fauna habitats requiring further survey effort to adequately describe their fauna community and potential for supporting endangered, vulnerable or rare (threatened) fauna species. As a result, the December 2007, May 2008, December 2008 and May 2009 surveys concentrated survey effort within non *Eucalyptus tetrodonta* dominated habitats occurring predominantly in riparian, seasonally inundated, coastal vine forest, and vine forest habitats occurring on the bauxite plateau. Additional surveys were also undertaken in *Eucalyptus tetrodonta* dominated habitats during these survey periods to extend the distribution of survey sites and coverage in this habitat within the Project area.

The location of fauna survey sites surveyed within the Project area is indicated in **Figure 7-10**. **Table 7-12** summarises the survey effort employed during all surveys in the Project area. A detailed description of fauna survey methods and other aspects of the study is provided in **Appendix 7E**.

Table 7-12 Summary of Fauna Survey Effort

Survey Component	Survey Effort
Comprehensive Fauna Sites	**12 Sites (48 days/nights)**
Elliot traps	2400 trap nights
Cage traps	16 trap nights
Pitfall traps	120 pitfall nights
Funnel traps	1000 trap nights
Hair tubes	288 hair tube nights
Anabat sessions	12 Anabat nights
Harp trap	12 trap nights
Morning bird searches	24 searches
Reptile searches	12 searches
Spotlight searches	12 searches
Call broadcast sessions	8 broadcasts
Supplementary Fauna Sites	**15 Sites**
Targeted (threatened) Fauna Survey	**27 days comprising**: • extensive foot traverses; • coastal observations with spotting scope; • Anabat sessions; • harp trapping; • funnel traps (224 trap nights); • spotlight surveys; • call broadcast sessions; • nocturnal crocodile spotlight surveys in the Ward River; • boat-based observational transect in Norman Creek; and • all terrain vehicle (ATV) traverses of beach habitats.



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RTA Mining Lease boundary
Township
Road/track
Freshwater dam
Tailings storage facility
Mining Years 1 -13
Mining Years 14 - 40

Comprehensive survey site (A - L)
Supplementary survey site
Targeted threatened fauna survey site

South of Embley Project

Fig. 7-10: Fauna Survey Sites

N

5 0 5km

Datum/Projection: GDA94/MGA Zone 54 Date: 16/07/2010

7.14 Fauna Habitats and Landscape Ecology

7.14.1 Description of Main Fauna Habitats

Detailed description of the floristic and structural composition of fauna habitats can be found in **Section 7-5** and **Appendix 7B**.

Darwin Stringybark (Eucalyptus tetrodonta) Open Forest on laterite

This habitat corresponds with RE 3.5.2 and is the dominant habitat type over the Project area and indeed the wider area of lateritic red earth plateau of the western Cape (covering more than 80% of the Weipa mining leases – Welch *et al.* 2004), and is the habitat where bauxite mining occurs.

Overall terrestrial microhabitat values are relatively abundant, comprising fallen timber, leaf litter, bark exfoliates and vegetative cover. Variability exists within localities supporting a number of tree species, especially where Cooktown Ironwood (*Erythrophleum chlorostachys*) is present, providing suitable microhabitats for a range of reptile, frog and mammal species. The denser exfoliates typical of Cooktown Ironwood not only provide thermally stable refugia but appear more resilient to fire damage, increasing the longevity of microhabitat availability. Furthermore, the canopy of Cooktown Ironwood provides increased shade and shelter opportunity as well as promoting a more patchy grass understorey compared to very tall closed grasslands beneath the canopy where Cooktown Ironwood is absent. Many stands of this habitat support a notable density and diversity of microhabitat for hollow dependant fauna.

Riparian Gallery Forest and associated alluvial/colluvial Woodland

The core feature of this habitat is as a narrow band of tall riparian "gallery" forest bordering the watercourses which drain the bauxite plateau within the Project area. The width of the riparian gallery forests (including the stream) generally ranges from a few metres in upper stream reaches to 90m in downstream reaches, with an isolated occurrence of 150m wide on Norman Creek. The associated woodlands comprise bands of *Banksia dentata* dominated low open woodland with sedgy understorey which occur on seasonal groundwater seepage zones, grading into a Bloodwood tall open woodland.

The water supply dam (Dam C) proposed for a freshwater tributary of Norman Creek would be situated within this habitat type. This habitat consists of a mosaic of RE types, which are defined as:

- Swamp Mahogany (*Lophostemon suaveolens*) dominated gallery open forest of streamlines, swamps and alluvial terraces (RE 3.3.9);
- Gallery notophyll vine forest on major watercourses (RE 3.3.5), which includes a high diversity of closed forest plant species;
- Bloodwood / Banksia in upper parts of broad basins (RE 3.3.21); and
- Bloodwood / Red Gum (*C. polycarpa* / *E. brassiana*) Woodland on colluvial upper reaches of broad drainage basins (RE 3.5.22c).

Arboreal habitat values are limited to a certain extent by a paucity of tree hollows and cavities which, if present, usually occur within dead and senescent *Lophostemon suaveolens*. The canopy structure and density is variable, with denser foliage providing potential refugia for bird and arboreal mammal species. The greater floristic diversity of shrub, small tree and canopy tree species provides a variety of feeding resources not available in drier vegetation types on the bauxite plateau.

Terrestrial habitat values comprise a mosaic of fallen tree litter and vegetation, with the persistent soil moisture providing refugial shelter opportunities beneath litter and logs and within burrows during the dry season. Leaf litter densities are variable with respect to the tree species present, time of year, and fire history, although piles of debris occur as a result of high streamflows. Scouring around tree roots in the riparian gallery forest caused by wet season

streamflows also provide shelter microhabitat and foraging areas for amphibians and small terrestrial reptiles. Ground mammal densities appear highest in association with this habitat type.

Notophyll Vine Forest on lateritic red earths

These habitats comprise notophyll vine forest on lateritic red earths of the bauxite plateau, and occur as isolated patches within broad areas of Darwin Stringybark open forest. Within the Project area this habitat occurs only in the Hey Point area with occurrences ranging in size from 2 to 50ha. These vine forest areas would not be disturbed by mining or infrastructure. These habitats are floristically diverse and structurally complex, with canopy heights reaching 20 to 30m with taller emergents. These habitats are often referred to as interfluvial vine forest and correspond with RE 3.5.4.

Arboreal habitat structure comprises fissures, exfoliations and some hollows with the abundance of each dependant on the frequency of large emergent trees such as *Ficus* spp. These trees also provide significant seasonal feeding and refugia resources for frugivorous birds and mammals. Terrestrial habitat opportunities are sporadic and highly dependent upon the failing structure of large trees. Although leaf litter is prolific and provides some refugia for smaller species of reptiles and amphibians the rotting ground timber and buttress structure associated with large tree species appears to be the most usable habitat for terrestrial reptile and mammal species.

Paperbark Woodland and Wetland Swamps

Small areas of Paperbark woodland habitat occur in association with seasonally inundated depressions within the Bauxite Plateau, with more extensive occurrences on the lower reaches of the larger streams (Winda Winda Creek, Norman Creek and Ward River) and peripheral to the marine plains associated with these stream systems. The depressional wetlands are locally referred to as tree swamps given that they usually support tree cover throughout; although some patches of open water may occur.

Many wetlands and streams within the Project area are recognised to be at least partially supplied by groundwater discharge from shallow aquifers hosted in the near-surface lateritic strata of kaolinite overlain by bauxite (refer to **Section 5.3.2**). The shallow aquifers discharge water to surface water bodies and streams in addition to the annual wet season surface runoff (Herbert 1995).

Habitat values vary depending on the species of *Melaleuca* present with only the oldest of stands supporting potential arboreal refugia for hollow dependant fauna. The exfoliating bark of *Melaleuca* and swamp mahogany (*Lophostemon suaveloens)* provides microhabitat for small lizards and frogs as well as harbouring invertebrate prey for these species and also insectivorous bird species. Associated flowering events are highly favoured by nectivorous bird and mammal species and often occur during the dry season when feeding resources are typically limited.

Terrestrial habitat composition is variable depending on soil and vegetative structure but is generally typified by a low microhabitat yield and therefore low species diversity. Seasonal inundation of these habitats limits opportunities for subsequent long-term microhabitat formation and occupation by fauna.

No mining is proposed for paperbark woodlands and wetland swamps in the Project area, however some wetland (RE 3.3.9 dominated by *Melaleuca leucadendra*) occurs within the footprint of Dam C.

Foreshores, Tidal Flats and Beach Strand Habitats

These habitat types form a discontinuous band along the Gulf coast of the Project area, and include beaches, sand dunes, beach strand herb fields and Coastal She-oak (*Casuarina equisetifolia*) woodland. The latter two habitats generally occur on raised dunes of the coastal margin away from estuaries and creek systems, where mangrove communities do not occur. These communities are of limited extent within the Project area due the prevalence of bauxite

cliffs along the Gulf coast and the absence of extensive hind dune and strand areas. Similarly, extensive tidal flats that provide habitat for wader birds do not occur along the Gulf coast adjacent to the Project area, with limited areas in the Hey River area. The productivity of these areas is apparently not significant given an observed paucity of wader activity throughout the year.

Habitat values are varied depending on the presence of strand vegetation but scavenging/predatory species including feral pigs, goannas, wild dogs and a number of raptor species are frequently encountered in these areas. The seasonal presence of marine turtle eggs attracts feral pigs, feral dogs and potentially goannas to these habitats. The foreshore habitats provide key habitat for the Beach Thick-knee (*Esacus neglectus*) and seasonal habitat for nectivorous and frugivorous birds that take advantage of flowering shrubs within the strand vegetation. No mining would occur within the coastal environment, although a bauxite ship loading port would be constructed on the coastline area south of Boyd Point.

Semi-evergreen Coastal Vine Forest

Semi-evergreen Coastal Vine Forest habitat corresponds with RE 3.2.2 and occurs on the primary dune sequence behind coastal fore dune habitats. Structural development is limited to a single closed canopy layer to 10m, with a diversity of mesic plant species in this layer. Within the Project area Semi-evergreen coastal vine forest occurs as isolated patches along the Gulf coastline associated predominantly with dunal deposits adjacent to rocky points and headlands. No mining or infrastructure related disturbance would occur within this habitat type.

Arboreal microhabitats including fissures, exfoliations and occasional hollows are dependant on the frequency of large emergent trees such as *Ficus* spp. These trees provide significant seasonal feeding and refugia resources for frugivorous birds and mammals. Terrestrial habitat opportunities are variable and highly dependant upon the failing structure of large tree species. Although leaf litter is prolific and provides some refugia for smaller species of reptiles and amphibians, the ground timber and buttress structure associated with large tree species appears to be the most favourable habitat for terrestrial reptile and mammal species. Considerable damage to the ground surface and lower vegetation can occur in these habitats from activity by sheltering and foraging feral pigs.

Mangrove and Estuary

This habitat occurs extensively in association with Norman Creek within the Project area and along downstream reaches of the Ward River and Triluck Creek that are just outside the Project area. Mangroves and estuaries also occur along the northern coastline of the Project area within the Embley/Hey River estuaries. These habitats provide significant foraging habitat for a variety of bird species, especially predatory species such as raptors, herons, egrets and diving birds but also smaller passerines associated with the nectivorous and insectivorous feeding resources provided within the mangrove forests. These areas are also the main habitat for the Estuarine Crocodile (*Crocodylus porosus*) within the Project area, providing year round foraging and shelter habitat compared to seasonal wetland areas. The only Project related disturbance to this habitat type would be construction of the barge and ferry terminals on the Embley and Hey rivers. Construction would involve some dredging, reclamation and piling at the barge and ferry terminals. The main disturbance to mangroves would be at the Hey River barge / ferry terminal, where removal of a relatively thin band of mangroves (400m^2) would be required directly at the terminal site.

7.14.2 Habitat Landscape and Condition

Other than minor direct disturbance associated with exploration drilling tracks, no broadscale clearing of vegetation has occurred within the Project area and consequently the natural habitat cover persists within the area, although significant modification of habitat features has apparently occurred as a result of the current regime of frequent intense fires (refer **Section 7.15.2**). Fires in the Cape York region start through: maintenance of fire regimes by Traditional Owners; fire management for the purposes of biodiversity conservation and protection of the community by DERM in the National Parks; maintenance of native pastures by the pastoral industry; as well as through storms and accidental or deliberate means. Although

mature canopy trees would take a significant time to re-establish along drill lines, the ground cover and midstorey vegetation re-establishes rapidly on drilling tracks and quickly emulates the lower strata of undisturbed forest. This limits the potential disruption to habitat continuity across drill lines to a short temporal effect and consequently, the existing system of drill lines within the Project area is not anticipated to have significantly altered the prevailing landscape of continuous native habitats.

The Darwin Stringybark open forest community is by far the most extensive habitat type covering approximately 85% of the vegetation within the Project area. There is very little intra-habitat variation within the Darwin Stringybark community; however, significant variation occurs between habitats within the Project area by virtue of the freshwater and marine wetland and riparian habitats, and small areas of coastal and bauxite plateau vine forest. A feature of fauna communities in tropical climes is the highly variable nature of availability of feeding resources determined by the pronounced dry and wet seasons. Typically this results in a large proportion of the relatively mobile component of the fauna community undergoing either seasonal migratory movements or undertaking local sequential use of a mosaic of different habitat types throughout the year. Migratory movements may be local or more extensive including beyond the Australian continent. Local migratory movements are anticipated to focus on movement between riparian/wetland habitats and the adjacent Darwin Stringybark open forest habitat. Although the Darwin Stringybark open forest habitat becomes progressively drier as the dry season proceeds, Darwin Stringybark (*Eucalyptus tetrodonta*) usually flowers in the early dry season providing a productivity peak.

Flowering, fruiting and seeding of plants from all vegetation strata within all habitats in the mid-late wet season also provides a significant peak in feeding resources. Within the riparian, wetland and vine forest habitats similarly staggered productivity spikes attract mobile vertebrate fauna at different times of the year. Overall this implies that the aggregation of woodland, riparian and wetland habitat types that occurs in a typical topographically determined sequence from the drop off of the bauxite plateau into the drainage systems (refer **Figure 7-5**) represent a key landscape element for fauna, as a wide array of resources are available throughout the year within a relatively compact area. This drainage corridor habitat aggregation occurs throughout the Project area on drainage systems but is best developed on the mid to lower reaches of tributaries of the Norman Creek system.

The riparian corridors linking upper tributary and bottom end wetlands and estuary habitats are also likely to represent key natural fauna movement corridors providing seasonal access to a variety of habitat opportunities.

Within the Project area the bauxite plateau typically extends right to the beach and a dunal system with associated vine forest and dunal woodland occurs only as an intermittent feature in association with isolated dunal systems, close to stream mouths and rocky points. Consequently there is not a natural corridor of denser vegetation linking individual drainage systems such as can be observed to the north of Weipa where a continuous band of dunal vine forest and swale wetlands links the lower end of drainage systems. This implies that mobile fauna that need to move between riparian habitats hosted by different drainage systems to fulfil their annual foraging and possibly breeding requirements may need to traverse extensive areas of Darwin Stringybark open forest between these systems.

Relevant species include raptors, waterfowl, honeyeaters, parrots and cockatoos, fruit pigeons and flying fox. For instance, the Norman Creek and Ina Creek systems are separated by extensive Darwin Stringybark open forest with bauxite cliffs as is Norman Creek and Winda Winda Creek. It is anticipated that corridors of Darwin Stringybark open forest would be important in providing access between these riparian features and connectivity would be maintained by buffer vegetation and unmined remnant vegetation.

7.15 Fauna Communities

7.15.1 Overview

A combination of surveys and literature reviews were completed to develop an understanding of Project area fauna. A total of 269 native terrestrial vertebrate fauna species (including common species) was recorded from all habitat types within the Project area based on the results of EIS surveys and preliminary studies. This constitutes approximately 83% of the 324 native species of terrestrial vertebrate fauna collated in a recent review of fauna occurring in the Weipa region. About 98 species or approximately 36% of the total compliment of species from the Project area have been identified from Darwin Stringybark open woodland which is the habitat that occurs almost exclusively on the bauxite plateau. A detailed list of the fauna species recorded from the Project area indicating the relative abundance and habitats for each species and the results for each of the twelve comprehensive survey sites is provided in **Appendix 7F.**

Table 7-13 summarises the fauna diversity recorded in the Project area compared to the Regional fauna community and indicates that there is considerable fauna diversity within the Project area reflecting the diversity of habitats present including closed forest, woodland, and a range of stream, wetland and coastal habitats. Fauna diversity is concentrated within the non Darwin Stringybark open forest habitats which together comprise less than 20% of the total area of the Project area.

Five species were recorded only from Darwin Stringybark open forest: Black-headed Python (*Aspidites melanocephalus*), King Brown Snake (*Pseudechis australis*), Australian Bustard (*Ardeotis australis*), Red-tailed Black Cockatoo (*Calyptorhynchus banksii*), and *Pipistrellus westralis* (a microbat). However, this is regarded as an artefact of sampling probability as all of these species are known to utilise the other types of habitats present within the Project area, and no species are expected to be restricted to Darwin Stringybark open forest.

Table 7-13 Native Fauna Diversity within the Project and Weipa Areas

Area	Main Habitats	Birds	Mammals	Reptiles	Amphibians	Total
Project area	Darwin Stringybark open Forest habitat	62	10	23	3	98
	Riparian Gallery Forest/alluvial woodland	95	10	28	16	149
	Vine Forest on bauxite	20	2	5	2	29
	Paperbark Woodland and Wetland Swamps	78	5	14	15	112
	Foreshores, Tidal Flats, Beach	39	1	4	0	44
	Coastal Vine Forest	23	5	8	2	38
	Mangrove and Estuary	49	1	3	1	54
	All habitat types	184	23	45	17	269
Weipa region	All habitat types	201	41	61	21	324

Note: All data are numbers of species

The relatively low proportion of the regional native mammal diversity recorded within the Project area is notable. A total of 23 mammal species was recorded, including 10 microbat species, representing 56% of the regional mammal fauna. The Sugar Glider (*Petaurus breviceps*) was recorded at five locations and the Common Brushtail Possum (*Trichosurus vulpecula*) was recorded only once and within beach strand vegetation near False Pera Head. The absence of the Common Brushtail Possum from the extensive Darwin Stringybark open forest habitat and riparian habitats suggests the current land management regime is adversely affecting arboreal mammals (refer **Section 7.14.2**).

Similarly, only minimal numbers of small ground mammals from four species were recorded during the surveys, with a single individual Cape York Melomys (*Melomys capensis*) the only small mammal captured in Darwin Stringybark open forest. Small mammals were generally

restricted to moister refugial habitats comprising vine forest and riparian gallery forest but did not attain high densities in any of these habitats.

7.15.2 Habitat Condition and Effects on Fauna Diversity

Habitat condition within the Project area appears significantly affected by fire; however, little information is available for the Weipa region in particular that details the effect of fire and subsequent changes to fauna habitat quality and utilisation by various fauna species. General fire research in northern Australian savannah vegetation suggests that biodiversity would be maintained through administration of a diverse range of fire regimes that retain or enhance heterogeneity of habitat (Crowley 1995). The creation of a mosaic of vegetation patterns (with different fire age) increases the ability of fire-sensitive fauna species to move into refuge areas (swamps, vine forest, drainage lines) and areas of the more widespread open forest habitat types which have been less recently burnt. Extensive late dry season fires which are currently a feature of the fire regime within the Project area do not result in such mosaics, leading to extensive areas from which species can be eliminated and few refuge areas from which recolonisation can occur (Crowley 1995).

Habitat types that are infrequently burnt, including vine forest, riparian gallery forest and some Melaleuca wetlands, support species that are poorly adapted to fire, and also act as refuge areas for open forest/woodland species which breed or roost in these areas. Responses to fires vary considerably among fauna groups in northern Australia, ranging from seeking refuge in soil fissures or tree hollows to movements to unburnt areas or refuge habitats (Crowley 1995). Responses relate to the ability of individuals to survive fire events and, following this, survive predation/competition while continuing to locate necessary resources in the post-fire landscape (Crowley 1995).

Variable responses to fire lead to changes in assemblages of animals, depending on the fire history of an area. This is particularly relevant to the Project area as recent fire history appears to have favoured fire-tolerant species across large tracts of forest/woodland, and a decline in fire-sensitive species that formerly occurred in open forest/woodland is apparent. There is also evidence to suggest floristic changes and contraction in area of fire-sensitive habitat types is continuing to occur in response to the current fire management regime (Dames and Moore 1996), a factor which is likely to have implications for fauna species that rely on these areas as primary or secondary habitat.

The current occurrence of late dry season burning produces hot fires with high scorch height and extensive spatial extent that burn into moist riparian forest and wetland communities that would otherwise be too moist to burn in the early dry season. This has had the effect of further reducing the availability of refuge habitat from which animals can re-colonise open eucalypt forest/woodland communities after fire. A regime of patchy, early dry season fires when vine forest, riparian and swamp vegetation is less dry would help to maintain a greater diversity of habitats and would benefit species that require specific less fired vegetation types and fire-sensitive species that require vegetation to remain unburnt for many years. Significant fauna species identified for the Weipa region are included in both these groups.

RTA is involved in the Cape York Peninsula Sustainable Fire Management (CYPSFM) project, which aims to improve coordination and cooperation between land holders across all land tenures, and develop a sound basis for sustainable fire management strategies and practices (CYPDA 2009).

Significant changes to the fauna assemblage of most habitat types, including the more common and widespread Darwin Stringybark open forest habitat, were noted for a nearby area of similar habitat composition between 1985 and 1996, and attributed primarily to inappropriate fire management practices (Dames and Moore 1996). This fire regime is similar to that occurring within the Project area and was identified as responsible for degrading habitat values (Dames and Moore 1996), and resulted in the contraction and decline in abundance of terrestrial fauna species within these habitat types (Winter and Lethbridge 1994). An example of this is the contraction and decline in abundance of the Common Brushtail Possum (*Trichosurus vulpecula eburacensis*) in a large tract of Darwin Stringybark open forest and associated woodland to the

north of Weipa. Formerly dense populations of this species, described as being "particularly common" in the area and easy to locate if present in an area (Winter and Atherton 1985), appear to have become locally extinct due to changes in fire management (Winter and Lethbridge 1994). This decline was also confirmed across the broader northern Cape York area (Winter 2007) and is reflected in the survey data for the Project area where only one individual of Common Brushtail Possum was recorded from beach vegetation near False Pera Head.

Other groups of fauna have also recently become less common in the Weipa area, such as birds that feed on bark and foliage invertebrate communities. In particular, the decline of the Brown Treecreeper (*Climacteris picumnus*) on Cape York has been associated with recent burning practices (Winter and Lethbridge 1994), and this species was not recorded from the Project area.

Disturbance of ground habitat resulting from wallowing and foraging pigs is widespread within the Project area and impacts on the quality of habitat for fauna. Wetland and riparian areas are particularly targeted and the former can experience significant damage towards the end of the dry season. This may not have a significant effect on fauna activity which typically declines in these areas as the wetland dries out; however, there may be a long-term effect on the quality of this habitat – for instance, by consumption of sedge and rush tubers that would otherwise regenerate the following wet season.

7.15.3 Introduced Fauna

Six species of introduced fauna were detected during the survey, including three species listed under the *Land Protection Regulation 2002* (class 2 pest animals). **Table 7-14** lists these species. All these species are commonly encountered throughout the Weipa–Aurukun area.

Pest animals can have major impacts on native animals by preying on them, competing for food and damaging ecosystems.

The Feral Pig is by far the most abundant species within the Project area, occurring within all habitat types. The distribution and occurrence of feral pigs within the Project area follows seasonal patterns related to the inundation of wetland habitats and availability of potential food sources. Fresh pig diggings were consistently observed within the Darwin Stringybark woodland habitat of the bauxite plateau following the wet season, indicating widespread utilisation of this habitat during the wet season when substantial vegetative growth provides foraging opportunities. The inundation of wetland habitats during this time also tends to transfer pig activity from wetland areas as pigs tend to avoid substantially inundated areas presumably due to the risk of predation by Estuarine Crocodiles (*Crocodylus porosus*). As the dry season progresses, feral pig activity becomes more concentrated on wetland and riparian areas where sustained shallow inundation and elevated soil moisture continue to provide foraging opportunities. The seasonal 'Bulkuru' spike rush (*Eleocharus dulcis*) wetlands located in lower catchment areas are particularly targeted for foraging as water levels recede.

Foraging by feral pigs for fruit and seeds, leaves and stems, bulbs, tubers, fungi, soil invertebrates and insects causes disturbance which can damage soil structure resulting in erosion, affect plant succession or play a role in dispersing exotic plant seeds, and subsequently affect native fauna habitat. Predation of turtle nests by feral pigs is discussed in **Section 6.9.4.3**.

The Yellow Crazy Ant (*Anoplolepis gracilipes*) is a declared pest animal in Queensland. Crazy ants spray formic acid as a defence mechanism, which can kill some fauna (e.g. crabs) (DEWHA 2009b). They also protect scale insects which, when high in density, can cause forest trees to die back. There have been no crazy ants detected in the Weipa area to date. They are most commonly transported in sea cargo. The Australian Quarantine Inspection Service (AQIS) inspect and eradicate these types of pests in port areas. All vessels owned and contracted by Rio Tinto would comply with AQIS guidelines, where required.

Disease vectors and biting insects are discussed in **Section 18.5.3**.

Relatively high densities of feral cats were recorded during the July 2007 survey period, with numerous individuals recorded in a single night's spotlighting effort. High numbers of feral cats

were not subsequently recorded in later surveys but the species is regarded as ubiquitous and numerous throughout the Project area. Given the low densities of small mammals within the Project area, key prey items for feral cats are likely to be ground reptiles, amphibians and birds.

Table 7-14 Pest and Introduced Fauna in Project area

Species*	Common Name
Class 2 Pest Animals	
Feral Cat	*Felis catus*
Dingo/Dingo Hybrid	*Canis familiaris dingo / x C. Familiaris*
Feral Pig	*Sus scrofa*
Other Introduced Fauna	
Cane Toad	*Bufo marinus*
Feral Horse	*Equus caballus*
Feral Cattle	*Bos* spp.

* Declared under *Land Protection Regulation 2002*

Class 1 Not generally established in Queensland and has potential to cause an adverse economic, environmental or social impact.
Class 2 Established in Queensland and can cause significant adverse economic, environmental or social impact.
Class 3 Established in Queensland and has or could have adverse economic, environmental or social impact.

Feral Dogs/Dingoes were observed occasionally during survey events with signs of the species also observed from time to time. The species was most frequently observed at campsites utilised during surveys that were located close to the coast and wetland areas. It is anticipated that, although the species would be encountered in all habitat types, it is most prevalent close to the coast where scavenging opportunities exist along beaches and close to human campsites.

The Cane Toad was not observed in the very high densities that can be encountered on the east coast of Queensland, but was observed frequently in and around wetland and riparian areas. Similarly, no dense aggregations of Cane Toad tadpoles were observed in any of the wetland waterbodies within the Project area, although minimal observations were possible during the commencement and middle of the wet season when peak reproduction would be expected. Cane Toads were not observed within the Darwin Stringybark Woodland habitat but may utilise these habitats during the wet season, although extensive use of this habitat away from wetland and riparian areas is not anticipated.

Feral horses and cattle were observed infrequently during all surveys but most often encountered in the Hey Point area close to the coast. It is likely that both species make use of grassy areas associated with seasonal wetlands and marine plains but neither are anticipated to be widespread in the Project area.

7.15.4 Threatened and Migratory Fauna – EPBC Act

Threatened Fauna

The Commonwealth EPBC Act provides for the listing and protection of threatened fauna in Australia. The threatened status categories for fauna under the EPBC Act in order of increasing conservation significance are "vulnerable", "endangered", "critically endangered" or "conservation dependant". **Table 7-15** lists the threatened fauna species that:

- have been previously recorded from within or in close proximity to the Project area (DERM 2009c);
- have been found during surveys for the EIS;
- could potentially occur within the Project area based on EPBC database search; and
- could potentially occur within the Project area based on previous surveys in the Weipa area for RTA.

Table 7-15 Threatened fauna listed under the EPBC Act

Species **Common Name (Source of Record)**	**EPBC Status**	**Key Resources**	**Habitat**	**Likelihood of Occurrence within Project Area and Areas of Proposed Disturbance within the Project Area (Site)**
Birds				
Erythrotriorchis radiatus Red Goshawk (Wild, epbc)	V	Trees >20m high for nesting within 1km of a watercourse or wetland. Abundance of passerine prey	Favours coastal and sub-coastal areas. Prefers a mix of vegetation types including tall open forest, woodland, lightly treed savannah and the edge of rainforest and riparian forests. If present, the species could utilise all RE's within the Project area (Refer to **Figures 7-6** to **7-6d** for the locations of RE's within the Project area).	**Project Area** **Possible**: the open forest, woodland, riparian, and wetland habitats that occur throughout the Project area, in areas not to be disturbed by mining, present suitable nesting and feeding opportunities for the species. **Mining Area** **Possible:** the open forests of the mining area and adjacent habitats constitute likely foraging habitat for the Red Goshawk, although no sightings of the Red Goshawk were made during the surveys. Darwin Stringybark woodlands within 1km of permanent water could be used for nesting. It is possible that nests of the species could be within proposed mining areas. **Dam C on Norman Creek and infrastructure footprint** **Possible**: no nests were located within the proposed dam site. However, Dam C contains potential foraging and nesting habitat.
Erythrura gouldiae Gouldian Finch (Wild, epbc)	E	Annual and perennial grasses (especially Sorghum), a nearby source of surface water and unburnt hollow-bearing *Eucalyptus* trees for nesting	Inhabits open woodlands that are dominated by *Eucalyptus* trees and support a ground cover of Sorghum and other grasses, close to a reliable dry season water supply.	**Unlikely**: The species is recorded only rarely, and in small numbers, on the Cape York Peninsula. The Project area is located well outside the historical known range of the species although there are confirmed WildNet records from the Aurukun Council area. The current regime of frequent extensive fires is likely to affect the availability of favoured seed during the dry season over large areas of the Project area. In most years, fresh water does not persist across the vast majority of the Project area during the dry season, and it is likely that fresh surface water is totally absent following poor wet seasons. The species was not located during surveys in the most suitable habitat location within the Project area and consequently it is anticipated that the Project area does not support the species.
*Rostratula australis** Australian Painted Snipe (epbc)	V	Vegetated ephemeral wetlands	Inhabits shallow vegetated ephemeral wetlands in coastal and inland areas	**Unlikely:** Project area is well beyond the known range of the species, which is not known to occur on Cape York Peninsula.

Species **Common Name** **(Source of Record)**	**EPBC Status**	**Key Resources**	**Habitat**	**Likelihood of Occurrence within Project Area and Areas of Proposed Disturbance within the Project Area (Site)**
Tyto novaehollandiae kimberli Masked Owl (+)	V	Medium to large tree hollows for nesting, and availability of preferred small mammal prey	Prefers tall eucalypt forest and woodlands. Potential habitat comprises REs 3.2.2, 3.2.3, 3.3.5, 3.3.9, 3.3.14a and 3.5.4 (Refer to **Figures 7-6** to **7-6d** for the locations of RE's within the Project area).	**Project Area** **Possible**: the majority of key habitat resources for the species within the Project area are located in areas not to be disturbed, however, the prevalence of the species may be significantly limited by the apparent paucity of small mammal populations. **Mining Area** **Unlikely:** key potential habitat areas (riparian, wetland and vine forest habitats) and peripheral habitat (Darwin Stringybark open forest habitat adjacent to the key habitat areas), are not located within the proposed mining area. **Dam C on Norman Creek and infrastructure footprint** **Possible**: sections of tall closed forest on major drainages along Norman Creek and the Ward River provide potentially suitable habitat. The Dam C footprint contains some suitable habitat, however, this area is not regarded as especially significant for foraging or breeding. The prevalence of the species may be significantly limited by the apparent paucity of small mammal populations within the Project area.
Mammals				
Dasyurus hallucatus Northern Quoll (Wild, epbc)	E	Availability of tree hollows and rock crevices for den sites. Availability of land based prey	Rocky escarpments in eucalypt forests and woodlands within coastal regions (Oakwood 2008, Menkhorst and Knight 2001). Potential habitat comprises REs 3.2.2, 3.3.9, 3.3.14a, 3.3.21, 3.5.4 and 3.5.22c (Refer to **Figures 7-6** to **7-6d** for the locations of RE's within the Project area).	**Project Area** **Possible**: although the optimal habitat for the species, rocky outcrops and other rocky habitat, is not available within the Project area, the Northern Quoll may occur in vine forest and riparian gallery forest. All vine forest areas, and most riparian habitats within the Project area, are located in areas not to be disturbed. **Mining Area** **Unlikely:** this species has declined on Cape York following the spread of Cane Toads to the area. A paucity of favoured rocky habitat and continued exposure to modification and suppression by fire may see limited persistence of the species in suitable habitat within the Project area. Whilst the species may once have utilised Darwin Stringybark woodland it is most likely that patches of vine forest and riparian forest habitat currently provide the most likely habitat for the species within the Project area. Suitable habitat for the species includes the riparian communities of Norman Creek, and the vine forest patches in the Hey Point area, which are not within mining areas. **Dam C on Norman Creek and infrastructure footprint** **Possible**: minor areas of suitable riparian habitats are located within the footprint of the water supply dam, although targeted surveys did not locate the species in these areas. The habitat areas within the proposed dam footprint are not regarded as especially significant for foraging or breeding.
Notomys aquilo Northern Hopping Mouse (epbc)	V	Suitable sandy substrates for burrow excavation	In the Northern Territory part of its range, known to occur in Acacia scrub, heath and grasslands on sand dunes within coastal regions (Menkhorst and Knight 2004)	**Unlikely:** The type specimen of this species was recorded from Cape York Peninsula in 1867 but has since not been recorded in Queensland. Very little potential habitat within the Project area associated with isolated dunal systems.

Species **Common Name** **(Source of Record)**	**EPBC Status**	**Key Resources**	**Habitat**	**Likelihood of Occurrence within Project Area and Areas of Proposed Disturbance within the Project Area (Site)**
Saccolaimus saccolaimus nudicluniatus Bare-rumped Sheathtail Bat (Wild)	CE	Long deep tree hollows for roosting. Availability of flying insect prey.	Known habitats on Cape York include riparian forest and vine forest and adjacent woodland, including Darwin Stringybark dominated habitats. Potential habitat comprises REs, 3.2.10c, 3.3.5, 3.3.9, 3.3.21, 3.3.49b, 3.3.61, 3.5.2, 3.5.4, 3.5.11, 3.5.22c and 3.7.3 (Refer to **Figures 7-6** to **7-6d** for the locations of RE's within the Project area).	**Project Area** **Possible**: This species' habitat is poorly known. The species may favour riparian forest and vine forest and adjacent Darwin Stringybark dominated habitats and was found roosting in Darwin Stringybark at Iron Range. Vine forest areas and most riparian habitats within the Project area are located in areas not to be disturbed. Extensive areas of Darwin Stringybark woodland also occur outside of the disturbance footprint. **Mining area** **Possible**: Darwin Stringybark habitat within proposed mining areas may be suitable for the species, especially in the vicinity of riparian gallery forest and vine forest patches. **Dam C on Norman Creek and infrastructure footprint** **Possible**: Riparian forest within the Dam and infrastructure footprint may present suitable habitat.
Xeromys myoides Water Mouse (epbc)	V	Availability of prey especially crustaceans; availability of estuary and adjacent freshwater wetland habitat	Inhabits mangrove communities and associated saltmarsh, sedgelands, clay pans, heathlands and freshwater wetlands with intact hydrology	**Unlikely:** DSEWPC habitat mapping indicates the western Cape York area as potential habitat for the species but there are no known populations within approximately 750km of the Project area. Extensive traverses of wetland and mangrove habitat areas were undertaken within the Project area and no signs of the species, particularly nesting mounds, were located. It is not anticipated that the species occurs within or adjacent to the Project area.

* The schedules of the Queensland *Nature Conservation Act 1992* list this species as *Rostratula benghalensis* rather than the recently proposed species *R. australis*, formerly considered as a subspecies of *R. benghalensis*.

Key to Source of Record codes:

epbc	Potential species from the EPBC database
Wild	Records from the WildNet database
+	Additional potential threatened species added to assessment based on local knowledge

Key to Status:

CE	Critically Endangered
E	Endangered
V	Vulnerable

An assessment is provided of each species' potential occurrence in the Project area based on their habitat requirements and the condition and array of habitats available. The source of records for each species is indicated in **Table 7-15** along with the preferred habitat and known occurrence in the Weipa region. **Figure 7-7a**, **Figure 7-7b** and **Figure 7-11** detail the location of threatened fauna recorded during field surveys.

Of the 8 threatened species identified as potential inhabitants of the Project area, 1 is listed as critically endangered, 2 are listed as endangered and 5 are listed as vulnerable, and:

- 4 species possibly occur in the Project area; and
- 4 species are unlikely to occur in the Project area.

The REs that represent potential habitat for each threatened species is provided in **Table 7-15**. Refer to **Figure 7-6, Figure 7-6a, Figure 7-6b, Figure 7-6c** and **Figure 7-6d** for the location and distribution of these REs within the Project area. Refer to **Table 7-10** for data on the area of proposed disturbance of REs compared to the total area within the Project area, the Weipa Plateau subregion, and the Cape York Bioregion.

Profiles of each of the eight threatened species are provided below.

Red Goshawk *(Erythrotriorchis radiatus)*

The Red Goshawk has a wide range from northern WA to northern NSW, although it occurs in low numbers. The species has been recorded in riparian gallery forest associated with the lower Wenlock River to the north of the Project area (Blandford and Associates 1994), and was also recorded in the open woodland of the Merluna Plain to the north-east of the Project area (Winter and Atherton 1985).

The Red Goshawk is known to inhabit large home ranges of between 50 and 220km^2 in Queensland, with foraging regularly taking birds up to 8km from established nesting sites (Marchant and Higgins 1993). Habitat utilised in north Australia is described as tall open forest and woodlands traversed by waterways supporting gallery forest (Garnett and Crowley 2000). The open forests of the Project area and adjacent habitats constitute likely habitat for the Red Goshawk, although no sightings of the Red Goshawk were made during the surveys. The species could possibly utilise the study area at least occasionally as part of its extensive home range.

The nest trees are restricted to trees taller than 20m located within 1km of, and often beside, permanent water (Aumann and Baker-Gabb 1991, DEWHA 2009c, NPWS 2002). On this basis it is possible that nests of the species could be located within Darwin Stringybark open forest adjacent to permanent water or coastal habitats, or adjacent to seasonally inundated wetlands or seasonal watercourses supporting riparian gallery forest.

The species hunts in open forests and gallery forests, taking mostly medium to large birds (Czechura and Hobson 2000). It is most likely that wetlands of the lower Ward River area (located immediately downstream of the Project area) provide the best dry season foraging for the species as they support a greater abundance of these wetland habitats compared to areas contained within the Project area.

Habitat clearing is the major known threat to the Red Goshawk (EPA 2006). Human disturbance at nest sites are also known to disturb breeding pairs and result in reduced reproductive success, because breeding pairs can use the same nest in successive years (EPA 2006). However, they have been reported to build new nests after nests have failed or been cleared, or to nest in different areas seasonally to be closer to target prey. Debus and Czechura (1988) reported that after clearing of habitat, one pair left their nest site and were presumed to have re-nested 5km away. Aumann and Baker-Gabb (1991) reported that following the failure of a nest the pair concerned constructed a replacement nest. In winter in eastern Australia, the birds appear to move from nest sites in the ranges to coastal plains, where they are associated with permanent wetlands and often feed on waterbirds (Czechura and Hobson 2000). It is likely that Red Goshawks also undertake this habitat shift on northern Cape York as large numbers of waterfowl become concentrated on fewer wetland areas as wet season inundation recedes.

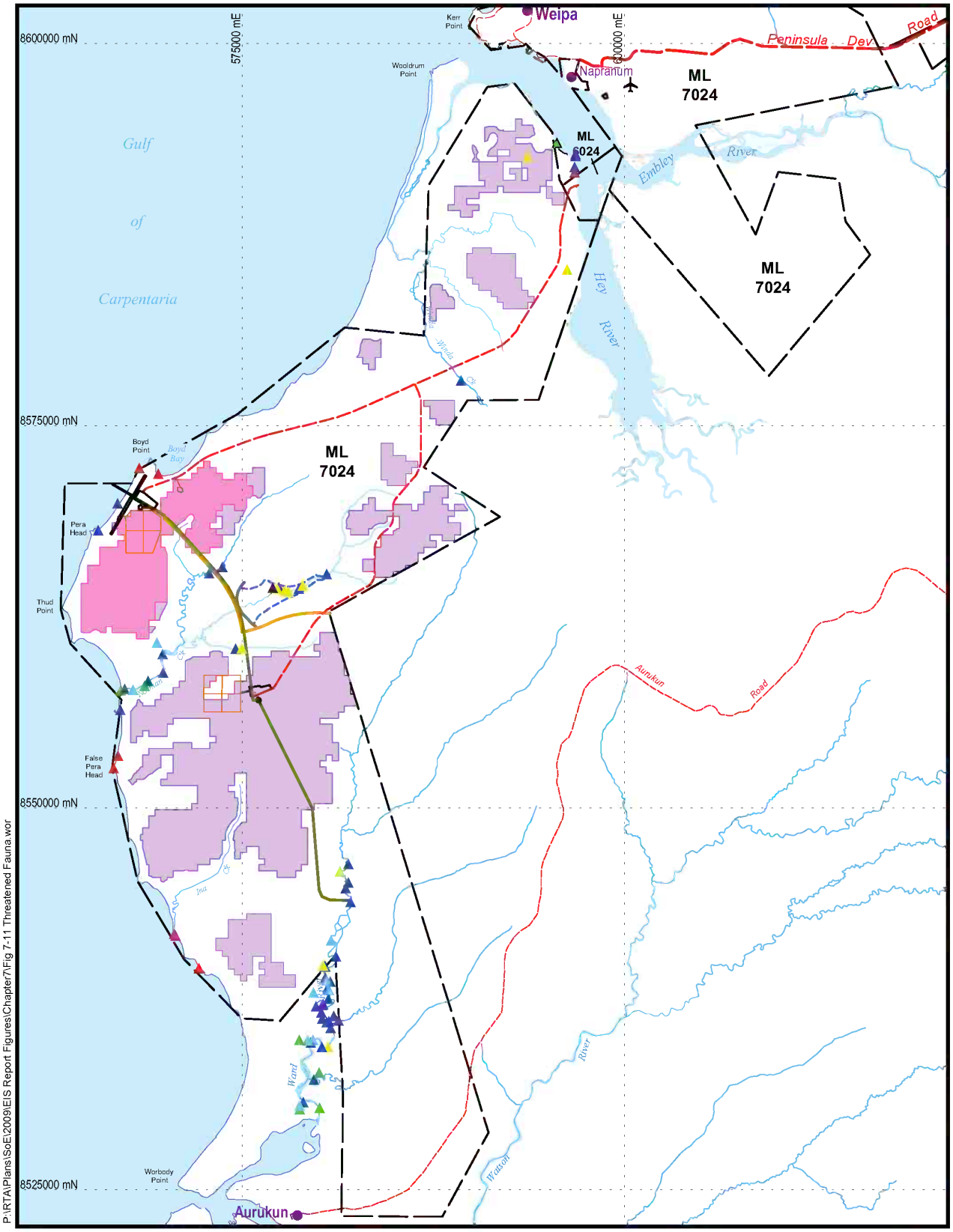

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Fig. 7-11: Threatened and Migratory Fauna Records

Based on the EPBC Act species profile for the Red Goshawk (DSEWPaC 2010), other possible threats include the following:

- The theft of eggs for egg collections and the intentional killing of adults.
- The application of persistent pesticides such as DDT may have caused a historic reduction in the population. In 1989, Australia ceased widespread use of organochlorine pesticides and most affected species have now recovered;
- Overgrazing, or other changes in land management which could reduce prey availability, and therefore reduce productivity.
- Altered fire regimes have the potential to impact breeding sites and reduce prey availability, thus reducing productivity.
- The occurrence of a catastrophic event which may exaggerate the impact of existing threats.
- Possible genetic bottlenecks in the population.

Gouldian Finch (*Erythrura gouldiae*)

The Gouldian Finch is recorded reliably only at a small number of sites within six Northern Territory and Western Australia bioregions, while in Queensland the species is now rarely seen in the wild (O'Malley 2006). The Project area is located well outside the historical known range of the species. There are confirmed WildNet records from the Aurukun Council area, however, the habitat within which the species was recorded is unclear.. The species was not recorded during surveys within the Project area.

The critical components of suitable core habitat for the Gouldian Finch appear to be the presence of favoured annual and perennial grasses (especially *Sorghum*), the presence of reliable sources of dry season surface water in close proximity to nesting habitat (given their need to drink every day) and, in the breeding season, the presence of significant numbers of unburnt potential nesting hollows in *Eucalyptus* trees (O'Malley 2006a; Tidemann 1996).

The Gouldian Finch is largely sedentary although there may be some dispersal of young over a number of kilometres from nesting sites. Consequently, the critical components of core habitat would need to occur within, or in very close proximity to, the Project area for the species to be able to occupy the Project area.

The Project area supports grass species that are favoured by the Gouldian Finch, but the current regime of frequent extensive fires is likely to affect the availability of seed during the dry season over large areas of the Project area. In most years, fresh water does not persist across the vast majority of the Project area during the dry season, and it is likely that fresh surface water is totally absent following poor wet seasons. The Gouldian Finch requires access to unburnt eucalypts with hollows during the breeding season. It is unclear when the breeding season of the species would be on northern Cape York but elsewhere there is a peak in breeding activity in the late wet season. The species would have access to unburned eucalypts at this time, although many trees would be recovering from fire the previous season.

The characteristic vagaries of seed and fresh water availability within the Project area are anticipated to render the area unsuitable for the Gouldian Finch.

Vegetation change, through inappropriate fire regimes and grazing impacts of stock and feral herbivores, is the factor most likely to be contributing to ongoing declines, or absence of recovery, in Gouldian Finch populations. During the 1980s there was evidence of high rates of air sac mite (*Sternostoma tracheacolum*) in wild Gouldian Finch populations, however, the extent of impact from disease remains unclear (O'Malley 2006).

Australian Painted Snipe *(Rostratula australis)*

The Australian Painted Snipe generally inhabits shallow terrestrial freshwater (occasionally brackish) wetlands, including temporary and permanent lakes, swamps and claypans. They also use inundated or waterlogged grassland or saltmarsh, and dams.

The species has not been recorded on northern Cape York Peninsula (Garnett and Crowley 2000) and is regarded as unlikely to occur within the Project area.

Masked Owl *(Tyto novaehollandiae kimberli)*

The northern race of the Masked Owl occurs between Townsville and the Kimberley region with other races extending down the east coast to Tasmania. The Masked Owl has been recorded in the Aurukun area with a specimen record reported on the WildNet database although the habitat within which it was recorded is unclear. The species was not recorded during surveys within the Project area. General habitat preference of this species comprises riparian gallery forest, rainforest, mangroves and the periphery of Melaleuca swamp forest (Garnett and Crowley 2000). Clearly, all of these habitat types occur in the Project area with the sections of riparian forest on major drainages along Norman Creek and the Ward River providing likely habitat. However, the Masked Owl is a specialist predator of small–medium sized ground mammals and the apparent paucity of these mammal populations within the Project area is likely to limit the habitat values of the Project area for the species. On this basis the Masked Owl is regarded as a possible inhabitant of the Project area but would most likely be restricted to riparian gallery forest above the coastal/brackish wetland zone where reduced seasonal inundation allows persistence of small mammal populations.

Potentially suitable habitat occurs along Norman Creek and Coconut Creek/upper Ward River. Construction of the water supply dam would disturb some suitable habitat, although the majority of preferred habitat areas would not be disturbed by the Project.

There is some evidence to suggest that the main threat to the Masked Owl is the decline in populations of small and medium sized native mammals, which are the Masked Owl's primary food source (Woinarski, 2004). The broad scale application of the rodenticide Klerat (now banned) may also have lead directly to the mortality of Masked Owls.

Northern Quoll *(Dasyurus hallucatus)*

The Northern Quoll is distributed from south-east Queensland across northern Australia to the Pilbara but has declined in many parts of this range. The Northern Quoll historically occurred in Darwin Stringybark open forest and associated habitats within the Weipa area prior to the arrival of the Cane Toad in the 1980s. Although numerous records exist for Northern Quoll in the region surrounding Weipa, the majority of these are historical, and no other confirmed sightings are available for the area around Weipa after 1990. The decline of Northern Quoll around Kakadu National Park in the Northern Territory as a direct consequence of Cane Toad invasion is now well documented, and has resulted in listing this species as endangered in a national context (EPBC Act 1999).

Consultation with Traditional Owners during a targeted survey for Northern Quoll north of Weipa revealed an anecdotal record from around 2001 in vine forest on bauxite (Possum Scrub). Subsequent consultation with Traditional Owners from the Project area did not indicate any recent sightings of the species. Consequently it is anticipated that the Northern Quoll is now very rare in the Weipa area. With respect to the Project area, whilst the species may once have utilised Darwin Stringybark woodland, patches of vine forest and riparian forest habitat currently provide the most likely habitat for the species. Optimal habitat for the species, rocky outcrops and other rocky habitat, is not available within the Project Area. Nevertheless it is possible that the species could be present in certain locations, most likely the riparian communities and coastal vine forest associated with Norman Creek, and the vine forest patches in the Hey Point area.

Vine forest areas would not be disturbed by the Project. Minor areas of riparian habitats would be disturbed within the footprint of the water supply dam, although targeted surveys did not locate the species in these areas.

A number of factors are considered to be threatening the survival of the Northern Quoll (DSEWPaC 2010). These include:

- inappropriate fire regimes;

- predation following fire; and
- lethal toxic ingestion of Cane Toad toxin.

Northern Hopping Mouse *(Notomys aquilo)*

The type specimen of this species was recorded from Cape York Peninsula in 1867 but has since not been recorded in Queensland. Known threats to the Northern Hopping Mouse include (DSEWPaC 2010):

- predation of whole communities by feral cats;
- grazing by feral cattle, pigs and buffalo causing changes in the vegetation composition of the Northern Hopping Mouse's habitat and food resources;
- changes in habitat vegetation due to altered fire regimes; and
- mining activities adjacent to habitat.

Very little potential habitat associated with sandy dune systems occurs within the Project area and given the lack of recent records it is regarded as unlikely that the species would be present in the Project area. The preferred coastal dune habitat of the species would not be affected by mining or infrastructure.

Bare-rumped Sheathtail Bat (*Saccolaimus saccolaimus nudicluniatus*)

The Bare-rumped Sheathtail Bat has been recorded in the Aurukun area (DERM 2009c) although the habitat within which it was recorded is unclear. The species was not recorded during surveys within the Project area.

The Bare-rumped Sheathtail Bat is a poorly known species that is difficult to detect. The species is not readily captured using existing bat trapping techniques, and cannot be reliably identified from Anabat recordings.

Records of the species from Iron Range and Coen indicate that the species may favour riparian forest and vine forest and adjacent woodland including Darwin Stringybark dominated habitats. The species was found roosting in Darwin Stringybark at Iron Range. Based on this information, large areas of the Project area may be suitable for the species, especially in the vicinity of riparian gallery forest and vine forest patches but potentially also deeper into the Darwin Stringybark woodland that occurs across the majority of the Project area.

Known and likely threats are described by Schulz and Thomson (2007). The current known threat to the Bare-rumped Sheathtail Bat is habitat loss due to land clearing. Likely threats include:

- vegetation change due to clearing of understorey vegetation for agriculture and livestock grazing, altered fire regimes, saltwater intrusion and invasion by exotic weed species;
- timber collection and the targeted removal of hollow-bearing and dead trees resulting in destruction of roosts;
- competition for hollows;
- disease; and
- loss of climatic habitat such as tropical forests caused by anthropogenic emissions of greenhouse gases (identified as a key threatening process under the EPBC Act).

Water Mouse *(Xeromys myoides)*

The Water Mouse is a specialist rodent of tidal areas and adjoining wetland or heath areas. It is currently known from only three populations located in southeast Queensland; central Queensland between Agnes Waters and Cannonvale; and the Top End in eastern Arnhem Land and the Daly River. Water Mouse forage in wetland habitats, especially within the tidal zone amongst mangroves and saltmarsh and may construct a mud nest near the tidal limit. Habitat mapping for the species produced by DEWHA (2009d) indicates the western Cape York region,

including the Project area, as possible habitat for the species; however, this is well beyond the limits of known populations.

Extensive traverses of potential habitat for the species including mangrove fringes, saltmarsh and seasonally inundated freshwater wetlands were undertaken during post wet and dry seasons but no signs of the species were located. Given the survey results and the lack of records of the species for North Queensland it is not anticipated that the Water Mouse occurs within the Project area. Potential habitat for the species would not be directly disturbed by the Project.

7.15.5 Migratory Species

Migratory Bird Species

A large group of bird species recorded in the Weipa region are listed in international agreements and conventions such as the Japan–Australia Migratory Bird Agreement (JAMBA), the China–Australia Migratory Bird Agreement (CAMBA) and the Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention), and are covered by the EPBC Act. According to DEWHA (2009e), the known threats to migratory shorebird species include the following.

- Clearing, inundation, infilling or draining of habitat.
- Changes in hydrology, water quality or structural changes near roosting site causing an indirect loss or degradation of habitat.
- Habitat degradation due to loss of marine or estuarine vegetation, weed invasion of intertidal mudflats, water pollution and changes to the water regime, changes to hydrological regimes and the exposure of acid sulphate soils.
- Disturbance of migratory birds during foraging as a result of residential and recreational activities.
- Direct mortality as a result of interferences in the flyways or degradation of important sites across flyways. These may include but are not limited to the development of wind farms in migration pathways, bird strike by aeroplanes and oil and chemical spills.

The above threats are occurring mainly as a result of population growth and economic development, especially in east and south-east Asia.

Table 7-16 lists the EPBC listed migratory bird species potentially occurring in the Project area and indicates the likelihood of each occurring in the Project area. The list in **Table 7-16** comprises:

- species identified in the EPBC search for the Project area (and identified in the Project EPBC referral);
- additional species recorded during field surveys; and
- additional species assessed as potential inhabitants of the area based on the array of available habitats observed during field surveys.

The REs associated with each potential habitat for each migratory bird species is also provided in **Table 7-16**. Refer to **Figure 7-6, Figure 7-6a, Figure 7-6b, Figure 7-6c** and **Figure 7-6d** for the location and distribution of these REs within the Project area. Refer to **Table 7-10** for data on the area of proposed disturbance of REs compared to the total area within the Project area, the Weipa Plateau subregion, and the Cape York Bioregion. A description of each habitat is summarised in **Section 7.14.1**.

A discussion of the occurrence and habitat of other migratory species is summarised at the end of this section.

Of the 44 migratory bird species identified as potential inhabitants of the Project area:

- 19 species have been confirmed as present in the Project area;

- 3 species are likely to occur in the Project area;
- 17 species possibly occur in the Project area; and
- 5 species are unlikely to occur in the Project area.

Twenty of these migratory species are trans-equatorial migratory waders, which arrive in Australia each spring and disperse throughout the continent to feeding grounds amongst coastal and wetland habitats. The western Cape York coastline is known as a major entry corridor for many individuals of these species travelling to eastern Australia.

Given the location of the Project area within the East Asian-Australasian Flyway, these waders were identified in preliminary reviews as a key fauna group for field surveys. A detailed description of the survey methodology used for migratory shorebird species is provided in **Appendix 7E**. Initial observations of likely shorebird habitats including the Gulf shoreline, the lower and upper estuary of Norman Creek, Hey Point estuary, and coastal wetlands associated with Norman Creek and the Ward River revealed a notable paucity of migratory shorebirds both in terms of species diversity and density of individuals. It was also noted that despite the large rise and fall of tides that can occur in the Gulf, the Project area did not support any extensive inter-tidal flats. The shoreline of the Gulf coast in particular was predominantly sandy and of sufficient gradient to expose only minimal tidal flats at the mouth of Norman Creek. Furthermore, seasonal coastal wetlands formed by freshwater inundation of marine plains during the wet season were invariably dry during December survey events and frequently heavily impacted by feral pig activity.

During the field surveys only 5 species of migratory shorebird were recorded within the Project area (refer **Table 7-16**). The largest group of migratory shorebirds observed at any one time was six Whimbrels (*Numenius phaeopus*) flying up the Norman creek estuary. No high tide roosts of any migratory shorebird were observed during surveys nor any foraging aggregations during lower tides. Isolated roosting shorebirds were occasionally observed in larger roosts of terns.

The paucity of migratory shorebirds within the Project area is attributed to the lack of inter-tidal flat habitat, the dry nature of coastal wetlands during the late dry season until wet season rains occur, and a possible low productivity of inter-tidal benthic habitats potentially related to the very low sediment loads emanating from contributing spring fed drainages and the extraordinarily low mineral status of these waters. The survey results establish clearly that there are no internationally or nationally important sites or locations for migratory shorebirds located within or immediately adjacent to the Project area, and furthermore the Project area does not support an ecologically significant proportion of any migratory shorebird population.

The remaining species are known to undertake seasonal migratory movements within mainland Australia or to the mainland from areas to the north including Papua New Guinea and eastern Pacific islands.

A number of migratory wetland species occur within the Project area and predominantly utilise the more extensive wetland areas associated with the estuarine reaches of the main drainage systems, with the largest aggregations of species observed on the lower Ward system downstream of the Project area. No large-scale roosts of these species were observed within the Project area; however, it is possible that roosts and/or breeding of some of the species may occur within these habitats. These wetland habitats would not be directly affected for mining or infrastructure.

Table 7-16 Migratory Bird Species

Species	Likelihood of occurrence within Project area	Habitats						
		Darwin Stringybark Open Forest (RE 3.2.10c, 3.5.2, 3.5.11, 3.5.22c)	Riparian Gallery Forest/Alluvial Woodland (RE 3.3.5, RE 3.3.9 (excluding variant dominated by *Melaleuca leucadendra*), RE 3.3.21, 3.3.49b, 3.3.61)	Vine Forest on bauxite (RE3.5.4)	Paperbark Woodland and Wetland Swamps (RE 3.3.9 variant dominated by *Melaleuca leucadendra*, , 3.3.14a, 3.3.50a, 3.3.63, 3.3.64, 3.3.65, 3.7.3)	Foreshores, Tidal Flats, Beach (RE 3.2.3, 3.2.5a, 3.2.6a, 3.2.25)	Coastal Vine Forest (RE 3.2.2)	Mangrove and Estuary (RE 3.1.1a, 3.1.1c, 3.1.3, 3.1.5, 3.1.6, 3.3.60a)
Acrocephalus stentoreus Clamorous Reed-Warbler	Confirmed during EIS surveys	-	-	-	✓	-	-	-
Actitis hypoleucos Common Sandpiper	Possible	-	-	-	-	✓	-	-
Apus pacificus Fork-tailed Swift	Confirmed during EIS surveys	✓	✓	✓	✓	✓	✓	✓
Ardea alba Great Egret, White Egret	Confirmed during EIS surveys	-	-	-	✓	-	-	✓
Ardea ibis Cattle Egret	Unlikely	-	-	-	-	-	-	-
Calidris acuminata Sharp-tailed Sandpiper	Possible	-	-	-	-	✓	-	✓
Calidris canutus Red Knot	Possible	-	-	-	-	✓	-	✓
Calidris ferruginea Curlew Sandpiper	Possible	-	-	-	-	✓	-	✓
Calidris ruficollis Red-necked Stint	Possible	-	-	-	-	✓	-	✓
Calidris tenuirostris Great Knot	Possible	-	-	-	-	✓	-	✓
Calonectris leucomelas Streaked Shearwater	Unlikely	-	-	-	-	-	-	✓
Charadrius leschenaultii Greater Sand Plover	Possible	-	-	-	-	✓	-	✓
Charadrius mongolus Lesser Sand Plover	Confirmed during EIS surveys	-	-	-	-	✓	-	✓
Charadrius veredus Oriental Plover	Possible	-	-	-	-	✓	-	✓
Coracina tenuirostris melvillensis Melville Cicadabird	Unlikely; out of range	-	-	-	-	-	-	-
Cuculus saturatus Oriental Cuckoo	Likely	✓	✓	✓	✓	-	✓	✓
Egretta sacra Eastern Reef Egret	Confirmed during EIS surveys	-	-	-	-	✓	-	✓
Fregata minor Great Frigatebird	Confirmed during EIS surveys	-	-	-	-	✓	-	✓
Fregata ariel Lesser Frigatebird	Confirmed during EIS surveys	-	-	-	-	✓	-	✓
Gallinago hardwickii Latham's Snipe, Japanese Snipe	Likely	-	-	-	✓	✓	-	-
Glareola maldivarum Oriental Pratincole	Unlikely, out of range	-	-	-	-	-	-	-
Grus antigone Sarus Crane	Likely	-	-	-	✓	-	-	-
Haliaeetus leucogaster White-bellied Sea-Eagle	Confirmed during EIS surveys	-	✓	-	✓	✓	-	✓

Species	Likelihood of occurrence within Project area	Habitats						
		Darwin Stringybark Open Forest (RE 3.2.10c, 3.5.2, 3.5.11, 3.5.22c)	Riparian Gallery Forest/Alluvial Woodland (RE 3.3.5, RE 3.3.9 (excluding variant dominated by *Melaleuca leucadendra*), RE 3.3.21, 3.3.49b, 3.3.61)	Vine Forest on bauxite (RE3.5.4)	Paperbark Woodland and Wetland Swamps (RE 3.3.9 variant dominated by *Melaleuca leucadendra*, , 3.3.14a, 3.3.50a, 3.3.63, 3.3.64, 3.3.65, 3.7.3)	Foreshores, Tidal Flats, Beach (RE 3.2.3, 3.2.5a, 3.2.6a, 3.2.25)	Coastal Vine Forest (RE 3.2.2)	Mangrove and Estuary (RE 3.1.1a, 3.1.1c, 3.1.3, 3.1.5, 3.1.6, 3.3.60a)
Heteroscelus brevipes Grey-tailed Tattler	Possible	-	-	-	-	✓	-	✓
Hirundapus caudacutus White-throated Needletail	Confirmed during EIS surveys	✓	✓	✓	✓	✓	✓	✓
Hirundo rustica Barn Swallow	Possible	✓	✓	-	✓	✓	-	✓
Limnodromus semipalmatus Asian Dowitcher	Possible	-	-	-	-	✓	-	✓
Limosa lapponica Bar-tailed Godwit	Possible	-	-	-	-	✓	-	✓
Limosa limosa Black-tailed Godwit	Possible	-	-	-	-	✓	-	✓
Merops ornatus Rainbow Bee-eater	Confirmed during EIS surveys	✓	✓	✓	✓	✓	✓	✓
Myiagra cyanoleuca Satin Flycatcher	Confirmed during EIS surveys	-	✓	✓	✓	-	✓	✓
Numenius madagascariensis Eastern Curlew	Confirmed during EIS surveys	-	-	-	-	✓	-	✓
Numenius minutus Little Curlew, Little Whimbrel	Possible	-	-	-	-	✓	-	✓
Numenius phaeopus Whimbrel	Confirmed during EIS surveys	-	-	-	-	✓	-	✓
Pandion haliaetus Osprey	Confirmed during EIS surveys	✓	✓	-	✓	✓	✓	✓
Plegadis falcinellus Glossy Ibis	Confirmed during EIS surveys	-	-	-	✓	-	-	-
Pluvialis fulva Pacific Golden Plover	Possible	-	-	-	-	✓	-	✓
Pluvialis squatarola Grey Plover	Possible	-	-	-	-	✓	-	✓
Rhipidura rufifrons Rufous Fantail	Confirmed during EIS surveys	-	✓	✓	✓	-	✓	✓
Rostratula benghalensis s. lat. Painted Snipe	Unlikely, out of range	-	-	-	-	-	-	-
Sterna albifrons Little Tern	Confirmed during EIS surveys	-	-	-	-	✓	-	✓
Tringa nebularia Common Greenshank	Confirmed during EIS surveys	-	-	-	✓	✓	-	✓
Tringa stagnatilis Marsh Sandpiper	Confirmed during EIS surveys	-	-	-	✓	✓	-	✓
Xenus cinereus Terek Sandpiper	Possible	-	-	-	✓	✓	-	✓

The Great Frigatebird (*Fregata minor*) and Lesser Frigatebird (*Fregata ariel*) were observed to be common along the western coastline of the Project area during the December 2007, May 2008 and December 2008 survey events but were notably not observed during the May 2009 survey. Survey effort for the Great Frigatebird and Lesser Frigatebird included the extensive foot traverses and coastal survey tasks undertaken during targeted surveys for threatened species, as well as the comprehensive fauna survey undertaken over 48 nights which involved traversing hundreds of kilometres of the Project area, as detailed in **Table 7-12**. No roosts were observed within the Project area. The only known mainland roosts for these species occur in Weipa and individuals observed within the Project area are anticipated to come from these roosts. The coastal and beach habitats utilised by these species would not be directly affected by the Project other than construction of the proposed port. However, observations of these species in Weipa, and the location of the two roost sites in close proximity to the Weipa Port (north of Humbug Wharf), Weipa Airport, and active mining areas, indicates they are unlikely to be affected by operations.

Migratory Bird Species - Migration Paths

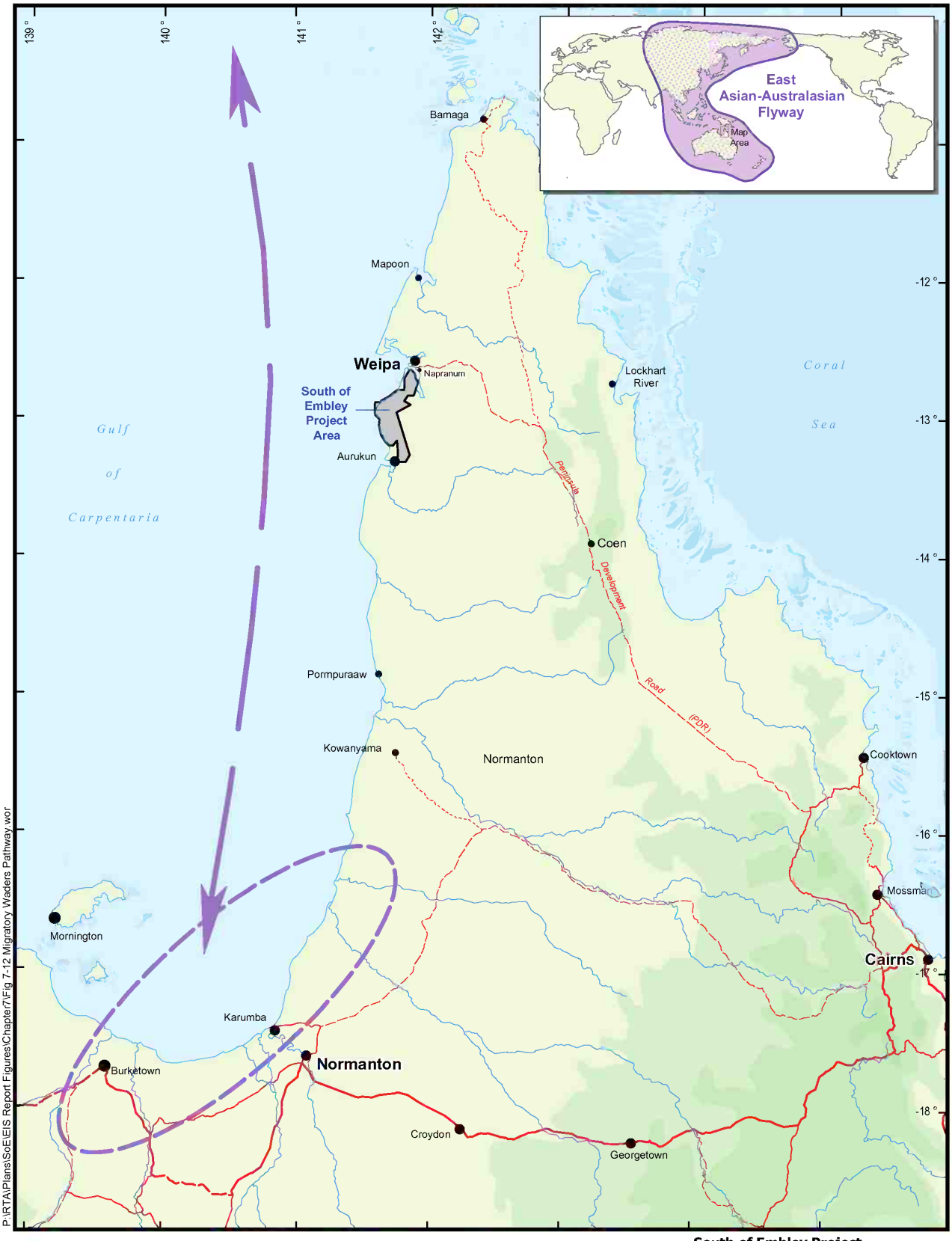
The Project area is situated within the East Asian-Australasian Flyway for trans-equatorial migratory waders. The Gulf of Carpentaria is regarded as one of the main access pathways for these species into Australia. The East Asian-Australasian Flyway is a general migratory route used by waders entering Australia from the northern hemisphere. Within the Gulf of Carpentaria, the south-east Gulf is recognised as a key site for waders with extensive wet season wetland habitats and tidal flats providing productive feeding grounds (Driscoll 2001). Tidal and wetland habitats within the Project area and along the Gulf coastline adjacent to the Project area do not provide extensive or productive feeding grounds for the species and although waders are present in these habitats they occur at relatively very low densities.

It is anticipated that the majority of waders that utilise the south east Gulf areas access these areas directly rather than work their way down the west coast of Cape York Peninsula (including the area covered by the Project). Consequently the Project area is not regarded as a significant component of the migratory pathway for migratory waders entering the Gulf of Carpentaria even though the Gulf waters in general form part of the East Asian-Australasian Flyway. A conceptual representation of the migratory pathway for waders is provided in **Figure 7-12**.

***Estuarine Crocodile* (*Crocodylus porosus*)**

The Estuarine Crocodile occurs in coastal and sub-coastal areas in northern Australia between Maryborough in Queensland and Broome in Western Australia. The Estuarine Crocodile is commonly encountered in the Weipa area, including the freshwater swamps and creek systems within the Weipa mining leases (Winter and Atherton 1985; Herbert 1995; Dames and Moore 1996). The tributaries that collectively form the Port Musgrave (Wenlock River – Tent Pole Creek) system and the Albatross Bay system surrounding Weipa (including the Embley–Hey estuary adjacent to the Project area) have been identified as the two most significant Estuarine Crocodile habitats in Queensland (Taplin *et al.* 1988).

The Estuarine Crocodile was recorded in all freshwater and marine habitats in the Project area, including freshwater swamps and streams well inland. Overall the species is widespread and numerous within the study area. Habitat utilisation appears to change seasonally with more use made of inland freshwater habitats during the wet season including the middle and upper reaches of groundwater-fed tributaries of Norman Creek and Coconut Creek. It appears that feral pigs represent a key feeding resource for the species within the freshwater habitats of the study area, especially groundwater-fed stream reaches along Norman Creek, Waterfall Creek and the Ward River – Coconut Creek systems.



P:\RTA\Plans\SoE\EIS Report Figures\Chapter7\Fig 7-12 Migratory Waders Pathway.wor

Township
River
Road/track
Notional migratory pathway
Main migratory wader habitat
in Gulf of Carpentaria

South of Embley Project

Fig. 7-12: Notional Migratory Waders Pathway

N

50 0 50 100km

Datum/Projection: GDA94/MGA Zone 54 Date: 13/12/2010

Several nests and hatchling aggregations were located within the Project area on the middle reaches of Norman Creek and the lower reaches of the Ward River. An unused nest was located on the middle reaches of Winda Winda Creek. All these locations comprised a nest constructed of Blady Grass (*Imperata cylindrica*) within eucalypt fringing woodland and adjacent to an incised stream channel at least 2m deep. Each of these stream reaches would be fully fresh during the breeding season with the nests located above the high flow level. It appears that these locations may be favoured for nesting over downstream paperbark wetlands due to the inundation of these latter areas by freshwater flows during the wet season. Preferential use of riparian areas upstream of the paperbark wetland zone for nesting was also identified by Traditional Owners (Henry Kelinda pers. comm.). However, these nests may be more vulnerable to predation by feral pigs and wild dogs due to the exposed nature of the nesting areas.

Foraging and nesting habitat for the Estuarine Crocodile occurs within the footprint of Dam C. While some local effects on breeding habitat would be associated with the construction of Dam C, extensive nesting and feeding habitat would remain unaffected elsewhere in the Project area. Given the widespread nature of the species within the Project area, impact to the overall reproductive rates and population of the species within the Project area would minimal. Consequently, it is also not anticipated that the regional population of Estuarine Crocodile would also be minimal.

The REs associated with the habitats that the Estuarine Crocodile occurs in within the Project area are REs 3.1.1a, 3.1.1c, 3.1.3, 3.1.5, 3.1.6, 3.3.9, 3.3.14a, 3.3.50a, 3.3.60a, 3.3.63, 3.3.64, 3.3.65, 3.5.22c. Refer to **Figure 7-6, Figure 7-6a, Figure 7-6b, Figure 7-6c** and **Figure 7-6d** for the location and distribution of these REs within the Project area. Refer to **Table 7-10** for data on the area of proposed disturbance of REs compared to the total area within the Project area, the Weipa Plateau subregion, and the Cape York Bioregion.

Known threats to the Estuarine Crocodile (DSEWPaC 2010) include incidental mortality from fishing nets and habitat destruction. The incidence of feral animals within the Estuarine Crocodile's habitat may also lead to increasing drainage and destroying vegetation within the habitat.

Estuarine Crocodile - Migration Paths

Adult individuals of the Estuarine Crocodile are capable of extensive movements throughout the landscape and are known to move over several hundred kilometres in some cases although it does not appear that large scale migratory movements are a regular occurrence. Localised migration associated with dispersal of individuals from breeding areas and accessing nesting and feeding habitats however is common (Qld EPA, 2007). Within the Project area, seasonal movements of individuals into freshwater habitats created by wet season rains and movement between proximal drainage systems have been observed and are likely to represent the predominant movements undertaken by the species in the area.

In contrast to the Wenlock Basin, the area between Weipa and Aurukun within which the Project area occurs is not regarded as key breeding habitat for the species (Magnusson *et al.* 1980), although observations of nests and juvenile individuals confirm that the species does breed within the Project area at least at low densities. Some of the smaller seasonal stream systems within the Project area appear unlikely to support successful nesting and hatching of young, but support adult individuals, implying that seasonal movement of individuals between stream systems occurs within the Project area. **Figure 7-13** illustrates the likely movement pattern of individuals of the Estuarine Crocodile between stream systems within the Project area.

In addition to movement between drainage systems, regular wet season movement of sub-adult and adult individuals from estuary to freshwater stream reaches and wetlands occurs. Numerous observations have been made of individuals and slides well upstream on seasonal systems including Ward River/Coconut Creek, Norman Creek, and Triluck/Winda Winda Creek. These movements seem to be undertaken to take advantage of the nesting and feeding habitats that become available within these freshwater habitats during the wet season as the estuarine reaches of streams within the Project area are not well suited to nesting due to the

occurrence of dense fringing mangroves or flooding of Melaleuca swamps, whereas the grassy woodland habitat along the banks of the incised freshwater stream reaches provide flood-free nesting locations and access to deep water habitat for mothers. Seasonally available feeding resources that are exploited by Estuarine Crocodiles in wet season freshwater habitats are underpinned by seasonal fish breeding activity in seasonal wetlands and most likely the availability of feral pigs and macropods adjacent to freshwater streams. **Figure 7-13** illustrates notional wet season movement paths within the Project area.

Migratory Species Summary

Overall, the migratory species confirmed as present, likely or possible to occur within the Project area predominantly utilise habitats that would be located within environmental buffers and not directly affected by mining. Small areas of riparian gallery forest and associated alluvial/colluvial woodland that provide potential habitat for species would be disturbed within the footprint of the water supply dam but less than 10% of this habitat type within the Project area would be affected.

7.15.6 Threatened Fauna – NC Act

The Queensland NCA provides for the listing and protection of threatened fauna in Queensland. The main threatened status categories for fauna under the NCA in order of increasing conservation significance are: "near threatened", "vulnerable" and "endangered". **Table 7-17** lists the threatened fauna species that:

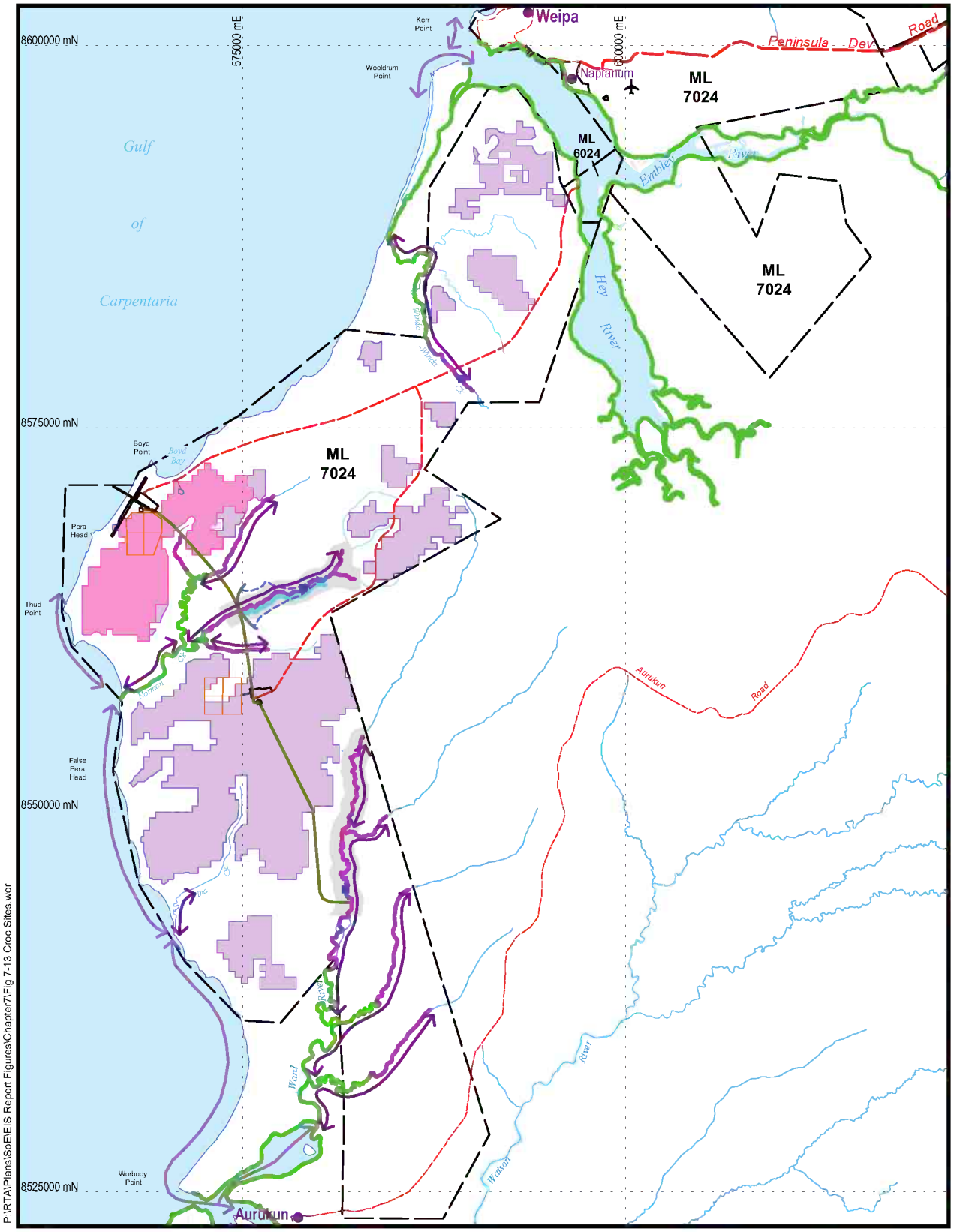
- have been previously recorded from within or in close proximity to the Project area (DERM 2009c, Queensland Herbarium 2009);
- have been found during surveys for the EIS;
- could potentially occur within the Project area based on EPBC database search; and
- could potentially occur with the Project area based on previous surveys in the Weipa area for RTA.

An assessment is provided of each species' potential occurrence in the Project area based on their habitat requirements and the condition and array of habitats available. The source of records for each species is indicated in **Table 7-17** along with the preferred habitat and known occurrence in the Weipa region.

Of the 20 NCA listed species identified as potential inhabitants of the Project area:

- 8 species have been confirmed as present in the Project area;
- 3 species are likely to occur in the Project area;
- 6 species possibly occur in the Project area; and
- 3 species are unlikely to occur in the Project area.

Profiles for these species are set out below but also refer to profiles in **Section 7.15.4** for species also listed under the EPBC Act.



P:\RTA\Plans\SoE\EIS Report Figures\Chapter7\Fig 7-13 Croc Sites.wor

RTA Mining Lease boundary
Township
Road/track
Freshwater dam
Tailings storage facility
Mining Years 1 -13
Mining Years 14 - 40
Surveyed for nests

Location of Estuarine Crocodile nest (2008/09)
Potential freshwater nesting habitat
Potential nesting habitat that would be disturbed by Dam C
Estuarine habitat
Seasonal and non-seasonal movements between drainage systems
Seasonal movements from estuary to freshwater wetlands and streams

Rio Tinto Alcan

South of Embley Project

Fig. 7-13: Estuarine Crocodile Habitat and Migratory Pathways

N

5 0 5km

Datum/Projection: GDA94/MGA Zone 54 Date: 13/12/2010

Table 7-17 Threatened Fauna Listed Under the NC Act

Species **Common Name** **(Source of Record)**	**NCA Status**	**Key Resources**	**Habitat**	**Likelihood of Occurrence within Study Area**
Birds				
Accipiter novaehollandiae Grey Goshawk (Wild)	NT	Large tall trees for nest sites. Availability of birds, small mammals, reptiles and insects	Occurs in a variety of more mesic forest types, particularly closed forests situated along coastal regions. Known from vine forest in the Weipa area	**Possible:** May occur in association with vine forest, riparian gallery forest and mangrove areas within the Project area, but not anticipated to be numerous.
Ephippiorhynchus asiaticus Black Necked Stork (Wild)	NT	Availability of prey items including fish, frogs, reptiles, crustaceans	Wetland areas including rivers, swamps and tidal areas with shallow pools and areas of deep permanent bodies of water	**Confirmed:** Frequently encountered in wetland, estuary and beach habitats throughout the Project area.
Erythrotriorchis radiatus Red Goshawk (Wild, epbc)	E	Trees >20m high for nesting within 1km of a watercourse or wetland. Abundance of passerine prey	Favours coastal and sub-coastal areas. Prefers a mix of vegetation types including tall open forest, woodland, lightly treed savannah and the edge of rainforest and riparian forests	**Possible:** The open forest, woodland and wetland habitats that occur throughout the Project area present nesting and feeding opportunities required by the species.
Erythrura gouldiae Gouldian Finch (Wild, epbc)	E	Annual and perennial grasses (especially Sorghum), a nearby source of surface water and unburnt hollow-bearing *Eucalyptus* trees for nesting	Inhabits open woodlands that are dominated by *Eucalyptus* trees and support a ground cover of Sorghum and other grasses, close to a reliable dry season water supply.	**Unlikely**: The species is recorded only rarely, and in small numbers, on the Cape York Peninsula. The Project area is located well outside the historical known range of the species although there are confirmed WildNet records from the Aurukun Council area. The current regime of frequent extensive fires is likely to affect the availability of favoured seed during the dry season over large areas of the Project area. In most years, fresh water does not persist across the vast majority of the Project area during the dry season, and it is likely that fresh surface water is totally absent following poor wet seasons. The species was not located during surveys in the most suitable habitat location within the Project area and consequently it is anticipated that the Project area does not support the species.
Esacus magnirostris Beach Stone Curlew (Wild)	V	Availability of vegetation near foraging areas for shelter. Availability of hind dune areas for breeding	Inhabits beaches, tidal flats, estuaries, reefs and rocky points	**Confirmed:** A number of pairs identified along the Project area Gulf coast and Hey–Embley estuary and expected to occur along beaches within the Project area wherever there are rocky points or hind dunes in close proximity.
Lophoictinia isura Square-tailed Kite (+)	NT	Availability of small passerine prey, including eggs and nestlings. Presence of large wooded areas in close proximity to breeding sites	Structurally diverse landscape of Eucalypt open forests and woodlands, scrubs, riparian gallery forest, estuaries; not generally encountered in more open habitats	**Likely:** Suitable open forest and woodland habitats occur throughout the Project area and present the nesting and feeding opportunities required by the species.
Ninox rufa meesi Rufous Owl (+)	NT	Availability of medium sized mammal or bird prey species including flying fox, parrots, cockatoos.	Inhabits rainforests, monsoon forest, wet forested gullies, and adjoining woodland	**Confirmed:** One individual recorded in riparian rainforest on Norman Creek. Otherwise not detected during extensive survey effort but anticipated to be present at least occasionally along all major drainages in the Project area including riparian gallery forest, Melaleuca swamp forest and mangrove forest on Norman Creek and Coconut Creek – Ward River system. Also

Species **Common Name** **(Source of Record)**	**NCA Status**	**Key Resources**	**Habitat**	**Likelihood of Occurrence within Study Area**
		Availability of large tree hollows for breeding		possibly in minor drainage systems such as Ina Creek as well as larger vine forest patches near the coast in proximity to mangrove areas such as Ina Creek dunal vine forest, and vine forest patches at Hey Point.
Numenius madagascariensis Eastern Curlew (Wild)	NT	Availability of invertebrate prey in moist substrate. No nesting behaviour recorded in Australia	Inhabits estuaries, tidal flats, mangroves, sand spits, saltmarsh and occasionally freshwater wetlands	**Confirmed:** Suitable estuarine, mud flat and sandy beach habitat is found within the Project area. The western Cape York region is a main entry point to Australia for trans-equatorial migratory waders.
Probosciger aterrimus Palm Cockatoo (Wild)	NT	Mature trees with suitably sized nesting hollows. Available fruits and nuts for feeding	Rainforest/mesic environs often associated with riparian localities	**Confirmed:** Recorded on the major drainages of Norman Creek and Ward River in association with riparian rainforest and wetland areas; also recorded from vine forest on bauxite, and Darwin Stringybark open forest. Breeding pairs located within a relatively substantial riparian rainforest patch located in Norman Creek within the footprint of Dam C.
*Rostratula australis** Australian Painted Snipe (epbc)	V	Vegetated ephemeral wetlands	Inhabits shallow vegetated ephemeral wetlands in coastal and inland areas	**Unlikely:** Project area is well beyond the known range of the species, which is not known to occur on Cape York Peninsula.
Sternula albifrons Little Tern (Wild)	E	Sandy foreshore nesting localities	Coastal environments, including beaches, sheltered inlets, estuaries, lakes, bays and harbours, especially where exposed sandbanks or sand spits occur	**Confirmed:** Observed on a sandbank roost near the mouth of Waterfall Creek. Likely to forage in coastal and estuary areas throughout the Project area. Limited potential breeding habitat present due to the prevalence of coastal bauxite cliffs, but the scattered dunal areas that are present could accommodate breeding colonies.
Tadornah radjah Radjah Shelduck (Wild)	NT	Availability of tree hollows for nesting. Availability of wetland invertebrate prey	Aquatic habitat types including coastal wetlands, rivers, flooded plains, marsh and swamp regions	**Confirmed:** Regularly observed in pairs or small groups in or near coastal wetlands and estuaries including Norman Creek, Ward River and Winda Winda catchments. Most numerous within the Ward River system on brackish wetlands and channels during the late dry season.
Tyto novaehollandiae kimberli Masked Owl (+)	V	Medium to large tree hollows for nesting, and availability of preferred small mammal prey	Prefers tall eucalypt forest and woodlands	**Possible:** Sections of tall closed forest on major drainages along Norman Creek and the Ward River provide potentially suitable habitat; however, the prevalence of the species may be limited by the apparent paucity of small mammal populations.
Mammals				
Notomys aquilo Northern Hopping Mouse (epbc)	V	Suitable sandy substrates for burrow excavation	In the Northern Territory part of its range, known to occur in Acacia scrub, heath and grasslands on sand dunes within coastal regions (Menkhorst and Knight 2004)	**Unlikely:** The type specimen of this species was recorded from Cape York Peninsula in 1867 but has since not been recorded in Queensland. Very little potential habitat within the Project area associated with isolated dunal systems.
Saccolaimus mixtus Papuan Sheath-tail Bat (Wild)	NT	Tall trees adjacent to open forests with suitable hollows for roosting	Tall open forests and woodlands (Churchill 1998)	**Likely:** Commonly recorded in Darwin Stringybark open forest north of Weipa by Dames and Moore (1996) and extensive potential habitat within the Project area. Cannot be definitively identified from Anabat analysis but some call sequences from a variety of habitats, recorded during field surveys, were tentatively credited to the species.

Species **Common Name** **(Source of Record)**	**NCA Status**	**Key Resources**	**Habitat**	**Likelihood of Occurrence within Study Area**
Bare-rumped Sheathtail Bat *Saccolaimus saccolaimus nudicluniatus* (Wild)	E	Long deep tree hollows for roosting. Availability of flying insect prey.	Known habitats on Cape York include riparian forest and vine forest and adjacent woodland, including Darwin Stringybark dominated habitats. Potential habitat comprises REs, 3.2.10c, 3.3.5, 3.3.9, 3.3.21, 3.3.49b, 3.3.61, 3.5.2, 3.5.4, 3.5.11, 3.5.22c and 3.7.3 (Refer to **Figures 7-6** to **7-6d** for the locations of RE's within the Project area).	**Possible**: This species' habitat is poorly known. Records of the species from Iron Range and Coen indicate that it may favour riparian forest and vine forest and adjacent woodland including Darwin Stringybark dominated habitats. The species was found roosting in Darwin Stringybark at Iron Range. Based on this information, large areas of the Project area may be suitable for the species, especially in the vicinity of riparian gallery forest and vine forest patches, and potentially also deeper into the Darwin Stringybark woodland.
Sminthopsis archeri Chestnut Dunnart (+)	NT	Limited information available regarding the life history specifics of the species	Tall eucalypt woodlands and heathlands on red earth soils (Kutt 2008)	**Possible:** Records in synonymous eucalypt habitats to the north and south of the Project area indicate the possible presence of the species in Darwin Stringybark open forest, or ecotonal areas adjacent to streams, although small mammal densities are low within the Project area.
Spilocuscus maculatus Common Spotted Cuscus (+)	NT	Tall dense canopy structure situated near fruiting tree species	Lowland rainforests, mangrove margins, eucalypt and paper-bark open forests adjacent riparian strips (Winter and Leung 2008)	**Possible:** Riparian gallery and vine forest communities found on the Norman Creek and Ward River drainages represent potential habitat for the species. Vine forest on bauxite in the Hey Point area also provide potential habitat similar to that where the species has been recorded in the Weipa area. Apparently no recent knowledge of the species by Traditional Owners.
Reptiles				
Antaioserpens warro (a burrowing snake) (Wild)	NT	Availability of scincid lizards and suitably friable soil composition for burrowing activity	Sclerophyll forests and woodlands with a grassy understorey on sandy soils(Cameron and Cogger 1992)	**Likely:** Recorded in very close proximity (a few kilometres) to the Project area with a single specimen recorded from Beagle North Camp in the collection of the Queensland Museum (Cameron and Cogger 1992).
Crocodylus porosus Estuarine Crocodile (Wild)	V		A ubiquitous inhabitant of tropical watercourses including swamps, rivers and creeks. Will utilise monsoonal inundation to take advantage of prey opportunities in ephemeral localities	**Confirmed:** Presence in all freshwater and marine habitats in the study area including freshwater swamps and streams well inland. Overall, the species is widespread and numerous within the study area. Habitat utilisation likely to change seasonally with more use made of inland freshwater habitats during the wet season. Potential breeding habitat exists on the lower reaches of Norman Creek, Ward River and Winda Winda Creek, though more abundant in the Ward River system. Nests and hatchlings located on the lower Ward River and Norman Creek including within the footprint of Dam C.

Key to Source of Record codes:

epbc	Potential species from the EPBC database
Wild	Records from the WildNet database
+	Additional potential threatened species added to assessment based on local knowledge

Key to Status:

E	Endangered
V	Vulnerable
NT	Near Threatened

Grey Goshawk *(Accipiter novaehollandiae)*

The Grey Goshawk occurs in coastal and sub-coastal areas from southern Australia around the east coast to the Kimberley. The Grey Goshawk has been recorded in the Weipa area from riparian gallery forest, interfluvial vine forest patches, and nearby eucalypt woodland (Winter and Lethbridge 1995). In the Weipa area, this species is apparently dependent on interfluvial vine forest and other mesic vegetation, together with adjoining areas of ecotonal Darwin Stringybark open forest, to complete their overall habitat suite.

This species has not been recorded within the Project area but is likely to occur there given the abundance of similar habitat to known occupied areas immediately to the north. It is likely that, if present, the species would occupy predominantly vine forest, riparian gallery and mangrove areas. The Grey Goshawk has an affinity with mesic habitats and it is possible the large stream systems such as the Wenlock River and Archer River that link the western Cape area with the east coast forests provide dispersal corridors from east coast populations. The proximity of the Project area to the Archer River system increases the likelihood of the species being present. Potential riparian habitat occurs within the footprint of Dam C; however, the majority of potential riparian habitat and all vine forest areas would not be disturbed by mining or infrastructure, and the species were not located during surveys.

Black-necked Stork *(Ephippiorhynchus asiaticus)*

The Black-necked Stork occurs from southern NSW around the east coast to the Pilbara region. The Black-necked Stork is frequently encountered in the Weipa area in estuary and freshwater wetlands. Up to six individuals have been observed simultaneously on large freshwater wetlands in the Weipa area (Jason Searle pers. comm.).

The species was commonly encountered in the Project area in freshwater wetlands and estuary habitats with locality records from the Ward River, Norman Creek, Pera Head Wetland and Hey Point areas. The species is anticipated to be widespread in preferred estuarine and wetland habitats throughout the Project area. As Project related disturbances would not detrimentally affect preferred habitat types, no impacts are expected to the distribution and abundance of the Black-necked Stork in the Project area.

Beach Stone Curlew *(Esacus magnirostris)*

The Beach Stone Curlew occurs from Ballina on the east coast around the northern coastline to Exmouth in WA. The Beach Stone Curlew is well known from coastal habitats on Cape York Peninsula (Abrahams *et al.* 1995) and the species utilises a range of habitats including beaches, tidal flats, estuaries, reefs and rocky points. The species is usually absent from beaches adjacent to cliffs (Marchant and Higgins 1993) where the high tide floods the entire beach area. Similarly, the species nests in a shallow scrape in the sand at the back of the beach so requires areas of beach for breeding where the back of the beach is not inundated by tides.

Within the Project area the Beach Stone Curlew was recorded from numerous beach locations and is anticipated to occur on beaches within the Project area in the vicinity of stream mouths and rocky reefs where dune systems occur. Such suitable habitats are scattered along the western coastline of the Project area and occur within the intermittent stretches of coastal habitat included within the Project area along the Embley and Hey estuaries. The beach area to be traversed by the port loading facility is not regarded as potential habitat for the species. The area where the ferry terminal would be located on the Hey River supports the species but habitat would not be substantially affected in this area.

Square-tailed Kite *(Lophoictinia isura)*

The Square-tailed Kite has been recorded from throughout Australia apart from the arid centre and Nullarbor region. The Square-tailed Kite has previously been recorded for the open forests and woodlands of the Weipa region, including in Darwin Stringybark open forest on the bauxite plateau (Winter and Atherton 1985; Thomas 2004). This species has also been recorded in post-mining regeneration, although is expected to be reliant on adjoining areas of mature woodland habitat for suitable nesting habitat.

This species has not been recorded within the Project area but is likely to occur given the availability of suitable Darwin Stringybark, riparian, wetland and coastal habitats. The species was not located in proposed infrastructure areas during targeted surveys.

Rufous Owl *(Ninox rufa meesi)*

The Cape York race of the Rufous Owl occurs along the east coast of Cape York Peninsula and in the Weipa region. The eastern race of the species extends down the east coast to Rockhampton. The Rufous Owl has been recorded in the Weipa area from riparian gallery forest, interfluvial vine forest patches, and nearby eucalypt woodland (Winter and Atherton 1985, Dames and Moore 1996, Winter and Lethbridge 1995). The Rufous Owl was recorded within the Project area in a patch of riparian rainforest on Norman Creek. This patch is the largest riparian rainforest area (7.2ha) identified within the Project area and occurs within a mosaic of habitats including paperbark wetland, riparian gallery forest and alluvial/colluvial woodlands.

The species requires large tree hollows within its preferred habitats for nesting and these are available, though not abundant, within large Melaleucas and Swamp Mahogany (*Lophostemon suaveolens*) in riparian and wetland habitats, and large canopy trees in rainforest and vine forest. Given the relatively significant size of the rainforest area where the species was recorded and the presence of tree hollows of suitable size, it is possible the species utilises the area for breeding. This same rainforest area was used by Palm Cockatoos (a similar sized hollow utilising species) for breeding in 2008–09 indicating the suitability of the area for large hollow nesting species.

Otherwise, the Rufous Owl was not detected during extensive survey effort throughout the Project area but is anticipated to be present at least occasionally along all major drainages in the Project area including riparian gallery forest, Melaleuca swamp forest and mangrove forest on Norman Creek and the Coconut Creek – Ward River system. The species possibly also utilises minor drainage systems such as Ina Creek as well as larger vine forest patches near the coast in proximity to mangrove areas such as Ina Creek dunal vine forest, and vine forest patches in the Hey Point area.

The riparian gallery forest area where the species was recorded occurs within the footprint of Dam C; however, the majority of potential wetland and riparian gallery forest habitat for the species would not be disturbed for mining or infrastructure, and none of the potential vine forest habitat for the species would be disturbed by mining or infrastructure.

Eastern Curlew *(Numenius madagascariensis)*

The Eastern Curlew is known from all coastal areas of continental Australia. The Eastern Curlew has previously been recorded in coastal estuary and foreshore habitats adjoining the Weipa mining lease areas (Dames and Moore 1996). Abrahams *et al.* (1995) suggest there are no major feeding sites for this species on the Cape, yet these areas may be important resting areas for migrating shorebirds.

The eastern Curlew was observed within the Project area in the Boyd Bay area during the 2006 preliminary survey. The coastline areas of the Project area probably do not provide extensive foraging areas for the species but may provide important stop-over locations for migrating individuals (Abrahams *et al.* 1995). It is anticipated the species would utilise beach habitats along the Gulf coast of the Project area, and estuary habitats associated with the Embley–Hey, Norman Creek, Ina Creek and Ward River systems. The preferred intertidal habitat of this species would not be affected by mining or infrastructure development apart from minimal disturbance associated with the proposed port and the Hey River barge/ferry terminal.

Palm Cockatoo *(Probosciger aterrimus)*

The range of the Palm Cockatoo comprises northern Cape York Peninsula north of Pompuraaw and Princes Charlotte Bay. The Palm Cockatoo is frequently encountered in the Weipa area, including within the town limits of Weipa township, but is most often encountered in riparian gallery forest, interfluvial vine forest patches, and nearby eucalypt woodland. The Palm Cockatoo was recorded from several locations in the Project area comprising vine forest on

bauxite near Hey Point, riparian gallery forest along Norman Creek and Ward River, and Melaleuca swamp on the Ward River. The records from Norman Creek include at least two breeding pairs attending hollows in a relatively large area (7.2ha) of riparian gallery rainforest within the footprint of the proposed Dam C impoundment.

It is likely the species utilises most areas of vine forest (including coastal vine forest), riparian gallery forest and Melaleuca wetland within the Project area and adjacent Darwin Stringybark open forest. The species would traverse extensive areas of Darwin Stringybark open forest to access these preferred habitat areas. The Project-related disturbance would disturb known nesting sites of the Palm Cockatoo in the Dam C footprint, although the majority of preferred habitats areas would not be disturbed by the Project.

Little Tern *(Sternula albifrons)*

The Little Tern is recorded from coastal areas from Adelaide along the south-east, east and north coasts of Australia to Exmouth in Western Australia. The Little Tern is regularly recorded in low numbers at foreshores, estuaries and coastal margins around Weipa. An important breeding colony for Little Tern is located north of the Pennefather River mouth (approximately 50km north of the Project area), indicating that the coastline north of the Project area is important for this species (Abrahams *et al.* 1995).

Within the Project area several Little Terns were observed with other shorebirds on a sandbank roost near the mouth of Waterfall Creek. The species is likely to forage in coastal and estuary areas throughout the Project area.

The species breeds in back beach environments between the high tide mark and dune vegetation (Garnett and Crowley 2000) with a naturally high rate of breeding failure rate due to natural stochastic events such as high tides, storm surge and expansion of dune vegetation, and predation from a range of feral and native animals. Limited potential breeding habitat is present within the Project area due to the prevalence of coastal bauxite cliffs, but the scattered dunal areas that are present could accommodate breeding colonies. The only coastline and estuarine developments are associated with the proposed port and the barge/ferry terminals, which are outside of preferred breeding environments for the Little Tern.

Radjah Shelduck *(Tadorna radjah)*

The Radjah Shelduck occurs between Maryborough in Queensland to the Kimberley in Western Australia, although it is now uncommon south of Cape York Peninsula. The Radjah Shelduck has previously been recorded from freshwater wetland habitats in the Weipa area (Winter and Atherton 1985), and is also known to utilise estuary and brackish wetlands. Radjah Shelduck were regularly observed in pairs or small groups in near coastal wetlands and estuaries within the Norman Creek, Ward River and Winda Winda catchments. The species was observed to be most numerous within downstream reaches of the Ward River on brackish wetlands and channels during the late dry season. The species is anticipated to occur extensively in preferred habitat situations throughout the Project area. The preferred habitat of this species would not be affected by mining or infrastructure development.

Papuan Sheath-tailed Bat *(Saccolaimus mixtus)*

The Papuan Sheath-tailed Bat is known from northern Cape York Peninsula in the Weipa and Iron Range areas and on Torres Strait islands and New Guinea. The Papuan Sheath-tailed Bat has been recorded in low numbers in the Weipa area within Darwin Stringybark open forest habitat (Winter and Atherton 1985, Richards and Thompson 1995).

Extensive areas of suitable Darwin Stringybark open forest habitat occur within the Project area. This species has been tentatively recorded within the Project area; however, it is not possible to positively identify the species from Anabat recordings as there are no reliable reference calls available for the species (Greg Ford pers. comm.). The tentative record of the species was made on the basis of Anabat recordings that matched the anticipated ultrasonic call characteristics of the species and exhibited slight differences to the calls of *Saccolaimnus flaviventris* with which the species is most likely confused. No individuals were trapped in Harp Traps during targeted surveys.

It is likely the species is present within the Project area, especially in Darwin Stringybark open forest throughout the Project area. Areas of Darwin Stringybark open forest would be affected by mining and to a lesser extent infrastructure development.

Chestnut Dunnart *(Sminthopsis archeri)*

The Chestnut Dunnart is known only from a few specimens from the lower Archer River, Iron Range and Mapoon areas on northern Cape York Peninsula and in New Guinea. The Chestnut Dunnart was recorded in low numbers in earlier surveys of the Weipa area (Winter and Atherton 1985), but has not been recorded in several subsequent surveys. The Chestnut Dunnart appears to be sparsely and patchily distributed, potentially over a wide area of open forest and woodland throughout the bioregion. The known distribution of the species is restricted to a few, isolated records (Winter and Alford 1999) including the lower Archer River near Aurukun. Although little qualitative data exists, it is plausible that changes in fire frequency and intensity over the past few decades may be responsible for the decline in the Chestnut Dunnart.

Records of the species in synonymous eucalypt habitats to the north and south of the Project area indicate the possible presence of the species within the Project area in Darwin Stringybark open forest, or ecotonal areas adjacent to streams, although small mammal densities are low within the Project area and any occurrence of the species is likely to be patchy. Darwin Stringybark open forest would be disturbed by mining, and smaller areas of stream habitats occur within the footprint of Dam C although the species was not located in these areas during field surveys.

Common Spotted Cuscus *(Spilocuscus maculatus)*

The Common Spotted Cuscus occurs on northern Cape York Peninsula north of the Coen and Archer River areas. The Common Spotted Cuscus was recorded in low numbers in earlier surveys of the Weipa area (Winter and Atherton 1985), but has not been recorded in several subsequent surveys. The Spotted Cuscus is considered a relictual species and is largely restricted to riparian gallery forest and interfluvial vine forest (Abrahams *et al.* 1995; Winter and Lethbridge 1994), with the known distribution of the species restricted to a few isolated records (Winter and Alford 1999). Although little qualitative data exists, it is plausible that changes in fire frequency and intensity over the past few decades may be responsible for the apparent decline in the species.

Ample suitable habitat for the species occurs in the Project area; however, substantial survey effort in these areas comprising extensive spotlight traverses did not locate any individuals. Riparian gallery forest and vine forest along the Norman Creek and Ward River drainages represent potential habitat for the species, with vine forest on bauxite in the Hey Point area also providing potential habitat similar to that where the species has been recorded in the Weipa area. There does not appear to be any recent knowledge of the species in the Project area by Traditional Owners.

The Common Spotted Cuscus possibly occurs in the Project area but at very low densities and in restricted localities. Minor areas of riparian gallery forest habitat occur within the footprint of Dam C, although the species was not located in this area during targeted surveys.

***Antairoserpens warro* (a burrowing snake)**

Antairoserpens warro occurs between Townsville and the Jardine River on northern Cape York Peninsula. *Antairoserpens warro* is a nocturnal burrowing snake known from three records in the Weipa region. These include two museum specimens for eucalypt open forest and woodland habitat (Cameron and Cogger 1992) near Mapoon and just outside the Project area near Beagle Camp, and a third record from previously mined and regenerating woodland habitat at Weipa.

Despite trapping survey and active searches for the species it was not located within the Project area; however, it is anticipated that it has a patchy distribution within Darwin Stringybark open forest and upper tributary riparian areas within the Project area.

Areas of Darwin Stringybark open forest would be disturbed for mining, although targeted surveys in mining and infrastructure areas did not locate the species.

Estuarine Crocodile *(Crocodylus porosus)*

Breeding habitat for the Estuarine Crocodile (*Crocodylus porosus*) occurs within the footprint of the water supply dam. This is discussed in more detail in **Section 7.15.5** above.

7.15.7 Other Species of Conservation Significance

There are a number of other fauna species known to occur in the Weipa region that are not formally listed under state or federal nature conservation legislation but are considered to be of conservation significance for the following reasons:

- fauna with "Near threatened", poorly conserved, declining or insufficiently known populations and/or distributions, as acknowledged in relevant assessments or action plans (IUCN 2008);
- "intrusive" fauna with limited distribution on Cape York but also occurring in New Guinea, and subsequently considered recent arrivals to the Australian continent (Abrahams *et al.* 1995); and
- fauna species with populations endemic to the Cape York Bioregion.

A summary explanation of the significance of each of these fauna species is provided in **Table 7-18**.

Of these species, the detection of the Spotted Whistling Duck (*Dendrocygna guttata*) in the Ward River Estuary downstream of the Project area is particularly significant. This species has only been recorded within Australia from a handful of locations on Cape York, including settling ponds at the Weipa Sewage Treatment Plant. The species is currently listed internationally (IUCN 2008) as "Least concern" and has no significant conservation status under Australian legislation.

However, the occurrence of the species in the Ward River Estuary downstream of the Project area represents the largest recorded aggregation of the species on continental Australia and is of significance. It is possible the species also occurs within other estuary areas both within and adjacent to the Project area. None of the fauna habitats in estuary areas likely to be utilised by the species would be adversely affected by the Project.

Of the remaining species, all apart from the Brown Treecreeper (*Climacteris picumnus melanotis*) utilise habitats that would not be adversely affected by mining or infrastructure. The Brown Treecreeper is a species that typically occupies eucalypt woodland communities, such as the Darwin Stringybark open forest present in the Project area. This species has declined to less than 50% of its former distribution and was not detected within the Project area, although it may be present in low densities and restricted areas. Potential habitat for the species occurs within the mining area, although it was not recorded during field surveys.

Table 7-18 Other Significant Fauna Species of the Weipa Region

Common Name	Scientific Name	IUCN	Action Plan	Rationale for Significance	Likelihood of occurrence within study area	Habitats						
						Darwin Stringybark Open Forest	Riparian Gallery Forest	Vine Forest on bauxite	Paperbark Woodland and Wetland Swamps	Foreshores, Tidal Flats, Beach	Coastal Vine Forest	Mangrove and Estuary
Amphibians												
Torrid Froglet	*Crinia remota*	LC	-	Endemic to Cape York	Confirmed during EIS surveys	-	✓	-	✓	-	-	-
Ground Frog	*Litoria nigrofrenata*	LC	-	Endemic to Cape York	Confirmed during EIS surveys	✓	✓	-	✓	-	-	-
a species of frog	*Sphenophryne gracilipes*	LC	-	Endemic to Cape York	Confirmed during EIS surveys	✓	✓	-	✓	-	-	-
Torres Gungan	*Uperoleia mimula*	LC	-	Endemic to Cape York	Confirmed during EIS surveys	-	✓	-	✓	-	-	-
Wood Frog	*Rana daemeli*	LC	-	Endemic to Cape York	Confirmed during EIS surveys	-	✓	-	✓	-	-	-
Reptiles												
a species of blind snake	*Ramphotyphlops chamodracaena*	-	-	Endemic to Cape York	Confirmed during EIS surveys	✓	-	-	-	-	-	-
Pelagic Gecko	*Nactus pelagicus*	-	-	Endemic to Cape York	Confirmed during EIS surveys	✓	✓	✓	-	✓	✓	-
a species of skink	*Glaphyromorphus nigricaudis*	-	-	Endemic to Cape York	Confirmed during EIS surveys	-	✓	-	✓	-	✓	-
a species of gecko	*Pseudothecadactylus australis*	-	-	Endemic to Cape York	Confirmed during EIS surveys	-	-	-	-	-	✓	-
Brown-headed Snake	*Furina tristis*	-	-	Endemic to Cape York	Confirmed during EIS surveys	-	-	✓	-	-	✓	-
a species of skink	*Ctenotus essingtonii brevipes*	-	-	Localised, disjunct population	Confirmed during EIS surveys	✓	-	-	-	-	-	-
Birds												
Australian Bustard	*Ardeotis australis*	NT	NT(c)	Declined in abundance (to less than 50% of former range)	Confirmed during EIS surveys	✓	-	-	-	-	-	-
Spotted Whistling Duck	*Dendrocygna guttata*	LC	-	intrusive species; rare in Australia	Confirmed during EIS surveys							✓
Brown Treecreeper	*Climacteris picumnus melanotis*	LC	NT(c)	Declined in abundance (to less than 50% of former range)	Possible	✓	-	-	-	-	-	-

Common Name	Scientific Name	IUCN	Action Plan	Rationale for Significance	Likelihood of occurrence within study area	Habitats						
						Darwin Stringybark Open Forest	Riparian Gallery Forest	Vine Forest on bauxite	Paperbark Woodland and Wetland Swamps	Foreshores, Tidal Flats, Beach	Coastal Vine Forest	Mangrove and Estuary
Papuan Frogmouth	*Podargus papuensis*	LC	-	Endemic to Cape York	Confirmed during EIS surveys	✓	✓	✓	✓	-	✓	✓
Yellow-billed Kingfisher	*Syma torotoro*	LC	-	Endemic to Cape York	Possible	-	✓	✓	✓	-	✓	✓
Red-bellied Pitta	*Pitta erythrogaster*	LC	-	Endemic to Cape York	Unlikely; east coast species	-	-	-	-	-	-	-
Magnificent Riflebird	*Ptiloris magnificus*	LC		Endemic to Cape York	Confirmed during EIS surveys	-	✓	✓	✓	-	✓	-
Trumpet Manucode	*Manucodia keraudrenii*	LC	-	Endemic to Cape York	Possible	-	✓	✓	-	-	✓	-
Fawn-breasted Bowerbird	*Chlamydera cerviniventris*	LC	-	Endemic to Cape York	Unlikely; east coast species	-	-	-	-	-	-	-
Black-backed Butcherbird.	*Cracticus nigrogularis*	LC	-	Endemic to Cape York	Confirmed during EIS surveys	-	✓	✓	✓	-	✓	✓
Mammals												
Cape York Melomys	*Melomys capensis*	LR(LC)	-	Endemic to Cape York	Confirmed during EIS surveys		✓				✓	
Cape York Rat	*Rattus leucopus*	LR(LC)	-	Endemic to Cape York	Unlikely; east coast species							

Key to Status:

LC Least concern
LR Lower risk
NT Near threatened
(c) Declined in abundance by >50%

IUCN 2008 IUCN Red List of Threatened Species
Action Plan Relevant Action Plans for each taxonomic group (Cogger *et al.* 1993; Lee 1995; Maxwell *et al.* 1996; Tyler 1997; Duncan *et al.* 1999; Garnett and Crowley 2000)

7.15.8 Culturally Important Fauna

A number of species favoured for hunting occur within the Project area. Wallabies/kangaroo are present in moderate numbers, comprising Agile Wallaby (*Macropus agilis*), Antilopine Wallaroo (*Macropus antilopinus*) and the Eastern Grey Kangaroo (*Macropus giganteus*) which is rarely encountered within the Project area. The Agile Wallaby tends to be more abundant in association with coastal, stream, wetland and vine forest habitats throughout the Project area but can also be observed in Darwin Stringybark woodland on the bauxite plateau. The Antilopine Wallaroo favours the extensive Darwin Stringybark woodland that occurs across most of the Project area on the bauxite plateau with solitary individuals or groups of up to six individuals commonly observed.

The Emu is not common in the Project area but was observed in a variety of habitats including Darwin Stringybark woodland. The Emu (*Dromaius novaehollandiae*) probably favours the more open woodland habitats occurring to the east of the Project area. The Magpie Goose (*Anseranas semipalmata*) is a key hunting species whose presence and location within the Project area varies according to seasonal conditions. The Magpie Goose was not observed in the very large numbers that are known from extensive wetland aggregations occurring to the south of Aurukun and north of Weipa, but does occur on seasonally inundated marine plains where stands of 'Bulkuru' spike rush (*Eleocharis dulcis*) establish following wet season rains (veg. unit 12f). It does not appear that the Project area is particularly significant in terms of providing dry season habitat for the species, with most records of Magpie Geese after the wet season and into the dry season comprising flocks flying at night over the Project area.

Freshwater turtles are apparently very scarce within the Project area, with no individuals recorded during terrestrial or aquatic fauna surveys. It appears that the low nutrient and mineral status within the groundwater-fed aquatic ecosystems that dominate the Project area do not provide adequate conditions for turtles, although individuals may be present within dune swamps or tree swamps.

Whilst the freshwater reaches of streams in the Project area support a limited diversity of fish, favoured eating species such as Baramundi and Mangrove Jack and a variety of other large species are abundant in the estuaries of the three main stream catchments within the Project area (Triluck/Winda Winda Creek, Norman Creek, Ward River). Individuals of these species were frequently observed from the bank, swimming in schools in the clear post wet season waters of the Ward River.

Further discussion of impacts to and mitigation measures for culturally important fauna is provided in **Section 11.1.4**.

7.16 Overview of Potential Impacts on Terrestrial Fauna

Direct impacts on fauna habitats are linked to removal of vegetation to accommodate mining and Project infrastructure and these impacts have been described in **Section 7.17**. Construction and operational phases of the Project may potentially impact some fauna within certain habitats. Clearing for mining would affect only Darwin Stringybark open forest habitat, whilst disturbance of vegetation for certain infrastructure (e.g. the water supply dam) would affect a selection of habitat types including Darwin Stringybark open forest, riparian gallery forest, and a small area of paperbark wetland. The areas of different REs to be directly disturbed by the Project, based on interaction with the 40-year mine plan, proposed Dam C, and the location of Project infrastructure, are summarised in **Table 7-10**.

Secondary impacts on fauna habitats may occur during the operational phase of the Project, linked primarily to potential effects from altered hydrological regime due to mining activity and construction and operation of the water supply dam (refer **Section 7.10.1**). The introduction of exotic and weed flora, feral pig activity, and frequent fire regimes also pose a potential mechanism for impacts on fauna habitat within the Project area.

Alterations to the habitat landscape may affect the movement patterns of mobile fauna that need to move through the landscape to facilitate access to seasonal food resources,

reproductive activity, dispersal of young individuals, seasonal migratory movements, or access to refugial habitat patches following fire or other natural disasters.

The overall fauna community would be affected by the reduction in carrying capacity of the Project area due to removal of vegetation for mining activities. This effect would be mitigated to some extent by regeneration of mined areas, although regenerated habitats would take some time to develop and the rehabilitated landscape would differ from the original communities and provide altered habitat opportunities. Reduction in the carrying capacity of the area would result in concomitant reductions in the abundance of fauna within the Project area.

Impacts on threatened and migratory species would occur where lost habitat areas correspond with home ranges and/or habitats used by these individuals. The extent of this impact would depend on the potential for threatened fauna individuals to relocate or transfer activity to other suitable habitat areas. However, for sedentary individuals relocation away from lost habitat areas is unlikely. Of particular concern for threatened and migratory species is the potential for loss of nesting and breeding locations or key feeding areas, which may impact on reproductive success and the overall population of these species.

7.17 Potential Impacts and Mitigation Measures – Direct and Indirect Impacts on Fauna Communities

7.17.1 Potential Impacts

Habitat removal for Project development would result in some direct impacts on certain fauna communities. Impacts would comprise direct mortality of fauna through land clearing activities, and displacement of surviving fauna into surrounding areas. The displacement of individuals into surrounding habitat areas would also eventually result in additional mortality of fauna as surrounding areas are unlikely to accommodate extra individuals in the long term due to the limited availability of resources and the capacity for those resources to support a finite density of individuals. Eventually, fauna populations in surrounding undisturbed areas would re-equilibrate at the carrying capacity of the habitats present.

Table 7-19 summarises the approximate areas of major fauna habitats to be directly affected by the Project. All data in **Table 7-19** are based on predicted RE clearing extents detailed in **Table 7-10**. The Darwin Stringybark open forest habitat, which is present in the area to be developed for mining, would be most affected, with smaller losses of riparian and wetland areas due to establishment of the water supply dam and associated infrastructure. RE 3.3.9 is split over two major fauna habitats, with the variant dominated by *Melaleuca leucadendra* occurring in 'Paperbark Woodland and Wetland Swamps', and the remainder occurring in 'Riparian Gallery Forest/Alluvial Woodland'. The Project area data have been adjusted to reflect the presence of the variant, however information on the variant is not available for the Cape York Bioregion. A small area of foreshore habitat comprising dune and beach would be affected for construction of the port infrastructure but would be allowed to regenerate following construction. Several major habitat types would not be directly affected by the Project's activities.

Analysis of fauna survey data indicates that the riparian, wetland and vine forest habitats within the Project area together support a greater proportion of terrestrial vertebrate fauna diversity than the far more extensive Darwin Stringybark open forest habitat. These non Darwin Stringybark habitats are consequently regarded as more significant for fauna diversity. Protection of these non Darwin Stringybark habitats would be important to limiting the effects of the Project on fauna biodiversity and would be preserved by development of an environmental buffer system.

Secondary impacts on fauna habitats may occur from hydrological change resulting from mining, operation of the water supply dam on Norman Creek, and water extraction from the Ward River (refer **Section 7.10.1**). These hydrological changes may have localised effects on riparian, wetland and estuary habitats.

Table 7-19 Area of Fauna Habitats to be Directly Impacted

Major Fauna Habitat	Approximate area to be affected (ha)	Total habitat area in Project area (ha)	Proportion of habitat area in Project area to be disturbed	Total area in Cape York Bioregion[1] (ha)	Proportion of area in bioregion to be disturbed[1]
Darwin Stringybark (*Eucalyptus tetrodonta*) Open Forest on Laterite (RE 3.5.2, 3.5.11, 3.5.22c)	29,150	91,187	32%	1,261,386	2.3%
Riparian Gallery Forest/Alluvial Woodland (RE 3.3.5, 3.3.9 (excluding variant dominated by *Melaleuca leucadendra*), 3.3.21)	150[2]	1,747[2]	8.6%[2]	139,446[3]	0.1%[3]
Paperbark Woodland and Wetland Swamps (RE 3.3.9 variant dominated by *Melaleuca leucadendra*, 3.3.14a, 3.3.49b, and 3.3.50a)	38.6[3]	3,242[3]	1.8%[3]	935,535[2]	<0.1%[2]
Foredune Habitat (RE 3.2.6a)	0.3	149	0.2%	1,731	<0.1%
Mangrove and Estuary (RE 3.1.1a, 3.1.1c, 3.1.3, 3.1.5, 3.1.6, 3.3.60a)	0.04	481	<0.01%	68,381	<0.01%

1. Adjusted with RTA ground survey data
2. Data excludes RE 3.3.9 variant dominated by *Melaleuca leucadendra*
3. Data includes RE 3.3.9 variant dominated by *Melaleuca leucadendra*

Impacts on the condition and extent of fauna habitats may also occur as a result of the potential introduction of weed flora, increased pig activity, and altered fire regimes within the Project area. These impacts are discussed in **Section 7.10.1** (for vegetation impacts) which identifies the need for appropriate management programs for fire, weeds and feral animals to minimise impacts on habitat.

Clearing of habitats for mining and infrastructure would also have some impacts on the way in which fauna can access feeding and shelter resources, and undertake feeding, reproductive, dispersal or migratory movements through the landscape. The proposed access road crossings of Winda Winda Creek and the southern branch of Norman Creek would produce a narrow gap (up to 40m wide) across groundwater-fed stream reaches with riparian gallery forest. These crossings may affect the ability of non-flying riparian fauna to move up and down the riparian corridor and would expose fauna to mortality through collision with vehicles.

7.17.2 Mitigation Measures

The primary mitigation measures for reducing the loss of fauna habitat are the same as proposed in **Section 7.9.2** for limiting the area of vegetation cleared for the Project. In summary these comprise:

- restrict clearing of vegetation for mining and infrastructure to the minimum required for the safe operation of mining equipment and infrastructure;
- avoid clearing vegetation outside of the mine plan/infrastructure footprint for infrastructure or purposes that could be accommodated within areas already disturbed by mining or to be disturbed by mining (e.g. borrow pits, laydown areas, access tracks);
- wherever possible, locate linear infrastructure – such as roads, tracks, pipelines, and power lines – in a single consolidated infrastructure corridor rather than several smaller corridors; and

- plan for clearing of vegetation and stripping of topsoil to occur as soon as practicable before mining to avoid redundant clearing of vegetation due to changes in the mine plan.

The direct impacts on fauna communities from habitat removal would be mitigated to a large extent by post-mining rehabilitation that seeks to establish a self-sustaining native vegetation community using appropriate local native tree, shrub and grass species from the pre-mining vegetation communities. However, post-mining rehabilitated areas are unlikely to support an equivalent diversity of fauna species as found in pre-mining habitats unless the full range of pre-mine microhabitats develops in the long term.

Monitoring of fauna communities in rehabilitated bauxite mine areas near Weipa indicates that a majority of pre-disturbance fauna would re-occupy the rehabilitated areas but a number of species are either absent or under-represented in rehabilitated areas (Winter and Alford 1999, Reeders and Morton 1983). In addition, the exact extent to which the areas are utilised by fauna is not well understood and there is evidence (Winter and Alford 1999, Reeders and Morton 1983) that rehabilitated areas may be used by many species as a component of an overall habitat suite that must also include undisturbed habitat areas, or that rehabilitated areas are annually recolonised by individuals (particularly frogs) from nearby undisturbed areas. Winter and Alford (1999) found that under-represented or absent fauna were predominantly those associated with mature trees and the microhabitats they provide including hollows and spouts for nesting and shelter, flaking bark and large canopies for foraging. **Table 7-20** summarises the colonisation success of different fauna groups within regenerated mine sites near Weipa.

The SoE rehabilitation program would incorporate aspects to maximise habitat diversity which in turn would maximise native fauna diversity in the post-mining landscape. It is anticipated that the proposed rehabilitation program for the Project would at least achieve a similar re-creation of fauna habitats and re-colonisation by native fauna to the ranges indicated in **Table 7-20**.

Table 7-20 Faunal Colonisation of Rehabilitated Mine Areas Near Weipa

	Species Recorded in Rehabilitated Areas as a percentage of total Species Occurring in Area					
Monitoring Study	**Mammals**	**Birds**	**Reptiles**		**Frogs**	**Overall**
			Lizards	Snakes		
Reeders and Morton 1983	55%	73%	86%	94%	94%	73%
Winter and Alford 1999	83%	80%	78%		94%	N/A

Manual trapping and relocation of fauna from mine development areas would not be undertaken as a mitigation measure for fauna mortality as the relocation of fauna into adjoining habitat areas would result in elevating fauna densities above the carrying capacity of the area which would be is unsustainable. Mortality of the relocated fauna or the resident fauna in the receiving habitat area would eventually occur as the population recedes to the carrying capacity of the area. To ensure the welfare of any injured animals found during mine activities, RTA would ensure that appropriate staff are trained or have access to trained professionals to handle injured animals or humanely destroy them.

Minimising disturbance to vine forests, riparian gallery forest and wetland habitats would be achieved via the environmental buffer system as proposed in **Section 7.9.2** for mitigation of impacts on sensitive vegetation types. The environmental buffer system is discussed in detail in **Section 7.9.2**, but in summary comprises a system of spatial buffers from sensitive vegetation types in which mining is excluded. The retained tract of undisturbed land within the buffer between mined bauxite areas and nearby riparian and wetland ecosystems would minimise changes to the groundwater hydrology and limit effects on nearby vegetation. The environmental buffer system would be a primary mitigation measure for edge effects and

hydrological effects on sensitive vegetation types, and would ensure hydrological changes would not significantly alter the overall availability or utilisation of habitats by fauna communities.

Impacts of habitat removal on the overall habitat landscape for fauna and in particular faunal movement patterns would be mitigated by retention of the coastal margin vegetation buffer and remnant vegetation not disturbed by the mine plan. Importantly, the main habitat corridors and conduit for fauna movement in the Project area are the natural drainage systems, and these would not be affected by clearing for mining. Development of the water supply dam on the southern tributary of Norman Creek would fragment this corridor, although adjacent remnant habitats would provide some opportunity for faunal movements. Furthermore, it has been observed at Ely Dam (north of Weipa) that establishment of a new water supply level would promote the establishment of a riparian gallery forest along the margins of the full supply level. While the extent to which this new gallery forest would emulate natural riparian gallery forest habitat is dependent on the operation of the impoundment and the periodicity of full supply water levels, it is likely that this newly established riparian gallery forest would provide some habitat continuity between riparian habitats upstream and downstream of the impoundment. The proposed environmental buffer system would protect habitats within the riparian corridors and maintain their faunal movement function.

Constructed access road crossings of Winda Winda Creek and the southern branch of Norman Creek would incorporate "dry culvert" cells to maintain habitat continuity along the riparian corridor apart from during periodic high flow events. These comprise culverts on either end of the crossing structure positioned above perennial streamflow levels so as to provide a passage opportunity for non-aquatic fauna beneath the crossing.

Rehabilitated mined areas would provide certain habitat values for native fauna and support faunal movement, but many species may require undisturbed habitats to provide full movement functionality.

The network of habitat preserved within environmental buffers and located outside of the proposed mining area provides a substantial system of habitat corridors between all minor and major drainage tributaries and isolated habitat types within the Project area. Of particular functionality is the band of habitat within the proposed environmental buffer that extends along the western coastline of the Project area, providing a linkage between the lower sections of the Gulf drainage systems and coastal habitats. This network of retained habitat would to a large extent maintain habitat functionality and the pre-disturbance faunal movement regime.

The proposed fire and feral animal management programs (refer **Section 7.10.2**) would provide positive outcomes for fauna in undisturbed habitats throughout the Project area by delivering enhanced habitat quality.

Periodic monitoring of targeted fauna communities shall be undertaken to monitor the condition and any trends in communities likely to be subject to indirect impacts such as hydrological changes, fire regime change, weeds and feral animals. Monitoring sites would be representative of the major habitats present and provide an appropriate seasonal and spatial coverage of the Project area. Monitoring sites would be established progressively as mining proceeds.

The mitigation measures described above would effectively minimise the potential impacts of the Project on the fauna community as outlined in **Section 7.17.1**.

7.18 Potential Impacts and Mitigation Measures – Impacts on Threatened Fauna

7.18.1 Potential Impacts

Mining Area

Of the 17 threatened fauna species either confirmed as present or assessed as possible or likely to occur in the Project area, Darwin Stringybark woodland on bauxite is considered suitable habitat for nine of these species, comprising:

- Red Goshawk;
- Square Tailed Kite;
- Palm Cockatoo;
- Rufous Owl;
- Masked Owl;
- Northern Quoll;
- Chestnut Dunnart;
- Bare-rumped Sheathtail Bat;
- Papuan Sheathtail Bat; and
- *Antairoserpens warro* (a burrowing snake).

The Red Goshawk has not been recorded from the Project area during numerous surveys but ample suitable habitat exists for the species. The Red Goshawk is anticipated to utilise Darwin Stringybark open forest as part of its extensive home range. If present, it is likely the species would establish a home range centred on a riparian, wetland or coastal locality but include extensive areas of Darwin Stringybark open forest. It is unlikely that progressive removal of Darwin Stringybark open forest for mining would significantly adversely affect any potentially occurring populations with respect to the availability of foraging areas as it is a highly mobile species that could access other habitat areas. Re-establishment of prey fauna within rehabilitated mine areas would reinstate potential foraging habitat in these areas, although the productivity in these areas is unlikely to be as high as for undisturbed habitat.

The species has a preference for nesting in tall trees within 1km of permanent water (Aumann and Baker-Gabb 1991, DEWHA 2009c, NPWS 2002), which suggests Darwin Stringybark woodlands within 1km of permanent water could be used for nesting. Consequently, it is possible that nests of the species could be within proposed mining areas. The Red Goshawk is listed as endangered under State legislation and vulnerable under Commonwealth legislation and therefore any adverse effect on the reproductive effort of the species could be regarded as a significant impact under the EPBC Act. Red Goshawk breeding pairs can use the same nest site in successive years (EPA 2006), therefore, clearing of an unoccupied nest could lead to reproductive disruption in subsequent breeding seasons (Mr. Greg Czechura pers. comm.) as the adult birds would have to select a site for and build another nest. More significantly, if a nest with eggs or chicks was disturbed during clearing, mortality of those individuals would occur plus potential disruption to the adults' subsequent breeding season.

Re-nesting by Red Goshawk after nests have failed or been cleared, or nesting in different areas seasonally to be closer to target prey is known to occur (refer **Section 7.15.4**). Aumann and Baker-Gabb (1991) reported that nests were placed at the top of trees in exposed areas, in dead trees, and in dead sections of living trees. Given these nesting habits and the frequency of cyclones in northern Australia, it is likely there would be some natural loss of nests or nest trees due to cyclones within the Project area, and intentional removal of nests during clearing would be analogous to natural nest attrition.

With respect to the likelihood of a nest of the species intersecting with mining area, consideration of the proposed mine plan for the Project indicates that for the large majority of the mid to lower reaches of the main drainage systems (Winda Winda Creek, Norman Creek and Ward River) the mining area is located more than 1km from permanent water or seasonally inundated wetlands or watercourses supporting riparian gallery forest.

This is also the case for the northern part of the Project area where the proposed mining area is almost exclusively located greater than 1km from permanent water or seasonally inundated wetlands or watercourses supporting riparian gallery forest. Consequently the probability of a nest intersecting with proposed mining areas is low. However, additional mitigation measures to avoid nest disturbance are proposed.

The Square Tailed Kite has not been recorded in the Project area, but is considered likely to occur. This species is a specialised predator of the tree canopy preying on small birds, nestlings and insects; if present, the Square Tailed Kite would utilise a habitat focussing on riparian and wetland areas where these prey resources are most abundant, although Darwin Stringybark open forest habitat is also likely to be utilised to a lesser extent. With respect to foraging habitat, the Square Tailed Kite is a highly mobile species that would be able to access un-mined areas to compensate for any lost Darwin Stringybark open forest foraging habitat within the mine area, and rehabilitation areas would also reinstate foraging habitat to some extent.

The species may also nest in Darwin Stringybark open forest. However, nesting is anticipated to occur within proximity to a diversity of habitats for foraging; thus, nesting deep within Darwin Stringybark open forest habitat is unlikely. As discussed for the Red Goshawk, very little of the proposed mining area occurs in close proximity to the riparian and wetland complexes occurring on the mid to lower reaches of the main drainage systems. Therefore, it is unlikely that the Square Tailed Kite would be adversely affected by mining area development.

For the Palm Cockatoo, Rufous Owl and Masked Owl, Darwin Stringybark open forest habitat represents only peripheral habitat to the main habitat areas for these species, which comprise riparian, wetland and vine forest habitats. The environmental buffer system would retain peripheral areas of Darwin Stringybark open forest habitat adjacent to the key habitat areas. None of the key habitats would be affected by mining; consequently, impacts on the species related to development of the mining area are not anticipated.

The Northern Quoll, Chestnut Dunnart, Bare-rumped Sheathtail Bat, Papuan Sheath-tail Bat and *Antairoserpens warro* were not confirmed to be present within the Project area during surveys but, if present, are likely to utilise Darwin Stringybark open forest as part of their overall habitat suite. However, these species are known to utilise other habitats such as riparian gallery forest and alluvial/colluvial woodland, and vine forest and consequently would not be confined to habitat within the mining area. While approximately 32% of Darwin Stringybark open forest within the Project area would be disturbed by mining (refer **Table 7-19**) other habitats used by the species occur outside of the mining area and would be largely unaffected by the Project. Consequently, it is unlikely that development of the mining area would have a substantial adverse effect on the species.

Infrastructure Development

Disturbance of fauna habitats from infrastructure development would be minimal given the location of significant portions of infrastructure (e.g. tailings storage facilities) in mined areas. **Table 7-19** details the overall disturbance to habitats from the Project. Disturbance of habitat due to infrastructure development would comprise the following:

- Approximately 1,769ha of Darwin Stringybark open forest (RE 3.5.2) would be disturbed in the vicinity of the proposed water supply dam, tailings storage facilities, beneficiation plants, stockpiles, and roads (refer **Table 7-10**).
- Approximately 35ha of Melaleuca wetland habitat (part of RE 3.3.9) would be affected by dam and infrastructure corridor development for the water supply dam (Dam C). Of this, a small area (7.5ha) is adjacent to the wall, while the remainder lies within the impoundment area. These wetlands comprise seasonal shallow freshwater swamps with a closed canopy and consequently no open water or macrophyte beds.
- Approximately 150ha of riparian gallery forest and associated alluvial/colluvial woodland would be disturbed within the footprint of Dam C and at access road crossings of upper tributaries of Norman Creek and Winda Winda Creek. This comprises approximately 8.6% of the overall extent of these habitats within the Project area.
- A very small area (0.3ha) of foreshore and beach strand habitat would be affected beneath the conveyor deck for the proposed port facility. However, the deck would span the area, with disturbance confined to the footings of support piers.

Of the 17 threatened fauna species either confirmed as present or assessed as possible or likely to occur in the Project area, construction of infrastructure may impact suitable habitat for 13 of these species.

These species comprise:

- Grey Goshawk;
- Red Goshawk;
- Square Tailed Kite;
- Rufous Owl;
- Palm Cockatoo;
- Masked Owl;
- Northern Quoll;
- Bare-rumped Sheathtail Bat;
- Papuan Sheath-tail Bat;
- Common Spotted Cuscus;
- Chestnut Dunnart;
- *Antairoserpens warro* (a burrowing snake); and
- Estuarine Crocodile.

Potential impacts on fauna associated with Darwin Stringybark open forest within the proposed mining area are discussed in the previous section, and impacts would be similar for areas disturbed by infrastructure although over a much smaller extent. With respect to potential disturbance of nesting by the Red Goshawk, the water supply dam (Dam C) would disturb potential nesting habitat along Norman Creek. The proposed dam site was surveyed for presence of threatened fauna and no nests were located. However, additional confirmation of the presence or absence of nests at the time of construction would be required to avoid potential impacts on breeding by the species.

Of the 13 species, the Rufous Owl, Palm Cockatoo, and Estuarine Crocodile have been confirmed as present within the footprint of Dam C, including confirmed breeding sites for the Palm Cockatoo and Estuarine Crocodile. Breeding sites for the Estuarine Crocodile also occur on the Ward River downstream of the proposed pump location. The remaining species potentially occur within the Dam C footprint.

For the Grey Goshawk, Red Goshawk, Square Tailed Kite, Masked Owl, Northern Quoll, Papuan Sheath-tail Bat, Chestnut Dunnart, and the burrowing snake, the habitat areas within the proposed dam footprint are not regarded as especially significant for foraging or breeding (although pre-construction confirmation of the breeding status of Red Goshawk is required). Given that the habitat loss would comprise a minor proportion (less than 10%) of the overall extent of these habitats within the Project area, and that most of these species would also utilise other undisturbed habitat types, the overall impact of the loss of habitat within the dam footprint is unlikely to be significant for these species.

For the Bare-rumped Sheathtail Bat the Dam C footprint supports a habitat mosaic similar to that where the species has previously been recorded on Cape York; i.e. riparian gallery forest and alluvial/colluvial woodland with adjacent Darwin Stringybark woodland. Given the critically endangered status of this species (EPBC Act) disturbance of breeding efforts by the species could lead to significant impacts under the EPBC Act. Given the proposed mitigation measures and that the majority of the habitat mosaic where the species is most likely to occur would be protected within the environmental buffer system, the overall impact of the loss of potential habitat within the dam footprint is unlikely to be significant for these species.

The Palm Cockatoo is known to breed within a small patch of riparian rainforest within the footprint of Dam C, apparently by virtue of the availability of large trees with suitable sized nesting hollows that occur in this area. While potential nesting trees do not occur in all riparian areas due to smaller tree sizes, potentially suitable nesting trees are likely to occur within vine forest on bauxite, coastal Melaleuca wetlands containing mature *Melaleuca leucadendra* and *Lophostemon suaveolens,* and other riparian rainforest patches located on spring heads (particularly on Norman Creek tributaries).

The species is also known to nest in eucalypts within woodland habitats. However, it is not anticipated that Palm Cockatoos nest in Darwin Stringybark trees within the Project area as these trees typically do not develop the types of hollows required by the species given the current fire regime where trees tend to get culled by fire before reaching full maturity, when larger hollows form.

Given the loss of the known breeding location within Dam C there is likely be a short-term impact on the breeding success of some pairs of Palm Cockatoos when this area is disturbed for dam construction. However, given the availability of other habitats likely to support suitable nesting trees, and the occurrence of foraging habitat elsewhere throughout the Project area, a long-term impact on the species is unlikely.

The Rufous Owl is not known to breed in the Dam C area but the species has a similar tree hollow size requirement to the Palm Cockatoo and thus the area provides potential breeding habitat for the species. As discussed for the Palm Cockatoo, other suitable breeding trees are likely to be located in wetland, vine forest and riparian gallery rainforest habitats which are all known to be used by the Rufous Owl and thus alternative breeding locations are available within the Project area. With respect to foraging habitat, the habitat complex within the Dam C footprint includes the largest (7.2ha) patch of riparian gallery rainforest within the Project area and is regarded as prime habitat for the species. The loss of this area is not insignificant in terms of habitat availability for the Rufous Owl; however, other areas of suitable habitat occur throughout the Project area in association with wetland, mangrove, riparian and vine forest habitats and overall it is not anticipated that there would be a significant impact on this species.

The Dam C area provides suitable habitat for the Common Spotted Cuscus, although intensive survey of this area failed to locate the species. Other suitable habitat for this species occurs within areas that would not be disturbed by the Project, including similar riparian gallery forest habitat on the other main arms of Norman Creek and along Winda Winda Creek, riparian gallery forest along the Ward River (Coconut Creek), and mangrove and Melaleuca wetland complexes occurring along the estuarine reaches of Norman Creek and the Ward River. The impoundment of Dam C may represent a partial barrier to movement by the Common Spotted Cuscus as the riparian gallery forest corridor would be removed for a distance of approximately 6.7km. This would certainly curtail day-to-day feeding movements. However, given that the species is known to occupy eucalypt woodland adjacent to its prime habitats, long-term genetic connectivity between individuals that may be present upstream and downstream of the impoundment is unlikely to be substantially affected. Furthermore, observation of the Ely Dam situated in similar habitats near Weipa indicate that at least a rudimentary gallery forest comprised of Melaleuca and Swamp Mahogany (*Lophostemon suaveolens*) is likely to re-establish at the periphery of the full supply level and provide some level of densely vegetated corridor.

Estuarine Crocodiles occupy and feed within freshwater reaches of Norman Creek, Winda Winda Creek and the Ward River during the wet season, with nests also located in these reaches on all three systems including within the footprint of Dam C. It appears that these reaches, where a deep channel is available in close proximity to grassy nesting areas above flood level, are used for nesting rather than the extensive shallow Melaleuca and estuarine wetland complexes on the lower reaches of these systems. However, where deep channels abut these wetlands with narrow levees, these areas may also be suitable for nesting.

Area suitable for Estuarine Crocodile habitat in and around the Project area is shown in **Figure 7-13**, including the approximate extent of potential freshwater nesting habitat within the Project area. The potential freshwater nesting habitat totals 71.3km of stream reach on Winda

Winda Creek, Norman Creek and tributaries, and Ward River and tributaries. The length of potential nesting habitat reach to be disturbed by the proposed Dam C footprint comprises 6.7km, representing approximately 9% of the total extent of the freshwater nesting habitat within the Project area. Additional nesting habitat could occur on stream levees in estuary areas, and therefore the total occurrence of nesting habitat is likely to be greater.

It is unclear whether the impoundment would affect access of breeding females to potential habitat upstream and whether juveniles potentially hatched upstream of the impoundment would be exposed to increased mortality rates in traversing to lower reaches as streamflows recede in the dry season. There is a possibility that the impoundment may provide a permanent aquatic habitat area that assists juvenile recruitment.

Changes to hydrology downstream of the dam may result in a localised reduction of water levels and flow rate during the breeding season. This may further alienate small reaches of breeding habitat for Estuarine Crocodiles immediately downstream of the dam due to less favourable (lower) water levels within the channel which may not provide sufficiently deep water to accommodate breeding females. Overall, the availability of potential freshwater nesting habitat for the Estuarine Crocodile would be reduced as a result of dam development. While this may have a local effect on reproductive rates of the species, it is not anticipated that total breeding effort within the Project area would be significantly affected.

Minor changes to streamflow would occur within the Ward River downstream of the pump location between July and the following wet season. Pumping would only occur if streamflow is above 1000L/s and the extraction rate would not exceed 20% of flow at any time; therefore flows would be within the natural inter-annual variation, with natural streamflow re-established prior to Estuarine Crocodile laying and hatching. Consequently, breeding effort of the Estuarine Crocodile within the area downstream of the pump location is not anticipated to be significantly affected.

Disturbance to foreshore and beach strand habitats at the location of the proposed port facility would be minor and is not expected to have any adverse effect on the usage of the area by threatened fauna. The area is not anticipated to be used for roosting or breeding by Beach Stone Curlew or Little Tern and therefore only minimal repulsion effects from the noise and lights associated with the facility can be expected for species that may be feeding in the area such as Black Necked Stork, Eastern Curlew and Little Tern.

The preferred habitat of the Radjah Shelduck would not be affected by infrastructure development (refer **Section 7.15.6**).

Hydrological Change

The potential effect on vegetation communities and habitat of hydrological change resulting from mining, operation of the water supply dam on Norman Creek, and water extraction from the Ward River is regarded as being minor (refer **Section 7.10.1**), apart from localised effects (particularly immediately downstream of the dam). The environmental buffer system as described in **Section 7.9.2** would ensure hydrological changes would not significantly alter the overall availability or utilisation of habitats by threatened fauna. Consequently, significant impacts on threatened fauna are unlikely to occur.

7.18.2 Mitigation Measures

The proposed fire management plan and feral animal control program (refer **Section 7.10.2**) would deliver positive benefits for threatened fauna in undisturbed areas by enhancing the current habitat values in these areas. A number of more specific mitigation measures are proposed below.

Mining Area

Surveys for Red Goshawk nests would be undertaken in sections of the mining plan located within 1km of permanent water supporting riparian gallery forest or paperbark wetland, seasonally inundated paperbark wetlands, seasonal watercourses supporting riparian gallery forest, or an estuary. Surveys would be completed as soon as practicable prior to vegetation

clearing for mining. If any active Red Goshawk nests are found within mining areas, a 200m buffer around the nesting tree would be excised from the mining plan until the end of the breeding season. Any active Red Goshawk nesting site identified within the mining path would be monitored until the nesting cycle has been completed, after which clearing activities would resume. If a nest is found in an area to be cleared it is considered likely that a breeding pair would find another location for nesting in the subsequent breeding season (refer **Section 7.15.4**).

Aumann and Baker-Gabb (1991) made several management recommendations to manage threats to the Red Goshawk. One recommendation was that when egg collection from a nest is strongly suspected, in an area where nest sites are not limiting, that the branch supporting the nest be removed during the non-breeding period to encourage the pair to re-nest at a new location. The proposed mitigation strategy for this Project to clear nest trees at the end of the breeding season and encourage the birds to re-nest in another location is consistent with this recommendation.

The mitigation measures described above would effectively minimise the potential impacts on Red Goshawk nesting as a result of vegetation clearing for mining as outlined in **Section 7.18.1**.

Infrastructure Development

Similar to surveys proposed for mining areas, targeted surveys for Red Goshawk nests would be conducted within the footprint of the water supply dam up to 1km from riparian gallery forest as soon as practicable prior to vegetation clearing. If any active Red Goshawk nests are found within the survey areas, a 200m buffer around the nesting tree would be established and the nest monitored until completion of the breeding season, after which vegetation clearing would resume.

The mitigation measures described above would effectively minimise the potential impacts on Red Goshawk nesting as a result of vegetation clearing for the construction of the water supply dam as outlined in **Section 7.18.1**.

The Bare-rumped Sheathtail Bat is reported to breed during the wet season with a colony containing juveniles reported as late as April in the Northern Territory (Schulz & Thompson 2007). Targeted pre-clearing surveys would be undertaken to determine the presence of the species within the Dam C disturbance area, and if present, disturbance of habitat trees would be avoided until after the breeding season (i.e. clearing to commence no earlier than May and be completed by end of November). If the species is present, all potential roost trees would also be identified within the Dam C disturbance area and pushed over in a manner that would allow any bats present to leave the roosts unharmed.

7.19 Potential Impacts and Mitigation Measures – Impacts on Migratory Fauna

7.19.1 Potential Impacts

Overall, the migratory species possible, likely or confirmed as occurring within the Project area predominantly utilise habitats that would be located within environmental buffers and not directly affected by mining. Small areas of riparian habitat that provide potential habitat for species such as Grey Goshawk (*Accipiter novaehollandiae*) and Red Goshawk (*Erythrotriorchis radiatus*) would be disturbed within the footprint of the water supply dam. However, less than 10% of the area of this habitat type within the Project area would be affected.

The migratory birds that are likely to or confirmed as occurring in the Project area comprise a range of species including mainly trans-equatorial migratory waders, and wetland and woodland species that undergo more local migratory movements. Whilst the waders fly from the northern hemisphere in large flocks, and the Gulf of Carpentaria is a main flight path for their entry to Australia, the birds themselves make only limited use of the Project area as it does not provide the extensive productive mudflats required by the species for feeding. It is not anticipated that

large flocks of these species would fly at low levels across the Project area, preferring instead to travel along the shoreline and out to sea. There is very little chance of these species colliding with infrastructure, including powerlines and port facilities. The remaining migratory species do not move through the Project area in mass movements but may utilise natural movement corridors such as riparian corridors and the coastline. Once again, the chance of large numbers of birds colliding with infrastructure is minimal given the high visibility of most project infrastructure and minimal suspended infrastructure across riparian corridors, wetlands and the shoreline (refer to **Section 2.7.5** for description of powerlines).

Disturbance to foreshore and beach strand habitats at the location of the proposed port facility would be very minor and is not expected to have any direct adverse affect on the usage of the area by migratory fauna. Most of the shorebirds confirmed as present, likely to occur or possibly occurring in the Project area utilise foreshore, tidal flat and beach habitats and/or mangrove and estuary habitats. Only 0.3 ha of foreshore habitats and only 400 square metres of mangrove habitat (0.008% of that mangrove community within the Project area) would be directly disturbed by the Project, which is a minor proportion of these habitats in the area. Indirect impacts on migratory shorebirds during the operational phase from lighting, noise or movement associated with the port facility and Hey Point ferry terminal are also unlikely to lead to significant impacts on migratory shorebirds given the very low incidence of these species within the Project area, and the capacity of most shorebirds to adapt to such disturbance.

Apart from potential impacts outlined for the Estuarine Crocodile, there are not anticipated to be any significant impacts on migratory fauna resulting from the Project.

7.19.2 Mitigation Measures

No specific mitigation measures are required for migratory fauna, as no significant impacts on migratory fauna are anticipated. However, the fauna impact mitigation strategies described in **Section 7.17.2** would minimise impacts on migratory fauna and areas of potential habitat.

7.20 EPBC Act Significant Impact Assessments for Threatened and Migratory Fauna

The "significant impact" assessments in this section are based on the *Significant impact guidelines* (DEWHA 2009a) provided by the Commonwealth Government.

7.20.1 Threatened Fauna

Individual "significant impact" assessments are provided below for each of the EPBC Act listed threatened fauna species assessed as possible, likely or confirmed inhabitants of the Project area comprising:

- Red Goshawk (*Erythrotriorchis radiatus*);
- Masked Owl (*Tyto novaehollandiae kimberli*);
- Bare-rumped Sheathtail Bat (*Saccolaimus saccolaimus nudicluniatus*); and
- Northern Quoll (*Dasyurus hallucatus*).

Key definitions from the DSEWPaC guidelines that apply to this assessment are as follows:

An "important population" is a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are:

- key source populations either for breeding or dispersal;
- populations that are necessary for maintaining genetic diversity; and/or
- populations that are near the limit of the species range.

"Habitat critical to the survival of a species or ecological community" refers to areas that are necessary:

- for activities such as foraging, breeding, roosting, or dispersal;

- for the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators);
- to maintain genetic diversity and long-term evolutionary development; or
- for the reintroduction of populations or recovery of the species or ecological community.

Such habitat may be, but is not limited to:

- habitat identified in a recovery plan for the species or ecological community as habitat critical for that species or ecological community; and/or,
- habitat listed on the Register of Critical Habitat maintained by the Minister under the EPBC Act.

An "invasive species" is an introduced species, including an introduced (translocated) native species, which out-competes native species for space and resources or which is a predator of native species. Introducing an invasive species into an area may result in that species becoming established. An invasive species may harm listed threatened species or ecological communities by direct competition, modification of habitat or predation.

Red Goshawk (*Erythrotriorchis radiatus*)

The Red Goshawk was not located in the Project area during general and targeted surveys. However, as the regional population size of this species is relatively small, if the Red Goshawk was to occur within the disturbance footprint of the Project area, it would be regarded as an important population. However, if the species is present within the Project area sufficient foraging habitat would remain undisturbed to support the species and proposed mitigation measures would avoid disturbance of active nests.

Habitat clearing is the major known threat to the Red Goshawk (EPA 2006). Human disturbance at nest sites are also known to disturb breeding pairs and result in reduced reproductive success. Based on the DSEWPaC (2010) SPRAT database, other possible threats to this species include:

- The theft of eggs for egg collections and the intentional killing of adults.
- The application of persistent pesticides such as DDT may have caused a historic reduction in the population. In 1989, Australia ceased widespread use of organochlorine pesticides and most affected species have now recovered;
- Overgrazing, or other changes in land management which could reduce prey availability, and therefore reduce productivity.
- Altered fire regimes have the potential to impact breeding sites and reduce prey availability, thus reducing productivity.
- The occurrence of a catastrophic event which may exaggerate the impact of existing threats.
- Possible genetic bottlenecks in the population.

The proposed Project is not expected to interfere with the recovery of the species.

Will the proposed works ...	**Red Goshawk (*Erythrotriorchis radiatus*): Vulnerable**
....lead to a long-term decrease in the size of an important population?	The Red Goshawk occurs in coastal and sub-coastal habitats from northern NSW to the Kimberley, although it has declined significantly in the southern part of its range. The species was not located in the Project area during general and targeted surveys. As the regional population size of this species is relatively small, if the Red Goshawk was to occur within the disturbance footprint of the Project area, it would be regarded as an important population. However, if the species is present within the Project area, sufficient foraging habitat would remain undisturbed to support the species and proposed mitigation measures would effectively avoid disturbance of active nests. A long-term decrease in any population of the species present is unlikely to occur.
....reduce the area of occupancy of an important population?	The key habitats for the species would be largely unaffected by the Project and the area of occupancy of any population of the species, if present, would not be reduced.
....fragment an existing important population into two or more populations?	Key habitats for the species would not be affected and, given the high mobility of the species, any population present would not be fragmented.
....adversely affect habitat critical to the survival of a species?	The Project area does not include any critical habitat areas for the Red Goshawk that are listed under the EPBC Act or identified in Recovery Plans, nor is the Project area regarded as critical habitat for the species given its similarity to other potential habitat areas on northern Cape York Peninsula.
....disrupt the breeding cycle of an important population?	Proposed mitigation measures would avoid disturbance of active nests and consequently the breeding cycle of the species would not be disrupted.
....modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?	The key habitats for the species would be largely unaffected by the Project; consequently, the species is unlikely to decline as a result of the Project.
....result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?	The Project is unlikely to lead to the introduction of any invasive fauna that could affect the species. Proposed control measures for weeds would effectively avoid the spread of invasive weeds within the habitat of the Red Goshawk.
.....introduce disease that may cause the species to decline?	Disease is not known as a threat to this species. It is not anticipated that the Project would represent a threat with respect to the introduction of disease.
....interfere substantially with the recovery of the species?	The Project is not expected to interfere with the recovery of the Red Goshawk.

Masked Owl *(Tyto Novaehollandiae)*

The Masked Owl was not recorded within the Project area. However, a population of Masked Owl, if present in the Project area, could be regarded as an important population as the species is now rare on Cape York Peninsula with limited recent records. It is not expected that the Project would lead to a long term decrease in the population as the key potential habitats for the species would be largely unaffected by the Project.

There is some evidence to suggest that the main threat to the Masked Owl is the decline in populations of small and medium sized native mammals, which are the Masked Owl's primary food source (Woinarski 2004). The broad scale application of the rodenticide Klerat (now banned) may also have lead directly to the mortality of Masked Owls. The proposed Project is not expected to interfere with the recovery of the species.

Will the proposed works ...	**Masked Owl (*Tyto Novaehollandiae*): Vulnerable**
....lead to a long-term decrease in the size of an important population of a species?	The northern race of the Masked Owl occurs between Townsville and the Kimberley region with other races extending down the east coast to Tasmania. The Masked Owl has been recorded in the Weipa area, although the habitat within which it was recorded is unclear. The species was not recorded during surveys within the Project area. A population of Masked Owl, if present, in the Project area could be regarded as an important population as the species is now rare on Cape York Peninsula with limited recent records. It is not expected that the Project would lead to a long-term decrease in the population as the key potential habitats for the species would be largely unaffected by the Project.
....reduce the area of occupancy of an	The key potential habitats for the species would be largely unaffected by the Project and therefore the area of occupancy of the species, if present, is unlikely to

Will the proposed works ...	Masked Owl (*Tyto Novaehollandiae*): Vulnerable
important population?	be reduced.
....fragment an existing important population into two or more populations?	Key habitats for the species would not be significantly affected by the Project and, given the high mobility of the species, any population present would not be fragmented.
....adversely affect habitat critical to the survival of a species?	The Project area does not include any critical habitat areas for the Masked Owl that are listed under the EPBC Act or identified in Recovery Plans. If the species is present, the area could be regarded as including critical habitat given the recent decline of the species within Queensland; however, key habitats for the species would not be significantly affected by the Project and habitat critical to the survival of the species is unlikely to be adversely affected.
....disrupt the breeding cycle of an important population?	Key habitats for the species would not be significantly affected by the Project and disruption to the breeding cycle of any population present is unlikely.
....modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?	The key habitats for the species would be largely unaffected by the Project and consequently the species, if present, is unlikely to decline as a result of the Project.
....result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?	The Project is unlikely to lead to the introduction of any invasive fauna that could affect the species. Proposed control measures for weeds would effectively avoid the spread of invasive weeds within the habitat of the Masked Owl.
.....introduce disease that may cause the species to decline?	Disease is not known as a threat to this species. It is not anticipated that the Project would represent a threat with respect to the introduction of disease.
....interfere substantially with the recovery of the species?	The Project is not expected to interfere with the recovery of the Masked Owl.

Northern Quoll *(Dasyurus hallucatus)*

The Northern Quoll was not recorded within the Project area. However, as the regional population size of this species is thought to be relatively small, if the Northern Quoll was to occur within the disturbance footprint of the Project area, it would be regarded as an important population. Vine forest areas would not be disturbed by the Project. Minor areas of riparian habitats would be disturbed within the footprint of the water supply dam, although targeted surveys did not locate the species in these areas.

A number of factors are considered to be threatening the survival of the Northern Quoll (DSEWPaC 2010). These include:

- inappropriate fire regimes;
- predation following fire; and
- lethal toxic ingestion of Cane Toad toxin.

The proposed Project is not expected to interfere with the recovery of the species.

Will the proposed works ...	Northern Quoll (*Dasyurus hallucatus*): Endangered
....lead to a long-term decrease in the size of a population?	The Northern Quoll is distributed from south-east Queensland across northern Australia to the Pilbara but has declined in many parts of this range. The Northern Quoll historically occurred in Darwin Stringybark open forest and associated habitats within the Weipa area prior to the arrival of the Cane Toad in the 1980s. Although numerous records exist for Northern Quoll in the region surrounding Weipa, the majority of these are historical, and no other confirmed sightings are available for the area around Weipa after 1990. The species has not been recorded from the Project area. If the species is present within the Project area, sufficient foraging habitat would remain undisturbed to support the species. A long-term decrease in any population of the species present is unlikely to occur.
....reduce the area of occupancy of the species?	Although a substantial area of Darwin Stringybark open forest would be disturbed by the Project, the majority of this habitat would remain undisturbed and other habitats utilised by the species would be largely unaffected. Sufficient habitat would remain to support the species, if present, and the area of occupancy of any population of the species present would not be reduced.

....fragment an existing population into two or more populations?	The main riparian habitat corridors and cross catchment habitat connections would be retained within the Project area and, given the high mobility of the species, any population present would not be fragmented.
....adversely affect habitat critical to the survival of a species?	The Project area does not include any critical habitat areas for the Northern Quoll that are listed under the EPBC Act or identified in Recovery Plans, nor is the Project area regarded as critical habitat for the species given its similarity to other potential habitat areas on northern Cape York Peninsula.
....disrupt the breeding cycle of a population?	The breeding cycle of the species (if present) would not be disrupted.
....modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?	Although a substantial area of Darwin Stringybark open forest would be disturbed by the Project the majority of this habitat would remain undisturbed and other habitats utilised by the species would be largely unaffected; consequently, the species is unlikely to decline as a result of the Project.
....result in invasive species that are harmful to an endangered species becoming established in the endangered species' habitat?	The Project is unlikely to lead to the introduction of any invasive fauna that could affect the species. Proposed control measures for weeds would effectively avoid the spread of invasive weeds within the habitat of the Northern Quoll.
.....introduce disease that may cause the species to decline?	Disease is not known as a threat to this species. It is not anticipated that the Project would represent a threat with respect to the introduction of disease.
....interfere with the recovery of the species?	The Project is not expected to interfere with the recovery of the Northern Quoll.

Bare-rumped Sheathtail Bat (*Saccolaimus saccolaimus nudicluniatus*)

The Bare-rumped Sheathtail Bat was not recorded during surveys within the Project area. Habitat for this species is poorly known and the habitats within the Project area that may be favoured by the species are uncertain. Records from elsewhere on Cape York Peninsula indicate that riparian gallery forest, vine forest and adjacent woodland, including Darwin Stringybark woodland, may be favoured. Much of this habitat suite would fall within proposed environmental buffer areas in the Project area; however, the species could also utilise Darwin Stringybark woodland within proposed disturbance areas.

If the species is present within the Project area it is highly likely that it would also be present in the extensive areas of similar bauxite plateau ecosystem that dominate the western half of northern Cape York Peninsula.

The Dam C footprint represents potential habitat for the species. The proposed mitigation measures would avoid disturbance of breeding activity and avoid impacts on individuals that may be present within the Dam C footprint.

The majority of habitat where the species is most likely to occur within the Project area would be protected within environmental buffers, therefore it is unlikely that a significant impact on the species would occur as a result of the Project.

Will the proposed works ...	**Bare-rumped Sheathtail Bat (*Saccolaimus saccolaimus nudicluniatus*): Critically Endangered**
....lead to a long-term decrease in the size of a population?	The current occurrence of this species within the Project area and disturbance areas is not known. Based on the nearest records of the species from Cape York Peninsula it is likely that the species would focus habitat utilisation on riparian or vine forest areas and adjacent woodland including Darwin Stringybark. These habitat mosaics would be largely protected within the environmental buffer system and not subject to disturbance, apart from at the proposed Dam C. Proposed mitigation measures would avoid impacts on breeding activity and impacts on individuals in this area, and would allow individuals to relocate to adjoining similar habitat. If the species is present within the Project area, targeted mitigation measures would avoid impacts on individuals, and the environmental buffer system would protect the majority of the habitat mosaic where the species is most likely to occur, and a long-term decrease in any population of the species present is unlikely to occur.
....reduce the area of occupancy of the species?	The key habitats for the species would be largely unaffected by the Project and the area of occupancy of any population of the species, if present, would not be reduced.
....fragment an existing population into two or more populations?	Key habitats for the species would not be significantly affected by the Project and, given the high mobility of the species, any population present would not be fragmented.

….adversely affect habitat critical to the survival of a species?	The Project area does not include any critical habitat areas for the Bare-rumped Sheathtail Bat that are listed under the EPBC Act or identified in Recovery Plans, nor is the Project area regarded as critical habitat for the species given its similarity to other potential habitat areas on northern Cape York Peninsula.
….disrupt the breeding cycle of a population?	Mitigation measures would ensure that breeding activity is not affected within the habitat areas where the species is most likely to occur and disruption to the breeding cycle of any population present is unlikely.
….modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?	Although a substantial area of Darwin Stringybark open forest would be disturbed by the Project the majority of this habitat within the Project area would remain undisturbed and other habitats more likely to be utilised by the species would be largely unaffected; consequently, the species is unlikely to decline as a result of the Project.
….result in invasive species that are harmful to an endangered species becoming established in the endangered species' habitat?	The Project is unlikely to lead to the introduction of any invasive fauna that could affect the species. Proposed control measures for weeds would effectively avoid the spread of invasive weeds within the habitat of the Bare-rumped Sheathtail Bat.
…..introduce disease that may cause the species to decline?	Disease is not known as a threat to this species. It is not anticipated that the Project would represent a threat with respect to the introduction of disease.
….interfere with the recovery of the species?	The Project is not expected to interfere with the recovery of the Bare-rumped Sheathtail Bat.

7.20.2 Migratory Species

Significant impact assessments are provided below for the EPBC Act listed migratory fauna species assessed as possible, likely or confirmed inhabitants of the Project area.

Key definitions from the DSEWPC guidelines that apply to this assessment are as follows:

An area of "important habitat" for a migratory species is:

- habitat utilised by a migratory species occasionally or periodically within a region that supports an ecologically significant proportion of the population of the species; and/or
- habitat that is of critical importance to the species at particular life-cycle stages; and/or
- habitat utilised by a migratory species which is at the limit of the species range; and/or
- habitat within an area where the species is declining.

Listed migratory species cover a broad range of species with different life cycles and population sizes. Therefore, what is an "ecologically significant proportion" of the population varies with the species (each circumstance would need to be evaluated). Some factors that should be considered include the species' population status, genetic distinctiveness and species-specific behavioural patterns (for example, site fidelity and dispersal rates).

"Population", in relation to migratory species, means the entire population or any geographically separate part of the population of any species or lower taxon of wild animals, a significant proportion of whose members cyclically and predictably cross one or more national jurisdictional boundaries including Australia.

Estuarine Crocodile *(Crocodylus porosus)*

An individual significant impact assessment is provided below for the Estuarine Crocodile (*Crocodylus porosus*).

Will the proposed works …	**Estuarine Crocodile *(Crocodylus porosus)***
… substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species?.	The migratory species confirmed as present within the Project area predominantly utilise habitats that would be located within riparian areas (environmental buffers) and not directly affected by mining and only minimally affected by infrastructure development. The vast majority of habitats utilised by this species would be unaffected by the Project and substantial modification of any important habitats present is not expected to occur.

… result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species?.	The Project is unlikely to lead to the introduction of any invasive fauna that could affect the Estuarine Crocodile.
… seriously disrupt the lifecycle (breeding, feeding, migration or resting behavior) of an ecologically significant proportion of the population of a migratory species?	Habitat is predominantly riparian areas with the exception of migration to new areas. Serious disruption to the life cycle of this migratory species is not anticipated as primary habitat is located within environmental buffers with minimal infrastructure development.

Significant impact assessments for the EPBC Act listed marine migratory fauna species are provided in **Section 6.9.5**.

Avian Migratory Species

The remaining EPBC Act listed migratory species assessed as possible, likely or confirmed inhabitants of the Project area are all avian species. These species have similar habitat requirements and have been grouped for the purpose of the assessment.

Will the proposed works …	**Refer to Table 7-16 for a list of the migratory fauna species covered by this assessment.**
… substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species?	The migratory species confirmed as present, likely or possible to occur within the Project area predominantly utilise habitats that would be located within areas to be protected by environmental buffers and not directly or indirectly affected by mining, and only minimally affected by infrastructure development. The vast majority of habitats utilised by these species would be unaffected by the Project and substantial modification of any important habitats present is not expected to occur.
… result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species?	The Project is unlikely to lead to the introduction of any invasive fauna that could affect migratory species. Proposed control measures for weeds would effectively avoid the spread of invasive weeds within habitats of the migratory species.
… seriously disrupt the lifecycle (breeding, feeding, migration or resting behavior) of an ecologically significant proportion of the population of a migratory species?	Serious disruption to the life cycle of any migratory species confirmed as present, likely or possible to occur within the Project area is not anticipated.

7.20.3 Summary of EPBC Impact Assessments

None of the EPBC Act listed threatened fauna or migratory fauna species known to occur or potentially occurring within the Project area are expected to experience significant impacts as a result of the Project. The proposed mitigation measures would be effective in minimising any potential impacts from the Project on the abovementioned EPBC Act listed threatened fauna or migratory fauna species.

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Environmental Impact Statement

for South of Embley Project

Section 8

Aquatic Ecology

8 AQUATIC ECOLOGY

8.1 Introduction

A summary of the biogeographic setting of the Project area is provided in **Section 7.1**. The Project area is essentially an elevated bauxite plateau that is fringed on much of its coastal margins by low cliffs and lateritic outcrop. The groundwater influenced ephemeral and perennial aquatic ecosystems within the Project area are typical of those occurring within the Weipa Plateau subregion within which the Project area is situated.

The SoE area sheds runoff from a centrally located topographic high to the west via Ina and Norman Creek (with four major tributaries), to the north via Triluck–Winda Winda Creek (with three major tributaries), Roberts and Leithen Creeks (the latter two primarily estuarine), to the east via unnamed tributary drainages of the Hey River estuary and to the south via the Ward River system (with two named tributaries, Coconut and Tappelbang Creek). A number of smaller, less defined drainage depressions also flow independently to the Gulf of Carpentaria between these named drainage systems. Coconut and Tappelbang Creeks have their headwaters in the Aurukun Project area to the east of the Project. Within the Project area there are also several swamps that occur in depressions within the bauxite plateau which are largely isolated from defined drainage networks**.**

Given the generally small size of these catchments and the highly seasonal rainfall of the region, many of the smaller streams and depressional swamps do not contain permanent aquatic habitats. However, shallow groundwater connectivity to surface water features is apparent throughout the Project area and semi-permanent groundwater discharge is observed to maintain streamflows and wetland water levels beyond the wet season period at many sites. The larger Norman Creek system includes perennial stream reaches and aquatic refugia and supports a host of aquatic habitat types including streams, tree swamps, sedge swamps, lagoons and lakes. This section describes freshwater and estuarine aquatic ecosystem survey results from a representative suite of sites within the Project area. It also identifies the potential impacts on these ecosystems from activities associated with mine development and identifies mitigation measures. Marine ecosystems are described in **Section 6**. The location of river systems and catchments described in this section can be identified in **Figure 5-1**.

8.2 Conservation Areas and Sensitive Environmental Areas

8.2.1 Conservation Areas

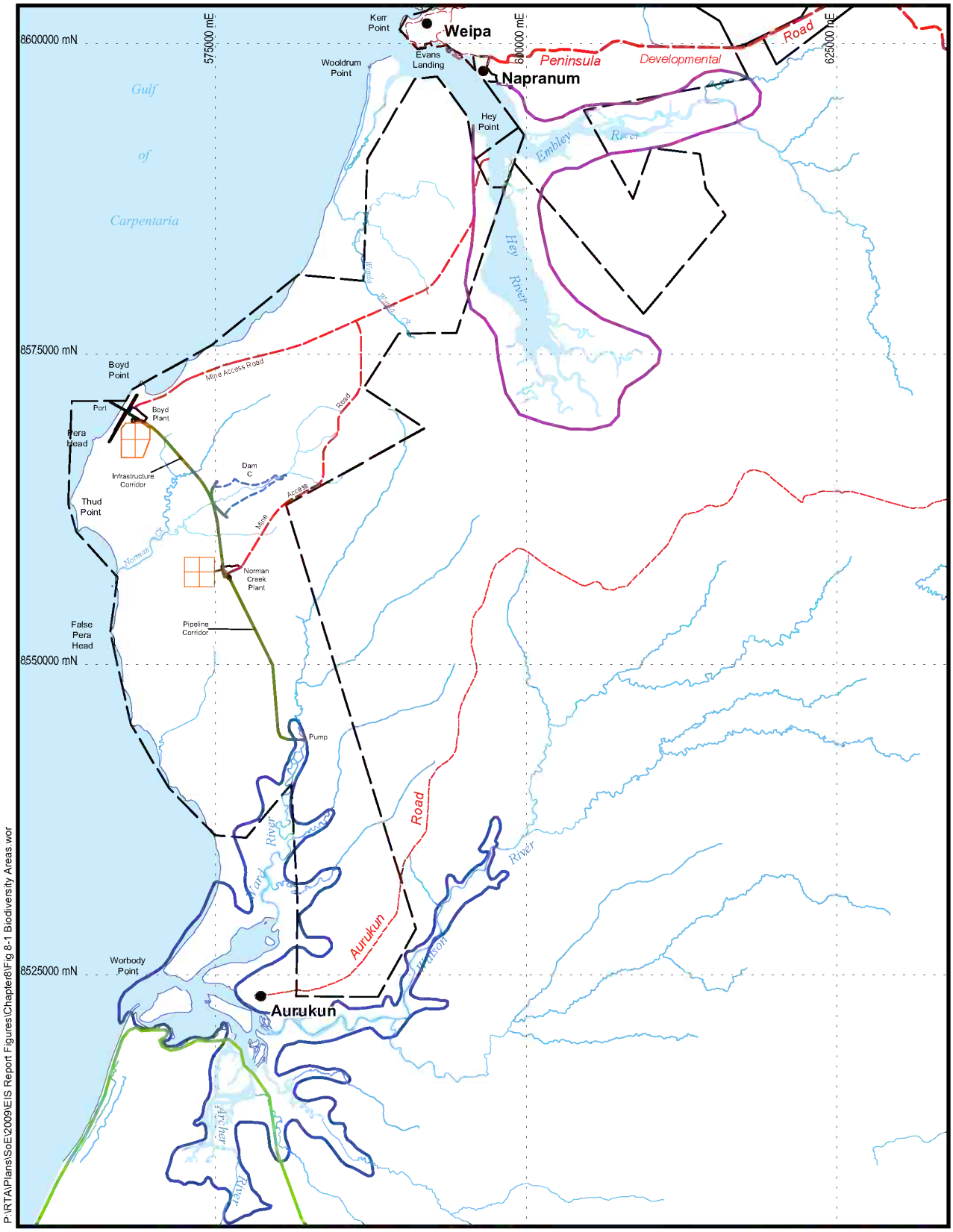
There are four conservation reserves located on northern Cape York (refer **Section 7.1** and **Figure 7-1**) each of which includes aquatic habitat to varying degrees. None of these reserves are located within or downstream of the Project area. The Mungkan Kandju National Park, located approximately 30km east of the southern portion of the Project area and the Jardine River National Park, approximately 125km north-east of the Project area, protect examples of the majority of aquatic ecosystems occurring within the Project area.

8.2.2 Directory of Important Wetlands in Australia

The southern extremity of the Project area overlaps with the Archer Bay Aggregation (refer **Figure 8-1**) which is a nationally significant wetland area listed in the Directory of Important Wetlands in Australia (DIWA) (Blackman *et al.* 1999). The Archer Bay Aggregation covers an area of 29,931ha and encompasses a large estuarine embayment at the mouths of the Ward, Watson and Archer Rivers together with their associated estuarine, riverine, lacustrine and palustrine wetlands. The DIWA area includes the lower freshwater and brackish reaches of the Ward River within the Project area.

The DIWA listing describes the significance of the area as follows:

> The aggregation is the best example of a large estuarine embayment with associated brackish and freshwater wetlands in the western Cape York Peninsula. It is significant for the extent of seagrass beds and the diversity of mangroves. The virtually pristine condition of much of the site adds to its significance.



P:\RTA\Plans\SoE\2009\EIS Report Figures\Chapter8\Fig 8-1 Biodiversity Areas.wor

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South of Embley Project

Fig. 8-1: Areas of Conservation Significance

> A significant feature of the area are the grassy coastal flats that are supported by the large amounts of freshwater entering Archer Bay via the surrounding surface and groundwater drainage systems. Relatively constant freshwater inputs are provided by virtue of the laterite and basement aquifers to the north of Archer Bay [i.e. within and to the east of the Project area].

The DIWA listing also describes the occurrence of important or notable wetland flora and fauna species, populations and communities, including the following:

- Spotted Mangrove (*Rhizophora stylosa*) dominated mangrove communities grow on the islands in the bay and along the lower tidal reaches of the rivers and creeks entering it.
- *Eleocharis dulcis* closed sedgeland occurs throughout the Aggregation, being particularly extensive immediately to the west of Aurukun, on Long and Sydney islands and along the Ward River.

Listed species of conservation significance include:

- Little Tern (*Sterna albifrons*); and
- Estuarine Crocodile (*Crocodylus porosus*)

Important breeding and dry season populations of Magpie Goose (*Anseranas semipalmata*) occur on the *Eleocharis* swamps.

Important populations of other waterbird species include Wandering Whistling-duck (*Dendrocygna arcuata*), Green Pygmy Goose (*Nettapus pulchellus*), Brolga (*Grus rubicundus*), Sarus Crane (*Grus antigone*), Little Black Cormorant (*Phalacrocorax sulcirostris*), Little Egret (*Egretta garzetta*), Great Egret (*Ardea alba*), Intermediate Egret (*Ardea intermedia*), Black-necked Stork (*Ephippiorhynchus asiaticus*), Royal Spoonbill (*Platalea regia*), Glossy Ibis (*Plegadis falcinellus*), Australian White Ibis (*Threskiornis molucca*) and Straw-necked Ibis (*T. spinicollis*).

Traditional owners from the Aurukun area have also noted the presence of Dugong (*Dugong dugon*).

8.2.3 Other Identified Conservation and Biodiversity Areas

A full summary of the Cape York Peninsula Land Use Strategy (CYPLUS) (Abrahams *et al.* 1995) assessment of conservation values is provided in **Section 7.2.2**. With respect to aquatic ecosystems, two areas of conservation significance were identified adjacent to the Project area comprising:

- the estuary of the Embley River which is the only known habitat of River Garfish (*Zenarchopterus buffonis*) on Cape York Peninsula; and
- the Aurukun Wetlands to the immediate south of the Project area, which have natural conservation significance due to a number of wetland and terrestrial biodiversity attributes, including the following:
    - It contains some of the best quality coastal wetland habitats in western Cape York Peninsula.
    - The wetlands around the Kirke River (60km south of the Project area) support an abundant wetland fauna and are likely to be the most important dry season refuge for waterbirds on Cape York Peninsula.
    - It is the most important known breeding area for several waterbird species on the Peninsula.
    - It contains four large Magpie Geese breeding colonies and two large waterbird breeding colonies.
    - Two wader roost sites of over 5,000 birds and two each with between 1,000 and 5,000 birds have been identified in the area.

- It supports the richest collection of vegetation communities anywhere on the west coast of the Peninsula, and this is likely to result in a rich fauna;
- Several mangrove crabs which are either new species or new Australian records have been identified in the area;
- The beach ridge system to the south of Kirke River is the most extensive on the west coast of the Peninsula, while the saltpans in the Kirke estuary are unequalled anywhere in the Gulf of Carpentaria; and
- About 25% of the area is of very high wilderness quality.

The northernmost portion of the Project area is within the catchment of the Embley River. The southernmost portion of the Project areas is within the catchment of the Ward River, which drains to the Aurukun Wetlands.

8.3 Survey Methodology

Project area aquatic ecosystems were surveyed and sampled in May 2008 and May 2009, with additional observations made during site visits in August–September 2007, November 2007, February 2008 and December 2008, and February–March 2009.

Survey efforts for fish species were subject to a number of constraints associated with sampling efficiency, access and safety. Within the estuary proper, large populations of estuarine crocodiles limited night work due to safety concerns for samplers associated with potential crocodile attack and with the removal of enmeshed crocodiles from gill nets.

A total of 63 accessible and representative survey sites were selected by reference to satellite imagery, aerial photography and field reconnaissance, with field sites located and fixed using a handheld GPS (refer **Figure 8-2**). At each site biophysical habitat including riparian and aquatic vegetation were described and digital photographs taken. Aquatic ecosystem assessments were made at the same sites, generally concurrently with sampling of fish, larger crustaceans, macroinvertebrates and tissue metal samples, and overlapping with the fourth round of water quality sampling at each site. The sampling effort (measured in hours) at each site for each sampling method is presented in **Appendix 8A**.

Sampling of aquatic biota for the EIS comprised two post wet season sampling periods in May 2008 and May 2009 as this presented the optimal site conditions for sampling. During the wet season stream reaches could not be sampled due to the inaccessibility of sites due to wet season inundation of the landscape and the presence of debris laden high flows that prevented the safe and effective deployment of sampling equipment. While field observations were made at other times, the limited biological sampling cannot fully quantify seasonal and inter-annual variation in the Project area. However, when combined with information from surveys conducted by the same biologists elsewhere on the Weipa Plateau, the general composition of the aquatic biota can be suitably characterised for the purpose of the EIS. It also provides an initial baseline snapshot prior to commencement of mining.

Sampling was conducted by using a number of standardised quantitative and qualitative sampling methods, including:

- Electrofishing – Backpack electrofishing is a method of sampling fish and larger crustaceans from shallow, wadable waters that is highly effective in small freshwater streams. The instrument used for this study was a Smith-Root Model B-12 backpack mounted electrofisher. Due to the very low conductivities typical of streams in the Project area, voltages generally between 900 and 1100V were required for the instrument to operate effectively. Electrofishing was conducted as a single sampling pass at each site for a minimum of 10 minutes, restarting that 10-minute count each time a new species was collected.
- Gill Netting – The gill net set used consisted of two identical panel nets and three small meshed gill nets. Dimensions of the nets used are listed in **Table 8-1**. At freshwater

sites the nets were set from approximately 3pm to 8am on the following day. At estuarine sites only day-time gill net sets were employed (from approximately 7am to 5pm) as a measure to reduce the risk of crocodile entanglement and drowning. On all occasions the total actual set time was recorded and used to scale the catch in subsequent analyses. Gill netting can provide catch per unit effort measures and samples a wide range of fish sizes and species including some species and larger individuals that avoid electrofisher capture.

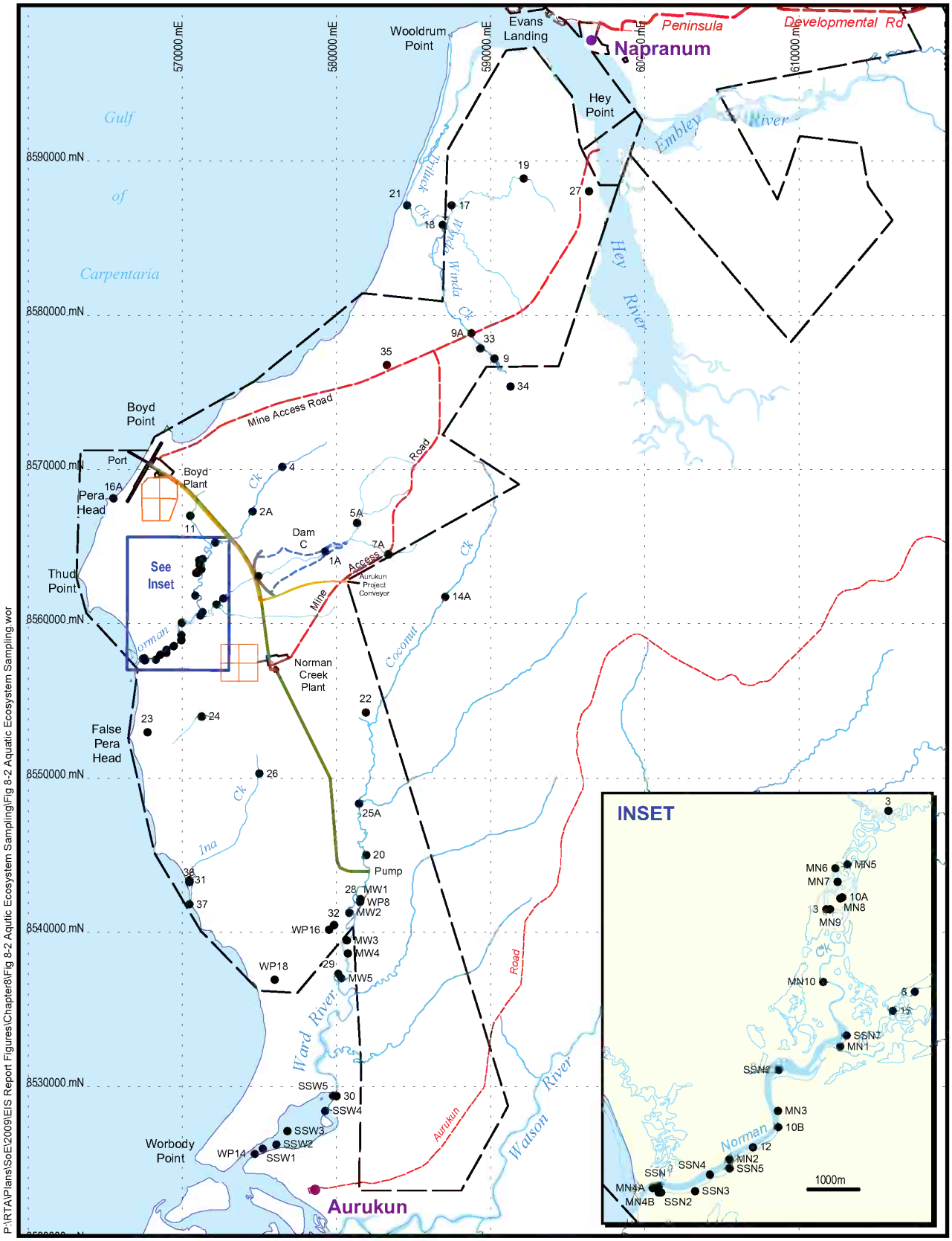
- Fyke Netting – Fykes (1.2m diameter, 6mm mesh, with two in-line funnels entrances and 5 × 1.5m wings of the same mesh size) were set overnight in stream sites with sufficient depth to ensure the fyke nets could be expanded to full length and the fyke net funnels were more than half immersed in the water. Fyke nets collected a wide range of species.
- Collapsible baited box traps (bait fish traps) – Traps were used in areas with low to moderate flows. These were left overnight in conjunction with the gill net set, and were baited with fish oil flavoured cat biscuits. These traps were effective in collecting small fishes and larger crustaceans.
- Crab trapping – Trapping was conducted at estuarine sampling sites in the Ward River and Norman Creek and utilised five each of two forms of commercially available set crab pots including a double entrance drum trap (730mm length x 280mm high x 300mm wide opening) with large (80mm) mesh and collapsible double entrance opera traps (600mm long x 450mm wide x 200mm high with 90mm opening) with finer (25mm) mesh. These traps were baited with fresh and frozen whole fish bait and set along mangrove fringes in conjunction with estuarine gill net sets.

Table 8-1 Dimensions of Gill Nets Used for Fish Sampling

Net Type	Quantity	Mesh Size (mm, stretched)	Length (m)	Depth (m)	Area (m²)
Panel	2	5m each of 75, 100 and 125	15	2	30
Fine monofilament	1	50	10	2	20
	1	35	10	2	20
	1	25	10	2	20

Fish and crustacean specimens were identified to species level and counted in the field, where possible or representative specimens were preserved and shipped to Brisbane for formal identification by the Queensland Museum. Up to 20 randomly selected specimens of each species from each sampling device were measured in the following manner: fish fork length to the nearest 0.5mm for fish less than 200mm in length and to the nearest 1mm thereafter; prawn post-orbital carapace length to the nearest 0.1mm; and crab carapace width to the nearest 0.1mm. Specimens were weighed to the nearest 0.1g up to 500g and the nearest 1g between 500g and 5,000g.

A macroinvertebrate sweep sample (250μm mesh) was collected using multiple sweeps over 10m of edge habitat at each site. This sampling technique produced a qualitative sample for the purpose of identifying the presence and absence of taxa and trophic guilds in a standardised habitat. Samples were then live-picked using the method of Conrick and Cockayne (2001). Macroinvertebrate samples were sent to Applied Freshwater Sciences for identification to the "Family" level of taxonomic classification.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Carpentaria
Wooldrum Point
Evans Landing
Napranum
Peninsula Developmental Rd
Hey Point
Embley River
Hey River
Boyd Point
Port
Boyd Plant
Mine Access Road
Pera Head
Thud Point
See Inset
Dam C
Access Road
Aurukun Project Conveyor
Mine Road
Norman Creek Plant
Coconut Ck
False Pera Head
Ina Ck
Pump
Ward River
Aurukun Road
Watson River
Worbody Point
Aurukun
INSET
1000m
RTA Mining Lease boundary
Township
Drainage
Road/track
Aquatic Ecosystem sampling
Tailings storage facility
Infrastructure corridor
South of Embley Project
Fig. 8-2: Aquatic Ecosystem Sampling Sites 2007 - 2009
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5 0 5 10km
Datum/Projection: GDA94/MGA Zone 54
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P:\RTA\Plans\SoE\2009\EIS Report Figures\Chapter8\Fig 8-2 Aquitic Ecosystem Sampling\Fig 8-2 Aquatic Ecosystem Sampling.wor

Tissue samples for tissue metal analysis were taken from species that were found to be widespread in the areas sampled, and representative of the fauna in each habitat. The species used in the present study are listed in **Table 8-2.** An additional species and tissues were collected and archived for subsequent analysis if required. Tissue samples were taken from up to five specimens of each species per site.

Descriptions of riparian vegetation communities and identification of dominant flora species were undertaken at sampling sites and elsewhere within the Project area concurrently with sampling of in-stream fauna. Identification of some riparian and aquatic flora was made during the terrestrial flora surveys as the riparian and wetland habitats within the Project area represent an area of overlap between terrestrial and aquatic systems.

Mangrove communities were targeted to evaluate the likely sensitivity to potential changes in catchment flows associated with proposed mining and infrastructure development. Surveys were conducted at points along the salinity gradient from the upper to lower estuary of both the Ward River and Norman Creek systems (Mangrove sites MW1–5 and MN1–10) during May 2009. The objective of the survey was a qualitative assessment of mangrove community composition and species distribution in relation to site location within the estuary.

Table 8-2 Species Selected for Tissue Metal Concentration Analysis

Species	Tissue types	Common Name
Cherax rhynchotus	Cephalothorax and flesh	Yabby
Cherax quadricarinatus	Cephalothorax and flesh	Red Claw Crayfish
Neosilurus hyrtlii	Hind, Gill	Hytrl's Tandan
Lates calcarifer	Flesh, Liver and Gill	Barramundi
Megalops cyprinoides	Flesh	Tarpon
Toxotes chatareus	Flesh, Liver and Gill	Archerfish
Glossamia aprion	Hind	Mouth Almighty
Liza subviridis	Flesh, Liver and Gill	Brown Backed Mullet
Melanotaenia splendida inornata	Hind	Chequered Rainbowfish
Neoarius graeffei	Flesh, Liver and Gill	Lesser Salmon Catfish
Neoarius midgleyi	Flesh, Liver and Gill	Shovelhead Catfish
Dytiscidae sp. 1	Whole body	Giant Water Beetle
Scylla serrata	Claw, hepatopancreas	Female Mud Crab

Formal seagrass surveys and sampling to characterise the seagrass communities and gain baseline data was conducted in May 2009. Seagrass sampling and surveying was conducted using aerial photo definition of "photo unit" survey targets (primarily sand bars and shallow intertidal flats and channel margins), and on ground by use of 1m quadrant transects across exposed intertidal flats and via grab sample transects across estuarine channel profiles at upper, mid and lower estuary sites.

8.4 Description of Stream and Wetland Habitats

The catchments and stream drainage networks occurring within the SoE area are small in comparison to elsewhere in the Cape York region and this limits the extent and perenniality of freshwater habitats that occur there. Generally, more permanent streams and perennial aquatic refugia are associated with larger and lower catchment areas; however, extensive areas of seasonal freshwater habitats occur throughout the Project drainage network system during the wet season.

Generalised habitat descriptions are provided here for the range of encountered freshwater habitats. These stream and wetland habitats are usually equivalent to one or more of the Department of Environment and Resource Management's (DERM) Regional Ecosystems (REs) which have been described for Cape York Peninsula. The REs occurring in the Project area are described and mapped in **Section 7.5.2**; however, the corresponding RE(s) for each of the stream and wetland habitats described in the following sections are summarised in **Table 8-3**.

Table 8-3 Relationship between Stream/Wetland Habitats and Regional Ecosystems

Stream/Wetland Habitat	Corresponding Regional Ecosystems
Perennial Flowing Streams	3.3.5 3.3.9
Semi-Perennial Coastal Lakes and Lagoons	3.3.14a
Perennial Channel Hosted Pools and Lagoons	3.3.9 3.3.14a
Coastal Swale Swamps*	3.2.3
Tree Swamps	3.3.14a
Seasonal Stream Channels	3.3.5 3.3.9 3.5.22c
Seasonal Coastal Lakes	3.3.14a 3.3.63 3.3.63 3.3.65
Spike Rush Swamps	3.3.63
Drainage Depressions and Flood Runners	3.3.21 3.5.22c
Groundwater Seepage Zones and Springs	3.3.5 3.3.9 3.3.14a 3.3.21 3.5.22c
Estuaries	3.1.1a 3.1.1c 3.1.3 3.1.5 3.1.6

* Coastal Swale Swamp 3.2.3 is listed "Of concern" under the *Vegetation Management Act 1999* (Qld)

8.4.1 Perennial Flowing Streams

The full extent of perennial stream habitat within the Project area has not been fully ascertained by dedicated late dry season survey but observations of persistent base flows made in September and November 2007 and December 2008 suggested such habitat occurs primarily within the mid and lower reaches of Norman Creek, and the upper (i.e. Site 7A) to lower reaches of its main eastern tributary. Surveyed perennial stream sections included Site 5A, Site 1A, Site 7A and Site 11 within the Norman Creek catchment (refer **Figure 8-2**).

The Winda Winda Creek system was observed to have a more seasonal flow regime, although it did retain perennial freshwater pools through the dry season. Aerial photo interpretation and Traditional Owner reports suggest that perennial pools also occur in the upper reaches of Coconut Creek though no perennial pools or reaches were observed in the Project area. Only a

brackish tidally influenced perennial reach persists in the Ward River below the old road crossing at Site 25A through the late dry season.

Dry season streamflow is driven by groundwater discharge, with the sites that drain the broadest and most elevated area of the bauxite plateau, which seasonally hosts shallow groundwater aquifers, exhibiting persistent dry season base flows. Seasonal streamflow also occurs in other stream reaches in lower catchment positions and persists well into the dry season in some locations.

In the Norman Creek catchment, perennial stream habitat extends into the incised upper reaches of the eastern tributary (Site 7A) but also includes spring fed channels emanating from a tree swamp (Site 11) draining the "lowlands" of its north-western tributary. In the Ward River system, small but persistent dry season base flows were observed in lower reaches below the Tappelbang Creek confluence (Site 25A) in November 2007, but flow had ceased in December 2008, while flows in the upper Coconut Creek tributary reaches had ceased by the first dry season survey in August 2007. It is possible that in years with below-average wet season rainfall no system within the Project area would retain flows for the full duration of the dry season. Flow regimes within these systems vary markedly between the wet and dry season. Observations indicate recession in flow rate occurs over an extended period beyond the wet season with both the Ward River and Norman Creek systems exhibiting high discharge volumes and flow velocities that made biotic sampling difficult in late May 2008. These same systems had only trickling base flows when observed in September the preceding year.

Water quality within perennial stream systems was characterised by low conductivity and very high clarity with some variability in clarity observed between sites and season. Water clarity within the upper reaches of the Norman Creek system (Site 11, Site 2A, and Site 7A) was greatest during high base flows while the Ward River system and lower reaches of the Norman had some colloidal content creating a bluish hue to the water. Later in the dry season, under low base flow conditions, water clarity was observed to become murkier due to tannin staining and organic material in the water column in the Ward River (Site 25A) while other sites possibly close to source springs (11, 7A, 5A, 1A) still exhibited high water clarity. Sites with isolated pools that were used as wallows by feral pigs (Ina Creek at Site 26 and Winda Winda Creek at Site 9A) were murky. Water quality is described in more detail in **Section 8.5.1**.

In addition to submerged and emergent aquatic plants, other more common aquatic micro habitats in perennial stream reaches include riffles, runs, pools, undercut banks, large woody debris and leaf litter packs and beds.

Perennial stream reaches act as refugia for aquatic biota within a highly seasonal environment and consequently the most diverse fish and crustacean communities were recorded (refer **Section 8.7**) from these sites, including bigger body species which require larger and more productive habitats for survival. Top order predators including Estuarine crocodiles were also more commonly encountered in these larger perennial habitats.

The key values associated with perennial streams within the Project area include:

- the aquatic refugia they provide for freshwater biota in a highly seasonal environment;
- the populations of larger bodied, fishery significant and ecosystem keystone fish species they support;
- the food chain productivity and downstream nutrient export they contribute to via maintenance of wetland habitats and aquatic plant communities; and
- the habitat they provide for species of conservation significance, including the Estuarine crocodile.

Freshwater discharge from perennial streams also affects the salinity regime in downstream estuarine ecosystems, which in turn affects estuary biological community composition, primary productivity and fishery nursery values.

8.4.2 Semi-Perennial Coastal Lakes and Lagoons

Semi-perennial coastal lakes and lagoons occur in a number of geomorphic settings, usually as part of a complex wetland habitat aggregation that includes other described habitat types (i.e. 'Bulkuru' spike rush swamps, Tree swamps). They are commonly characterised by a semi-perennial open freshwater body of variable size (approximately 2ha to more than 8ha) in immediate proximity to the coast. These water bodies do not occur within defined stream channels but in broad drainage depressions or linear basins within the bauxite plateau, with or without significant contributory catchments. Within the Project area such systems were identified at Pera Head (Site 16A), adjacent and to the south of the mouth of Norman Creek, in the lower reaches of the Ina Creek system, in the upper Waterfall Creek system south of Ina Creek and adjacent to the lower Ward River estuary. Site 16A at Pera Head and Site 32 adjacent the lower Ward River were field-sampled as part of aquatic ecosystem investigations while other sites were field surveyed from the air. All of these water bodies are generally located above sea level and generally lack saltwater intrusion due to downstream drainage line barriers of outcropping bauxite ridges and/or contemporary beach ridges. Their semi-perennial nature is attributed to connectivity with the shallow groundwater aquifer.

8.4.3 Perennial Channel Hosted Pools and Lagoons

Lagoons and pools occur within perennial flowing stream reaches but also within larger seasonal stream channel networks. Perennial pools and channel hosted lagoons also occur within the mid and lower reaches of all tributary branches of the Winda Winda – Triluck Creeks estuary system, and within the lower Ina Creek system. These habitats are hosted within defined stream channels, although in the Triluck Creek estuary tributaries they include prior streams and abandoned channel networks. In the lower reaches of the two main Norman Creek tributaries (Site 3 and Site 8) perennial lagoons form the core of an "everglades" habitat complex that includes contiguous paperbark tree swamps and emergent spike rush sedgelands.

Although grouped on the basis of perenniality, these pool and larger lagoon systems have variable hydrological and salinity regimes. In the lower Ina, Norman Creek and Ward River systems pools appeared to be maintained by groundwater seepage contributions throughout the year, although in the Ward tidal ingress was dominant and water quality brackish by the late dry season. Other systems (Triluck estuary tributary lagoons, Winda Winda Creek system) appeared to be more seasonal and primarily supplied by wet season surface runoff. Sampled perennial channel hosted pools and lagoons included sites on Winda Winda Creek (Site 9A), Norman Creek (Site 1A) and Ward River (Site 25A, 20). While some sampled pools (Site 26A and Site 25A) had significant inflows at the time of biological sampling these habitats would be more typically characterised as still waters for a larger proportion of the year.

8.4.4 Coastal Swale Swamps

Coastal beach ridge swale swamp formation is constrained within the Project area by bauxite plateau cliff frontages on most of the exposed coastline and is limited to areas where the bauxite surface has been lowered through fluvial erosion or where coastal geomorphology enables beach ridges to establish in front of the plateau. Beach ridge swale swamps within the Project area are located between Leithen and Franjum Points in the Embley River estuary and adjacent to the northern tributary drainages of the Norman Creek estuary mouth immediately to the north of False Pera Head. More significant swale swamp aggregations occur outside of the Project area between Worbody Point and "The Lake" in the lower Ward River estuary and around Urquhart Point in the north. The hydrology of these systems varies. Examples in the north appear to be highly seasonal and supplied only by localised wet season runoff and shallow beach ridge aquifers. Systems to the north of the Norman Creek mouth appear less seasonal and to be partially supplied by groundwater seepage from the adjoining bauxite plateau as well as rainfall runoff and shallow beach ridge aquifers. The Norman Creek system also appears to be less perched and subject to some tidal influence. Swale swamps south of False Pera Head are perched, supplied by more significant catchments and have tidal intrusion limited by coastal lateritic outcrops within their drainage outlets.

8.4.5 Tree Swamps

Tree swamps include areas of seasonal or permanent shallow water that are dominated by *Melaleuca* swamp forest communities. Within the Project area these habitats occur in a number of geomorphic and hydrological settings including:

- bank margins and back levee depressions of the lower freshwater reaches of the main perennial and semi-perennial drainage systems (Ward River, Norman and Winda Winda Creeks);
- marginal communities on semi-perennial coastal lakes formed within linear drainage depressions in the bauxite plateau (lower Ina Creek, Waterfall Creek and tributary drainage depressions adjacent the lower Ward River estuary);
- isolated circular depressions within and on the margin of the bauxite plateau (between the Pera Head access road and the Boyd Bay coast, east and south-east of False Pera Head, east of the Hey Point access road, Hey Point, and Leithen Point); and
- adjacent to seasonal lakes on the floodplain interface between freshwater and tidally influenced areas in the lower catchment of the main drainage systems.

Water supply to these tree swamps varies in terms of the contribution of surface runoff versus groundwater seepage. Three of the tree swamp sites surveyed are circular depressions in the bauxite plateau. One occurs in an isolated small tributary drainage of the Hey River estuary on the margin of the bauxite plateau (Site 27); another (Site 22) is more centrally located within the bauxite plateau and connected to the Coconut Creek – Ward River drainage system. The third, the Boyd Bay tree swamp (Site 35), is also located within the bauxite plateau but has no apparent connectivity to adjoining drainage networks. Both Site 27 and Site 22 appeared to be partially supplied by the shallow groundwater aquifer as evidenced by outflowing springs observed in February 2008 and 2009, and late May 2008. Water samples, but not biological samples, were collected from a fourth tree swamp, Site 23, which is an isolated depression between the bauxite plateau and False Pera Head. Upwelling of groundwater was also observed at this location.

Numerous other tree swamps formed significant marginal habitats particularly adjoining semi-perennial coastal lakes and lagoons, perennial channel hosted lagoons and seasonal coastal lakes.

8.4.6 Seasonal Stream Channels

Seasonal stream channel habitats are defined on the basis of a stream bed and channel (often incised) and non-permanent flows. Most of the defined surface drainage channel network within the Project area is seasonal, although flows may extend into the mid dry season in years of above average wet seasons, as observed in 2008. Perennial and semi-perennial pools are present throughout the seasonal stream channel network. Seasonal stream channels occur in most upper catchment tributaries of the main drainage systems including Norman and Coconut Creeks and throughout much of the drainage network of the Winda Winda and Ina Creek systems. However, drainage depressions (refer **Section 8.4.9**) also constitute a significant proportion of the upper catchment drainage network in these systems. Seasonal stream channels also occur in lower catchment areas linking coastal tree swamps and lakes to the coast at False Pera Head and in both the lower Ina (Site 36) and Waterfall Creeks. Except for their size and flow duration, seasonal stream channel habitats share much in common with perennial stream channel habitats. Surveyed seasonal stream channel sites included Site 9A, Site 33 and Site 34 on Winda Winda Creek, Site 19 on the eastern tributary of Winda Winda Creek, Site 4 and Site 2A on Norman Creek and its eastern tributary branch, Site 14A on Coconut Creek, Site 24 on the un-named drainage near False Pera Head and Site 26 on Ina Creek. Although not sampled, seasonal stream channels on minor coastal catchments were also observed at False Pera Head and Pera Head (upstream of Site 16A).

8.4.7 Seasonal Coastal Lakes

Seasonal coastal lakes are generally non-permanent bodies of open water of varying size (up to and greater than approximately 8ha) located on the floodplain interface between freshwater and tidally influenced areas. Seasonal coastal lakes occur in the lower catchment of the main drainage systems (Winda Winda and Norman Creeks and Ward River). These lakes occur within larger wetland aggregations and are usually surrounded by spike rush swamps (refer **Section 8.4.8**) and/or tree swamps and are often connected to smaller more perennial water bodies. During the wet season these lakes are inundated by surface runoff but, as the dry season proceeds, water levels recede to leave dry basins at most sites. At some sites and in wetter years remote sensed aerial images suggest perennial freshwater bodies may persist through the dry season (lower Ward River and Winda Winda Creek systems). Stands of paperbark trees and spring-head riparian communities growing at the base of lateritic profiles on the margins of the coastal floodplains that host these lakes indicate groundwater seepage zones, and contribution from groundwater seepage forms part of the hydrological regime of at least some of these lakes. In May 2009 lake sites in the lower Ward River (Site 29) and Winda Winda Creek (Site 17) systems were observed to be discharging freshwater to the adjoining estuary, while Site 13 adjoining the Norman Creek estuary – while brackish and fringed by sedge communities – exhibited no freshwater discharge during low tide periods and was inundated by tidal ingress during high tide periods.

These lakes are formed on clayey soils, including old marine sediments which, when dry, have the appearance of salt pans. Their location adjacent to tidally influenced mangrove channels, and the salt tolerant plant communities they contain, indicates they are subject to some tidal influence. This influence is likely to be greatest in terms of ingress late in the dry season when freshwater levels have receded and spike rush vegetation is senescent. Only three of these systems were biologically field surveyed (Site 17 and Site 18 Winda Winda Creek system and Site 13 Norman Creek system) but not sampled due to access and safety limitations. Several of the lower Ward River seasonal lakes were also surveyed and sampled during December 2008. Most other seasonal lakes were aerially inspected and discharge confluences from Site 13 to the upper estuary of the Norman Creek system were sampled for fish.

8.4.8 Spike Rush Swamps

Spike rush (*E. dulcis* and *E. sundaica*) swamps commonly occur within coastal wetland aggregations. Dense stands of *E. dulcis* are present in seasonal, brackish water bodies which form seasonal lakes (refer **Section 8.5.7**) on the floodplain interface between freshwater and tidally influenced areas in the lower catchment of the main drainage systems. In lower Norman Creek, spike rush occur in shallow drainage depressions draining the back of the beach ridge swale system to the north of the estuary mouth. In the Winda Winda – Triluck Creek estuary system, spike rush also occur on a drainage depression network draining the back of the southern coastline. Smaller occurrences of brackish spike rush swamps occur between Leithen and Hey Points in the north of the Project area. Although *E. dulcis* commonly grows in brackish environments subject to tidal influence as it is also dependent upon freshwater inputs, it does not grow on salt pan basins that lack sufficient surface catchment areas or contributory groundwater seepage (Blackman *et al.* 1999).

Another form of spike rush swamp in the Project area located away from tidally influenced areas is dominated by less dense stands of *E. sundaica.* This habitat includes water bodies that occur in the centre of tree swamps and semi-perennial coastal lakes (refer **Section 8.4.2**) including those in lower Ina and Waterfall Creeks. Only one spike rush habitat within a tree swamp was field sampled (Site 27) due to access and safety limitations in the larger wetland systems. However, on-ground field inspections were made of these communities in the lowermost reaches of Norman Creek (Site 13) and Winda Winda Creek (Site 17 and Site 18) and adjoining estuarine sites in the lower Ward River system. These systems were also aerially surveyed.

8.4.9 Drainage Depressions and Flood Runners

Drainage depressions and flood runners represent some of the most extensive seasonal freshwater habitat within the Project area. These two habitats have distinctive geomorphic and hydrologic characteristics but are grouped here on the basis of similar habitat features and values. Linear drainage depressions occur across the bauxite plateau and generally represent the uppermost definable reaches of surface drainage systems. These are differentiated from the surrounding Darwin Stringybark woodland on the basis of being topographic low points and hosting species associated with riparian and "soak" communities (i.e. *Lophostemon*, *Banksia* and *Melaleuca*). These drainage depressions generally lack any defined channel and have no pool features other than minor scours that have formed downstream of large woody debris. They occur in low relief upper tributary reaches of all the named drainage systems and intervening catchments including unnamed drainages east of False Pera Head, south of Ina Creek and flowing north-westerly from the existing Pera Head access road. These drainage depressions convey both surface runoff and shallow groundwater discharges. Sampled sites comprising the eastern tributary of Winda Winda Creek (Site 19) and northern tributary of Norman Creek (upstream of Site 4) were flowing strongly in late May 2008. Other drainage depression sites that were field inspected included water quality sampling Site 12, Site 13 and Site 24. Only the latter of these sites contained water when visited during the 2008 wet season water quality sampling and all were observed to be dry by late February 2009.

Flood runners occur within broad alluvial corridors in the mid and lower reaches of the more major drainage systems. Like drainage depressions, these features convey flows through back of stream levee drainage depressions differentiated from surrounding Darwin Stringybark woodland on the basis of changes in vegetation community towards species associated with riparian and "soak" communities (i.e. *Lophostemon*, *Banksia* and *Melaleuca*). Subject to the extent of lateral shallow groundwater flow these systems are more seasonal than upper catchment drainage depressions with flows primarily restricted to periods of elevated/overbank streamflows during the wet season. Flood runner habitats did not contain sufficient water during surveys to enable biological sampling, though these types of habitats were field inspected during site surveys of adjoining stream channels (i.e. at Site 11, Site 2A, Site 1A, and Site 25A).

8.4.10 Groundwater Seepage Zones and Springs

A range of shallow groundwater aquifer dependent aquatic habitat types is collectively referred to under this grouping of groundwater seepage zones and springs. Groundwater has been identified as an important component in the hydrology of the majority of the habitat types identified in streams and wetlands. One of the main forms of connectivity between groundwater and these habitats are springs and seepage zones which feed into surface water features. However, such springs and seepage features occur widely through the Project area and in many instances do not contribute to large surface water features and it is these smaller groundwater dependent habitat types that are identified here. Considering the lateritic profile as the primary host material for the shallow seasonal groundwater aquifer in the Project area (refer **Section 5.3.2**), the occurrence of springs and seepage zones can most readily be related to the depth of surface incision into this profile. An illustration of the contribution of the bauxite profile comes in the form of numerous out flowing springs emanating from the bottom of the bauxite cliffs that fringe the Gulf coastline of the Project area. While these springs are most prominent immediately after the wet season, some exhibit flow until the mid dry season. Subject to the distance between the point of groundwater out flowing and the beach, some of these systems support short seasonal streams with or without pools. In some instances these systems drain to the coast via plunge pools and channels formed into the bauxite surface, creating seasonal cascades and locally significant perennial pool habitats (e.g. at False Pera Head).

Away from the immediate coastline, other topographic low points that provide an outlet for bauxite hosted groundwater include deeply incised tributary valleys in the upper reaches of some systems (e.g. Norman Creek Site 7A) and fluvial erosion corridors (valleys, drainage depressions) draining the bauxite plateau. Circular depressions, possibly caused by dissolution collapse of the underlying lateritic profile, also occur within the bauxite plateau and in some

instances appear to be conduits for surface out flowing of groundwater, often hosting tree swamp communities. Groundwater outlets within these surface features are most likely controlled by the underlying hydraulic connectivity of the lateritic profile and are evidenced at the surface by high soil moisture dependent vegetation types and often small pools and emergent fringing aquatic vegetation. Low contour "embayments" that back the estuarine outlets of surface drainage systems (i.e. lower Winda Winda Creek, Norman Creek and Ward River estuaries) also appear to be sites of groundwater seepage zone formation as evidenced by stands of *Melaleuca spp.* growing in narrow bands on the margin between dry woodland and tidally influenced estuarine habitats.

Groundwater seepage zones or springs were not specifically targeted as part of the aquatic ecosystem investigations though such habitats were often observed at sampled sites (e.g. the perennial Norman Creek tributary stream at Site 11, tree swamp Site 22 and Site 27, coastal lagoon Site 16A, Ward River tributary swamp Site 32, and drainage depression Site 19). Spring fed habitats were also inspected adjacent to False Pera Head. Groundwater appeared to discharge from macro pores on the stream bed in clearwater reaches of the upper Norman (Site MN8) and Ward (Site 28) estuaries in May 2009 and December 2008 respectively.

The Great Artesian Basin Resource Operations Plan (GAB-ROP) (DNRW 2007) defines three spring types associated with artesian water of the Great Artesian Basin, these are recharge, watercourse and discharge springs. An assessment of the potential for these springs, and the threatened ecological community, to occur in the Project area concluded that only recharge and watercourse springs (not discharge springs) occur in the Project Area (refer Section 5.3.4). Therefore the ecological community is unlikely to occur in the Project area.

8.4.11 Estuaries

The estuaries of the Project area are a complex of continuous wetland aggregations (Blackman *et al.* 1999) including swale swamps, spike rush swamps, paperbark tree swamps, seasonal lakes and saline coastal flats. They are characterised by a diverse mangrove forest community, which is partially related to the freshwater discharge they receive and the wide range of salinity regimes and geomorphic habitats that occur within them. Saline flats are common on the landward side of mangrove forests and are particularly extensive along lower Winda Winda Creek and Ward River. These are sparsely vegetated as their relatively high salinity in the late dry season tends to discourage plant growth. They are commonly dominated by marine couch *Sporobolus virginicus* or by *Xerochloa imberbis*. Sedges, particularly *E. dulcis*, may become prominent or dominant in these areas during the wet season.

There are six estuarine ecosystems in the Project area, three of which occur entirely within it (Norman, Leithen and Ina Creek estuaries) and three that only partially occur within the Project area but have catchments that drain it (Ward River, Triluck–Robert's Creeks and Hey–Embley Rivers).

The Ward River drains the southern portion of the Project area to an estuary that is contiguous with the Watson and Archer River systems which adjoin to the south. Collectively these systems form Archer Bay, an estuarine wetland aggregation listed in the Directory of Important Wetlands in Australia (Blackman *et al* 1999). Only the uppermost reaches of the Ward River estuary occur within the Project area. The northern boundary of the Project area abuts the large open Embley estuary that forms the southern boundary of the Weipa Peninsula, and drains to it via the Triluck–Robert's Creeks estuary (upper reaches of which occur within the Project area). The Leithen Creek estuary (entirely within the Project area) and minor drainage lines in the north-east of the Project area also drain to the Embley estuary via the Hey River.

There are also a number of smaller defined drainage systems to the Gulf of Carpentaria within the Project area. The three more significant systems include an unnamed drainage that flows to the sea at Pera Head, another immediately south of False Pera Head, and Waterfall Creek south of Ina Creek. These systems lack "true" estuaries due to their mouths being partially occluded by beach ridge swales and lateritic rock outcrops which limit tidal intrusion and the development of an "estuarine" mixing zone. These latter systems are more appropriately described as swale swamp ecosystems.

The "true" estuaries within the Project area lie within "embayments" of the bauxite plateau surface which have been created by fluvial erosion resulting in the presence of estuarine mixing zones in the lower reaches of the drainage systems. They also exhibit a range of hydrological regimes differentiated on the amount and seasonal duration of freshwater discharge to them. Leithen Creek estuary in the north of the Project area lacks a significant catchment area and appears to receive the majority of its freshwater input as surface runoff during the wet season, though some groundwater seepage to this system would be expected to be sustained beyond the wet season. The Triluck–Roberts Creeks estuary is fed by the large Winda Winda Creek catchment. The Norman Creek estuary is fed by wet season flows and more perennial catchment discharges. The Ward River estuary is fed by wet season flows and by perennial groundwater inflows at the estuary margin. Distinctions in estuarine catchment hydrology influence the composition and relative dominance of habitats and vegetation communities (e.g. salt pans, seasonal lakes, spike rush swamps, paperbark swamps, mangrove communities) that comprise each estuarine wetland aggregation and the water quality, salinity regimes and primary productivity within them.

The Australian Catchment, River and Estuary Assessment was undertaken as part of the National Land and Water Resources Audit (NLWRA) and aimed to assess the current condition of Australian estuaries. The first stage of the assessment was an initial condition assessment where estuaries were classified as in 'near pristine' condition, 'largely unmodified' condition, 'modified' condition or 'extensively modified' condition. The classification was qualitative and determined from information obtained from state agencies through workshops and interviews. Of the 979 estuaries assessed, half were classified as being in 'near-pristine' condition (National Land and Water Resources Audit, 2002). An estuary was classified as near pristine if it had:

- a high proportion of natural vegetation cover in the catchment;
- minimal changes to hydrology in the catchment;
- no changes to tidal regime;
- minimal disturbance from catchment land use;
- minimal changes to floodplain and estuary ecology;
- low impact human use of the estuary; and
- minimal impacts from pests or weeds.

The other three categories of the assessment - largely unmodified, modified and severely modified were used to indicate increasing levels of change for some or all of these criteria.

The Archer Bay and Norman Creek estuaries are classified as being in 'near pristine' condition, and the Embley River estuary is classified as being in 'largely unmodified' condition (National Land and Water Resources Audit 2010).

Water quality and biological sampling were conducted within three Project estuarine systems: Norman Creek (Site 10A and Site 12), Ward River (Site WP8, Site WP14, Site 28, Site 29 and Site 30) and Winda Winda – Triluck Creeks (Site 21) and within the Pera Head coastal lagoon (Site 16A). Visual observations and opportunistic angling also provided site data for the Ina Creek estuary.

8.5 Water Quality and Hydrology

8.5.1 Water Quality

The surface water quality characteristics of the Project area including the sampling methods used and parameters sampled are summarised in **Section 5.1.4**. The fresh surface water quality of the Project area is generally similar to other tropical waters in northern Australia and can be summarised as mildly acidic with low conductivity and very low hardness. Aluminium and iron concentrations are elevated due to the influence of the bauxite plateau.

Low conductivity can potentially be the cause of osmotic (salt regulation) stress for many organisms, particularly those with recent marine affiliations. For organisms with calcareous body parts, the low hardness, and very low calcium concentrations are likely to make accumulation of this metal and secretion of calcium carbonate structures difficult. This may explain the absence of freshwater molluscs and the "soft" exoskeleton crayfish (*Cherax rhynchotus*) in the fresh waters of the Project area.

The lack of solutes in the waters of the Project area indicates there is little pH buffering capacity, and there can be a strong response to minor changes in the geochemistry. For example, **Figure 8-3** shows a stream in a bauxite plateau north of Weipa at a site where groundwater inflows were dominant over surface flows. Iron oxidation from Fe^{2+} to Fe^{3+} and the subsequent formation of iron oxy-hydroxides ($Fe_xO_yOH_z$) resulted in the release of sufficient H^+ ions (released from water in this process) to cause a drop in pH of almost 1 unit from that upstream of the point of groundwater inflow. Re-equilibration with atmospheric CO_2 caused a return to ambient pH within approximately 500m. Such geochemical processes occur naturally to some extent in most streams, but generally inherent buffering of pH reduces the influence of iron oxidation chemistry in harder waters. The pH level is a major influence on the chemistry of other solutes, including trace metals, many of which are also more soluble under low pH. Variations in surface water chemistry need to be taken into account when assessing the potential risks for mine-related alteration to water quality, particularly in relation to potential changes in surface and groundwater contributions.

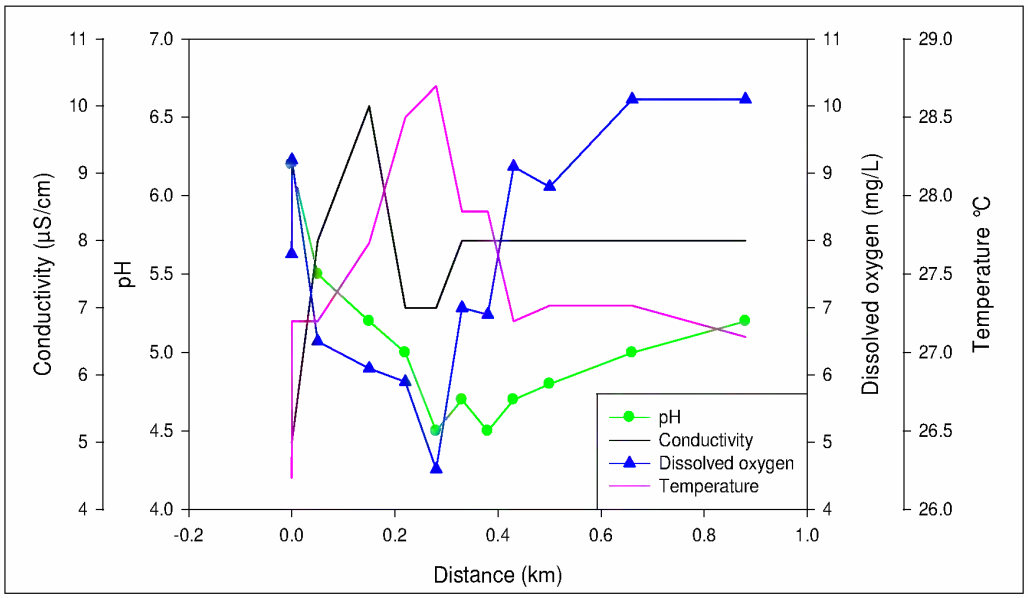

Figure 8-3 Field Parameters in Stream Downgradient from Groundwater Inflows

In soft waters geochemical mitigation processes to reduce the bioavailability of metals present may be inhibited. The hardness of the Project area freshwater streams and tree swamps is low and thus the default ANZECC/ARMCANZ (2000) water quality guidelines for protection of aquatic ecosystems for chromium, copper, cadmium, lead, nickel and zinc require correction for hardness.

The hardness of Project area freshwaters ranges from 0.36 to 9.7mg$CaCO_3$/L with a median of 1.3mg$CaCO_3$/L. ANZECC/ARMCANZ (2000) states that the hardness correction algorithms may be applied for hardness outside the 25 to 400mg$CaCO_3$/L range used to derive the relationships; however, Markich *et al.* (2001) in their derivation of the guidelines note that the

slope of the relationship (the exponent in the equations provided in ANZECC/ARMCANZ (2000) Table 3.4.3) is zero for extremely low hardness (ca. 1mg$CaCO_3$/L, which is quite typical of the Project area freshwaters), meaning that extrapolation of the standard algorithms will be overly protective for the Project area streams. In addition, commercial laboratories may not be able to consistently achieve such low reporting levels for the hardness dependent metals.

Metal toxicity in very soft waters has been investigated in Australia and elsewhere (Markich and Camilleri 1997), and generally the toxicity of metals for which hardness affects bioavailability, such as copper, is greater in very soft waters. For example, the default ecosystem protection trigger value for copper in ANZECC/ARMCANZ (2000) for water with hardness of 30mg$CaCO_3$/L ("soft waters") is 1.4µg/L, but Markich and Camilleri (1997) recommended a trigger value of 1µg/L for copper for waters with hardness <10mg$CaCO_3$/L. The standard commercial laboratory reporting limit for copper in analysis suites for environmental monitoring is 1µg/L. Therefore, it is likely that appropriate trigger values for metals in solution in soft waters such as found in the Project area would be lower than default trigger values of ANZECC/ARMCANZ (2000), but higher than that indicated by simple extrapolation of hardness correction algorithms.

The softest water that has been used for toxicity testing in Australia, or found in international literature, was 3.2mg$CaCO_3$/L in Buffalo Billabong water by the Environmental Research Institute of the Supervising Scientist, Northern Territory, Australia (then the Alligator Rivers Region Research Institute) (Markich and Camilleri 1997). The median hardness of the samples of freshwaters from the Project area ranged from 0.36 to 9.7mg$CaCO_3$/L. Given the lack of toxicity testing with soft waters it is not possible to rely on existing toxicity testing as a guide to assess site water quality.

In the absence of dedicated toxicity testing, a conservative approach is to assume that all dissolved metal concentrations in the site waters are bioavailable. The background dissolved concentrations in fresh surface water of metals requiring hardness correction are less than the default guideline values.

While acknowledging they are overly conservative, the hardness modified trigger values were calculated for applicable metals (**Section 5.1.4**) to evaluate if these are potential constituents of concern at the Project area. All hardness modified trigger values were less than commercial laboratory reporting levels. The concentration of metals in freshwaters compared with the hardness modified trigger values are discussed below.

- The maximum concentration of dissolved nickel and cadmium was less than the hardness modified trigger values in all freshwater samples.
- The maximum concentration of dissolved lead in freshwater stream samples (0.65µg/L) was greater than the hardness modified trigger value (0.066µg/L); however, the 80th percentile concentration was less (0.05µg/L). Both the maximum and 80th percentile concentrations of dissolved lead in freshwater tree swamps was less than the hardness modified trigger value.
- The maximum dissolved concentration of copper and zinc in freshwater streams and tree swamps was greater than respective hardness modified trigger values; however, the 80th percentile concentrations were less than hardness modified trigger values.
- The 80th percentile concentration of chromium in freshwater tree swamps was 0.10µg/L and in streams 0.08µg/L, both slightly greater than the hardness modified trigger value of 0.078µg/L.

Aluminium (along with iron and manganese where groundwater inflows are dominant) is naturally elevated in the surface waters of the Project area. The toxicity of aluminium in fresh water varies with pH, being more toxic below pH 5.5 and above 9 (ANZECC/ARMCANZ 2000), and separate trigger values are provided in the guidelines for freshwaters with pH below 6.5 (0.8µg/L, low reliability) and pH above 6.5 (55µg/L, moderate reliability). For some constituents there is insufficient data available for ANZECC/ARMCANZ (2000) to develop a high or moderate reliability trigger value, and a low reliability trigger value may be available to be used as an indicative interim working level. For marine waters there is insufficient data available for

ANZECC/ARMCANZ (2000) to develop a moderate reliability trigger value, and a low reliability value of 0.5µg/L was derived from the most sensitive test result.

The aluminium concentrations in fresh surface waters are generally above the ANZECC/ARMCANZ (2000) default trigger values. The concentration of iron in freshwaters exceeded the ANZECC/ARMCANZ (2000) interim working level of 300µg/L on occasions. Aluminium, iron and manganese may be affected by geochemical changes arising from mining impacts or natural causes. It is proposed to set Project trigger values for aluminium, iron and manganese based on the 80th percentile of the baseline data set for freshwaters. If, during operations, the median concentration of aluminium, iron or manganese exceeds the Project trigger value, an investigation would be carried out to determine the possible causes.

All estuarine samples, except for the September 2007 sample from Norman Creek, exceeded the low reliability default trigger value for aluminium in marine waters of 0.5µg/L. It is proposed to set Project trigger values for aluminium based on the 80th percentile of the baseline data set for estuarine and marine waters. If, during operations, the median concentration of aluminium exceeds the Project trigger value, an investigation would be carried out to determine the possible causes.

Note that for some site-specific guidelines to be developed, additional sampling over that achieved to date would be required in order to determine the 80th percentile of background concentrations, and additional sampling would improve the accuracy of the estimate of the 80th percentile for all sites.

The natural mineralisation of the Project area has resulted in dissolved aluminium concentrations that are higher than default ANZECC/ARMCANZ aquatic ecosystem protection trigger values. As this is natural, it is likely that the local ecosystems have adapted to the naturally high aluminium concentrations, at least to the extent that only those taxa able to tolerate those levels will persist (discussed further in **Section 8.15**).

8.5.2 Hydrology

The surface and groundwater hydrology of the Project area and potential impacts and mitigation measures are detailed within **Section 5**. The catchment hydrology of the Project area is characterised by naturally high inter-annual and inter-decadal variability in response to the summer monsoon, cyclonic rain depressions and El Niño – La Niña cyclical influences. Potential impacts on surface water and the shallow groundwater aquifer that may impact upon aquatic ecosystems have been identified. Modelling of catchment behaviour within the Project area (**Section 5.2.4**) indicates potential changes to catchment discharge associated with mining development fall within plus or minus 1% of mean annual discharge. This section provides a summary of the specific linkages identified between surface and groundwater hydrology and the character and values of Project area aquatic ecosystems.

8.5.2.1 Drainage Channel Morphology

The morphology of drainage channels and associated floodplain features in surface drainage catchments is determined by the scouring and sediment transport capacity of the flow regime. In the Project area, peak flow events are largely responsible for the geomorphology of stream valleys, including scour-formed pools, floodplains and associated flood runner channels and the estuary (**Section 7.2.5**). High within-channel flows in the Project area are often attributed to the hydraulic gradient between the contributing groundwater aquifer and the surface channel network, and are responsible for a large proportion of the sediment transport capacity of the drainage network. Alterations to the flow regime, particularly to extreme peak flows or modal flow characteristics, are likely to result in changes to channel and floodplain form, depending on the magnitude of the alteration. Alterations to the peak and modal flow characteristics may occur as a result of rainfall-runoff retention in mining pits, construction of water storages and alterations to shallow groundwater hydrology. Such changes would be likely to result in some geomorphic changes in the receiving drainage network.

8.5.2.2 Water Quality

The water quality of surface waters throughout the Project area is largely related to the infiltration and residence of rainfall and surface runoff within the seasonal aquifers provided by the bauxite lateritic profile, which effectively filters water before releasing it to perennial and seasonal flowing drainage networks. Alterations in surface and groundwater hydrology that change the residence time of water within these seasonal aquifers and/or the relative contribution of surface runoff and groundwater discharge to the surface drainage networks, particularly more seasonal ones, are likely to result in some alterations of the water quality characteristics of these systems.

8.5.2.3 Flow Associated Habitat Availability

In the Project area, groundwater discharge to surface drainage networks enables persistence of flowing stream reaches for extended periods into the annual dry season. Results from biological sampling within the Project area indicate some fish and macroinvertebrate community compositional differences that can be related to the relative availability of flow-associated habitats (e.g. riffles and runs), within different stream catchments. Alterations in surface and groundwater hydrology that change the extent and persistence of flow-associated habitats within these drainage networks could be expected to drive shifts in faunal composition at the reach and sub-catchment scale, depending on the magnitude of the alteration.

8.5.2.4 Habitat Connectivity

The duration and depth of surface drainage network flows is an important determinant of the level of connectivity between perennial freshwater habitats. Inter-habitat connectivity influences the diversity of fish communities including the distribution of migratory and larger bodied species (**Section 8.7**). Changes to inter-habitat connectivity through reduced surface water flow volumes or duration, or the construction of on stream storages, could affect the recruitment of fish species to upstream habitats, particularly those that already have some degree of isolation or intermittency. Refer to **Section 8.16** for further discussion on the magnitude of change to habitat connectivity associated with Dam C on a freshwater tributary of Norman Creek and proposed mitigation measures and **Section 8.14** for discussion on potential impacts to hydrology and proposed mitigation measures. An assessment of the potential impacts on listed species associated with habitat connectivity is in **Section 8.17** for freshwater species and **Section 6.9.5** for marine species.

8.5.2.5 Habitat Perenniality and Flow Duration

Perennial freshwater habitats are widely distributed throughout the Project area. In a highly seasonal environment, perennial water bodies influence the diversity of obligate freshwater biota retained within isolated sub-catchments, such as those typical of the bauxite plateau in the Project area. The potential for mining associated impacts to alter the duration of groundwater discharges to surface drainage networks, particularly in reaches hosted topographically higher in the bauxite lateritic profile, could impact upon the aquatic refugial value of individual stream reaches or sub-catchments during extended dry season periods. Initiation of flow with the onset of the wet season and persistence of flow for some time post wet season, is important to the total productivity of aquatic ecosystems and the populations of fauna and flora within them. Although population persistence through the dry season would require access to perennial habitat for obligate freshwater taxa, overall population productivity and hence probability of persistence would also be related to access to seasonally inundated habitats. Therefore, reduction in the total flow-duration in the drainage network may also impact total population productivity and likelihood of persistence of populations year by year. For those species with the ability to aestivate, having terrestrial life stages, or that have other mechanisms to persist through the dry without access to surface water, seasonally available surface water may be a substantial proportion of the habitat used by the population and supply much of the annual population productivity.

8.5.2.6 Ecotonal Zonation

Ecotonal riparian and wetland vegetation communities associated with perennial and seasonal surface water features in the SoE area, display a high degree of zonation occurring in linear or concentric bands of different species dominated communities, relative to the hydrological influence of the surface water feature. Hydrology (and associated soil typology) is one of the most important determinants of the location of these ecotonal zones governing plant survivorship and recruitment success via the inundation tolerances, soil moisture and germination requirements of individual species. Mining development associated impacts that result in alteration to catchment and groundwater hydrology that impact upon the inundation and/or soil moisture regimes experienced by ecotonal vegetation communities may drive changes in the location of ecotonal boundaries via the death of mature trees and migration of different vegetation zones in response to preferred germination conditions for individual species.

8.5.2.7 Fire Refugia

In the seasonal dry tropics within which the Project area is situated, fire regime interacts with many other drivers of ecosystem condition, including hydrology. In the Project area the distribution of fire-sensitive closed riparian forest communities is closely related to the fire refugia provided by channel form and soil moisture conditions. The potential for mining associated impacts to alter the seasonal duration of groundwater discharges to surface drainage networks could lead to impacts upon the seasonal soil moisture conditions experienced by some riparian vegetation communities and affect their fire regime. In reaches hosted higher topographically in the bauxite lateritic profile any potentially reduced base flow duration could potentially generate hotter fire conditions capable of driving fire-sensitive rainforest associated riparian vegetation toward replacement by more fire-hardy sclerophyll riparian vegetation. Lower in catchments, the potential for extension of basement aquifer base flow duration could perceivably increase the fire refugia function associated with moist alluvial landforms and generate vegetation changes toward greater representation and development of fire-sensitive riparian rainforest species.

8.5.2.8 Ecosystem Productivity

Most surface waters sampled over a range of seasonal flow conditions within the Project area have low nutrient values associated with their groundwater sources. The main sources of primary production input identified for the food chain of Project area aquatic ecosystems include leaf litter associated with riparian and swamp forests and in-stream algal and aquatic macrophyte growth in lower catchment wetland aggregations. Both of these sources of primary productivity are maintained to some degree by the hydrological conditions (riparian forests discussed above) of the catchment, particularly the sustained discharge of groundwater to surface drainage systems through a significant proportion of the dry season. Mining or infrastructure associated impacts that alter the initiation of flows and/or the seasonal duration of groundwater discharges to surface drainage networks could affect both the in-situ and exported productivity of lower catchment wetland aggregations, though the direction of such impacts could vary between catchments. Deferral of wet season onset flows due to water harvesting could delay the post dry season inundation of lower catchment wetlands and primary production exports or pulses from them. Conversely, increased base flow discharges from groundwater aquifers may have the capacity to drive increases in lower catchment primary productivity. If a truncation of base flows is experienced this could result in accelerated rates of wetland water level recession and associated declines in stream primary productivity with some potential also for increased tidal ingress and associated impacts at the estuarine interface of these systems.

8.5.2.9 Salinity Regimes

Sustained discharge of groundwater to surface drainage systems through a significant proportion of the dry season in some Project area catchments results in the maintenance of brackish environments within lower catchment wetland aggregations, including the upper reaches of estuarine systems. These brackish environments support a number of ecological

processes – e.g. enhanced fish recruitment (Robins *et al*. 2006, Halliday *et al*. 2008) – and valuable wetland habitats including 'Bulukru' spike rush *E. dulcis* swamps, seasonal coastal lakes (fishery nursery) and brackish mangrove communities. Potential mining associated impacts that alter the seasonal duration of groundwater discharges to surface drainage networks could result in the landward retreat of the extent of these brackish environments with an associated loss of habitat diversity and associated ecological values.

8.6 Riparian and Aquatic Flora

Generalised descriptions of the riparian and aquatic vegetation within the Project area are provided in **Section 8.4**. More specific floristic information is presented here for the two main vegetation community types comprising riparian overstorey communities and aquatic macrophytes. Detailed mapping of vegetation and associated Regional Ecosystems is provided in **Section 7.5**.

8.6.1 Riparian and Mangrove Communities

Riparian overstorey vegetation communities within the Project area can be classed into five generalised categories, though transitional and mixed communities including those categories occur in some geomorphic/hydrologic settings. The five categories are discussed below.

8.6.1.1 Closed Riparian forests

Closed riparian forests occur along most of the perennial and semi-perennial (seasonal) stream network within the Project area. These communities contain many rainforest-allied species and are fire sensitive. They generally occur on moist but well drained higher fertility alluvial soils on stream banks and levees and also within fire refugia created by incised channels and valleys (e.g. incised upper reaches of the Norman Creek system Site 7A), and on moist beach swales and areas of outcropping rock adjoining drainage lines. Closed riparian forest communities, particularly those associated with perennial stream reaches, showed a high level of compositional similarity throughout the Project area though the extent of their development varied in response to the level of fire refuge provided by channel and bank morphology. They develop their broadest expression in mid and lower catchment areas where alluvial deposits extend beyond stream banks and are fire protected by back levee flood runner channels. Elsewhere, such communities extend only one canopy tree diameter beyond the immediate stream channel bank. Common canopy trees within these communities include *Lophostemon suaveolens, M. leucadendra, Carallia brachiata, Dillenia alata, Syzygium suborbiculare, Syzygium spp. (~ ×2), Garcinia warrenii, Terminalia spp., Buchanania arborescens, Parinari nonda* and palms *Livistona muelleri,* and *Hydriastele wendlandiana* (only Site 7A). Where these closed forest communities occur they limit incident sunlight and in-stream aquatic plant growth and associated primary productivity but contribute leaf litter and snags. At sites where perennial streams occur in conjunction with tree swamps (i.e. Site 11 and the lowermost freshwater reaches of Norman Creek) closed riparian forests tend toward compositions more typical of swamp forest communities and include an increased dominance of paperbarks *M. quinquenervia* and *M. leucadendra*. Understorey vegetation is typically sparse on account of canopy shading.

8.6.1.2 Open Riparian Forests

Open riparian forests predominantly occur on the banks of more seasonal streams, or on reaches of perennial streams where banks are drier and more fire exposed due to non-conductive heavier soils or low water levels relative to bank levee heights (i.e. Ward River Site 25A). These open riparian forests comprise dry sclerophyll species including *Eucalyptus brassiana*, *E. polycarpa*, *Lophostemon suaveolens, Leptospermum longifolium, Calycopeplus casuarinoides, Banksia dentate* and *Livistona muelleri.* Subject to catchment location, bank margins will also usually have one or more species of paperbark present, most commonly *M. leucadendra*, *M. symphyocarpa, M. viridiflora* or *M. quinquenervia*. More fire-hardy representatives of the closed forest community, e.g. *Syzygium suborbiculare* and *Carallia brachiata*, are also commonly observed within these open forest communities. Understorey vegetation is usually a mixture of grasses associated with alluvial soils and a diverse mix of

sedges *Cyperus spp.* Sprawling twig rush *Dapsilanthus elatior* is also a common emergent macrophyte species encountered in the understorey and is found on seasonally waterlogged soils and stream and flood runner bank margins.

8.6.1.3 Swamp Forests

Swamp forests dominated by *Melaleuca spp.* occur in a range of catchment settings where soils are seasonally or permanently waterlogged, including depressional areas within the bauxite plateau, waterlogged lower catchment stream reaches of the major drainages, adjacent seasonal and permanent coastal lakes and within beach ridge swale systems. There are more than five species of *Melaleuca* recorded from the SoE area and each favours a specific set of soil and hydrological conditions. Some swamp forests comprise mono-specific stands of a single *Melaleuca* species, e.g. *M. leucadendra* in costal swale swamps or *M. quinquenervia* on coastal lakes and waterlogged lower stream reaches. While some communities, e.g. seasonal tree swamps in depressional areas within the bauxite plateau, host a mix of species which are arranged in ecotonal bands related to the variable hydrological conditions of the site, experienced in terms of different seasonal inundation and soil moisture regimes. These types of communities would be vulnerable to changes in catchment hydrology that result in spatial displacement of the conditions underlying these ecotonal zones. In dense mono-specific communities, canopy cover is often closed and there is limited understorey vegetation and the substrate is covered in leaf litter. In seasonal tree swamps in depressional areas within the bauxite plateau, canopy density is more variable and often includes open areas in the deeper central basin of the swamp and on the seasonally exposed outer margins. These open areas usually support emergent and aquatic macrophyte communities (discussed below). Transitioning from the deeper more permanently inundated areas of such swamps toward the upland margins, the sequence of *Melaleuca* species encountered includes *M. quinquenervia, M. symphyocarpa, M. leucadendra, M. viridiflora,* and *M. dealbata*. Other species that may be co-dominant in these tree swamps include *Lophostemon suaveolens* and *Calycopeplus casuarinoides. Livistona muelleri* is also often present on the upper margins of these tree swamps.

8.6.1.4 Drainage depression and Flood runner woodlands

These communities occur in association with the seasonal aquatic habitats created by wet season flooding and surface runoff and are also maintained post wet season by groundwater discharge and seepage. The boundaries of drainage depressions are demarcated by a transition from the Darwin Stringybark *Eucalyptus tetrodonta* woodland to *Banksia dentata* and *Lophostemon suaveolens* dominated woodland. Where these drainage depressions sustain flows for a greater proportion of the dry season, overstorey riparian vegetation trends more toward a swamp forest community and includes *M. symphyocarpa* and False Casuarina *Calycopeplus casuarinoides.* Equivalent vegetation communities are observed in flood runner habitats with the addition of more closed forest community representatives, e.g. *Syzygium suborbiculare* and *Carallia brachiata*, and alluvial levee associated eucalypts, e.g. *Eucalyptus brassiana* and *E. polycarpa.* Understorey vegetation in these habitats is also very similar, with a dominance of sedges *Cyperus spp.* and semi-aquatic grasses. Drainage depressions that have sustained dry season flows have a more developed aquatic macrophyte community dominated by emergent species (discussed below). Algal films and charophyte algae beds are also conspicuous in these habitats.

8.6.1.5 Mangrove Communities

The composition, distribution and extent of mangrove communities are associated with biophysical features of the intertidal environment including salinity, nutrient availability, oxygen levels in soil, and wave energy (Lovelock 1993). In the Archer Bay Aggregation, which includes the Ward River estuary, Blackman *et al.* (1999) noted that Spotted (= Red) mangrove *R. stylosa* dominated mangrove communities commonly occur along the lower tidal reaches of the rivers and creeks entering the estuaries and that only a few small patches grow along the main tributary stream of the Archer River due to the high volume of freshwater it carries. They also observed that on the landward side of the mangroves Yellow mangrove *Ceriops spp.* and Grey mangrove *Avicennia marina* var. *eucalyptoides* become dominant and the forest lower.

Other species previously recorded in these mangrove communities include Holly mangrove *Acanthus ilicifolus,* Kapok mangrove *Camptostemon schultzii*, Black mangrove *Lumnitzera racemosa*, Blind Your Eye *Excoecaria agallocha*, Wrinkle pod mangrove *Cynometra iripa,* Cannonball mangroves *Xylocarpus granatum*, *X. australasicus,* River mangrove *Aegiceras corniculatum*, Club mangrove *Aegialitis annulata*, Large-fruited orange mangrove *Bruguiera gymnorhiza,* Small leafed orange mangrove *B. parvifolia, B.cylindrica, B. sexangula,* Yellow mangroves *Ceriops decandra, C. tagal,* and Tall stilted mangrove *R. apiculata* (Blackman *et al*. 1999, Saenger 1982*).*

A total of 19 mangrove species was recorded during May 2009 surveys (**Table 8-4** and **Table 8-5**) including 4 species not recorded by previous surveys (Freshwater *Caralia braciata*, Mangrove Apple *Sonneratia alba*, Myrtle *Osbornia octodonta* and Looking Glass *Heritiera littoralis*). Five previously recorded species were not observed during current investigations including *Ceriops decandra, Xylocarpus australasicus, Aegialitis annulata, Bruguiera cylindrica* and *B. sexangula.*

Thirteen species of mangroves were recorded from Ward River sites and 18 species from Norman Creek sites. The greater diversity recorded in the Norman Creek estuary could be associated with greater sampling effort (10 versus 5 sites), broader range of sampling locations (uppermost tidal to estuary mouth c/f uppermost tidal to mid estuary) and/or intrinsically greater mangrove species diversity in Norman Creek in comparison to the Ward River estuary. The maximum number of mangrove species found at any one site (9) was equivalent for both systems.

Survey results indicated some broad compositional shifts from upper to lower estuary sites including an increased dominance of Red, River and Grey mangroves in lower estuary sites and an increased occurrence of Mangrove Fern, Wrinkle Pod and Cannonball mangroves in upper estuary areas. Many other species occurrence in upper or lower estuary sites was consistent with published salinity/estuarine zonal preferences (Lovelock 1993), but did not occur at a sufficient number of sites to draw such conclusions from survey observations alone. Recognised upper estuary / freshwater influenced species include Holly, Large-fruited orange, Cottonwood, Tall stilted and Looking glass mangroves. Lower estuary / higher salinity preferring species include Yellow, Black and Myrtle mangroves.

However, survey observations also indicated that site scale variations in salinity and tidal regime exposure associated with lateral inflows of freshwater and location in relation to bank/levee height, often generated local mangrove community zonation that served to mask broader scale compositional changes that may have been associated with site location within the broader estuary.

At the time of the May 2009 survey, freshwater influences on the mangrove ecosystems were readily apparent in terms of the freshwater salinities recorded from main channels of the upper estuaries and the open bodies of freshwater, with freshwater macrophyte and emergent plant communities observed in back levee sites behind mangrove forests fringing tidal main channels. Some of the species observed to occur on these freshwater swamp margins (e.g. Black Mangrove) are characteristic of higher salinity settings and indicate that in the absence of freshwater bodies being present, high spring tides must inundate these back levee sites. Emergent paperbark trees *Melaleuca spp*., indicative of freshwater seepage, also occurred at many mangrove survey sites including mid and lower estuaries. At one site in the Norman Creek estuary (Site 8), groundwater macro pores were observed discharging through the stream bed.

To identify high salinity constraints on mangrove community composition, conditions during the dry season, saline phase of the estuary need to be examined. Dry season observations (December 2008) in the Ward River estuary indicate that groundwater discharges continue to mitigate salinity levels in the uppermost Ward River estuary system into the late dry , albeit in the absence of surface freshwater flows. However, dry season observations (December 2008) in the Norman Creek estuary indicate that the upper Norman estuary continues to receive some surface flow presumably in addition to groundwater inputs.

Table 8-4 Ward River Mangrove Species Surveyed in May 2009

Species	MW1 (Upper Estuary)	MW2	MW3	MW4	MW5 (Mid Estuary)
Red *Rhizophora stylosa*	X – Isolated individuals and stands on stream margin	X – Dominant mangrove isolated stands on stream margin	X – Dominant mangrove semi continuous band on both banks	X – Dominant mangrove on stream margin	X – Dominant mangrove semi continuous band on both banks
Large-fruited Orange *Bruguiera gymnorrhiza*	X – Isolated individuals on stream margin	X – Isolated individuals on stream margin	X – Isolated individuals north bank forest band	X – Isolated individuals on stream margin	X – Isolated individuals in riparian forest band
Small Leafed Orange *Bruguiera parviflora*	—	—	X – Isolated individuals north bank forest band	—	X – Isolated individuals in riparian forest band
Blind Your Eye *Excoecaria agallocha*	X – Isolated individuals on stream margin	X – Isolated individuals on stream margin	X – Isolated individuals north bank forest band	X – Isolated individuals on stream margin	X – Tall individuals emergent in riparian forest band
River *Aegiceras corniculatum*	—	—	X – Sub-dominant mangrove on both banks	X – Sub-dominant mangrove forming thicket behind water margin	X – Isolated stands behind stream margin
Holly *Acanthus ilicifolius*	—	X – Isolated individuals on stream margin	—	—	—
Grey *Avicennia marina*	—	—	X – Isolated individuals north bank forest band	X – Tall individuals emergent in riparian forest band	X – Tall individuals emergent in riparian forest band
Black *Lumnitzera racemosa*	—	—	X – Isolated individuals on margin open swamp behind north bank	—	—
Mangrove Fern *Acrostichum speciosum*	X – Forms emergent stands on stream margin	X – Forms emergent stands on stream margin	X – Forms emergent stands on open stream margins and understorey in north bank forest band	—	—
Wrinkle Pod *Cynometra iripa*	X – Forms semi continuous band / thicket on stream margin	X – Isolated stands on stream margin	X – Understorey stands behind stream margin	X – Understorey stands behind stream margin	—
Freshwater *Caralia braciata*	X – Co-dominant in mid storey	—	—	—	—
Cottonwood *Hibiscus tiliaceus*	X – Co-dominant in mid storey	X – Present riparian forest	—	—	—
Paperbarks *Melaleuca Spp.*	X – Dominates overstorey *i*ncludes *M. quinquenervia, M. leucadendra & M. acaciodes* (back levees only)	X – Swamp forest stand *of M. quinquenervia and M. leucadendra* backs mangrove margin (east bank) – west bank *E. tetrodonta* woodland	Southern bank mangroves backed by narrow band of *M. acaciodes* and extensive sedge /saltpan flats. *M. quinquenervia,* occurs behind northern bank mangroves on wetland margin	—	—
Cheesefruit *Morinda citrifolia*	—	X – Present riparian forest	—	—	—

Species	MW1 (Upper Estuary)	MW2	MW3	MW4	MW5 (Mid Estuary)
Other Notes:	Back levee occupied by freshwater swamp with emergent sedges and *Chara sp* beds in drying open water areas	Isolated floating beds of Tiny Waterlilly *Nymphaea nouchali* occur on stream margins in front of mangroves	Isolated Tiny Waterlilly *Nymphaea nouchali* beds occur on stream margin. *Chara sp* and *Utricularia gibba* occur in open water areas of sedge swamp inland of north bank	Dense beds of Tiny Waterlilly *Nymphaea nouchali* in backwater and dense submerged beds of *Blyxa aubertii* and *Chara sp* covered substrate	Freshwater macrophyte community present including beds of Tiny Waterlilly *Nymphaea nouchali, Blyxa aubertii, Utricularia gibba* and *Chara sp* covered substrate

Note: "X" indicates positive record of species presence.

Table 8-5 Norman Creek Mangrove Species Surveyed in May 2009

Species	MN5 Upper Estuary	MN6	MN7	MN8	MN9	MN10	MN1	MN3	MN22	MN4 Lower Estuary
Red *Rhizophora stylosa*	X – Dominant mangrove in mixed overstorey of stream margin on north bank	X – Isolated individuals and stands on stream margin	X – Isolated individuals on stream margin	X – Co-dominant mangrove on stream margin	X – Sub-dominant on stream margin and in riparian forest	X – Dominant mangrove on inside bend (east bank) stream margin	X – Dominant mangrove on stream margin	X – Dominant band of mangroves on stream margin	X – Dominant mangrove on stream margin north bank continuous broad band south bank isolated stands	X – Dominant mangrove in mixed stream margin, monotypic dominance U/S and on south bank
Tall Stilted *Rhizophora apiculata*	—	—	X – Sub-dominant in riparian forest	—	X – Sub-dominant on stream margin	—	X – Co-dominant in riparian forest band	X – Co-dominant in riparian forest behind stream margin	X – Isolated individuals on stream margin	—
Large-fruited Orange *Bruguiera gymnorrhiza*	—	—	X – Sub-dominant in riparian forest	X – Sub-dominant in riparian forest	X – Sub-dominant on stream margin	X – Isolated individuals in riparian forest	X – Co-sub dominant mangrove on stream margin	—	—	—
Small Leafed Orange *Bruguiera parviflora*	—	—	—	X – Sub-dominant in riparian forest	—	—	X – Co-dominant in riparian forest band	—	—	—
Blind Your Eye *Excoecaria agallocha*	X – Isolated individuals in mixed stream margin on north bank behind margin south bank	X – Co- dominant mangrove on stream margin	—	—	X – Sub-dominant in riparian forest	X – Isolated individuals in riparian forest	X – Very tall co-dominant in riparian forest band	—	X – Co-sub dominant individuals on stream margin	—
River Mangrove *Aegiceras corniculatum*	—	—	—	—	X – Sub-dominant in riparian forest	X – Dominant mangrove on outside bend (west bank) stream margin	X – Co-sub dominant mangrove on stream margin	X – Co-dominant in riparian forest behind stream margin	X – Co-sub dominant individuals on stream margin	X – Dominant in riparian forest behind stream margin south bank
Mangrove Apple *Sonneratia alba*	—	—	X – Isolated individuals in riparian forest	—	—	—	—	—	—	—
Yellow *Ceriops tagal*	—	—	X – Isolated individuals on land margin	—	—	—	—	—	X – Isolated individuals on stream margin	—

Species	MN5 Upper Estuary	MN6	MN7	MN8	MN9	MN10	MN1	MN3	MN22	MN4 Lower Estuary
Cannonball *Xylocarpus granatum*	—	—	X – Dominant mangrove on stream margin and riparian forest	X – Co-dominant mangrove on stream margin	X – Sub-dominant on stream margin	—	X – Isolated individuals on stream margin	—	—	X – Isolated individuals on high bank (aquifer discharge?)
Myrtle *Osbornia octodonta*	—	—	—	—	—	—	—	—	—	X – Isolated individuals on high bank
Grey *Avicennia marina*	—	—	X – Sub-dominant in riparian forest	—	—	—	X – Tall emergent individuals in riparian forest band	—	X – Isolated individuals on stream margin	X – Isolated individuals on stream margin
Black *Lumnitzera racemosa*	—	X – Isolated individuals on stream margin	—	—	X – Isolated individuals / stands on inland /wetland margin	—	—	—	—	X – Isolated individuals on stream margin
Mangrove Fern *Acrostichum speciosum*	X – Forms band of emergent stands on southern stream margin	X – Forms continuous band of emergent stands on sunlit stream margins	X – Forms isolated emergent stands on sunlit stream margins	X – Forms isolated emergent stands on sunlit stream margins	—	—	—	—	—	—
Wrinkle Pod *Cynometra iripa*	X – Isolated stands on northern stream margin	X – Dominant semi continuous band / thicket on stream margin	X – Sub-dominant mangrove understorey on stream margin	X – Isolated understorey stands on stream margin	X – Isolated understorey stands on stream margin	—	—	—	—	—
Kapok *Camptostemon schultzii*	—	—	—	—	—	X – Isolated individuals on stream margin and emergent in riparian forest	—	—	—	—
Looking Glass *Heritiera littoralis*	—	X – Isolated individuals emergent in riparian forest	—	—	—	—	—	—	—	—

Species	MN5 Upper Estuary	MN6	MN7	MN8	MN9	MN10	MN1	MN3	MN22	MN4 Lower Estuary
Paperbarks *Melaleuca Spp.*	*M. quinquenervia* fringed *Eleocharis* sp. sedge swamp with Twig rush *Dapsilanthus elatior* margins occurs behind southern bank levee	X – Swamp forest stand of *M. quinquenervia* and *M. leucadendra* backs mangrove margin (north bank)	Emergent *M. quinquenervia* through mangrove canopy on stream margin	Emergent *M. quinquenervia* through mangrove canopy on stream margin	Emergent *M. quinquenervia* through mangrove canopy in riparian forest band	—	—	—	Only narrow mangrove band in front of *M. leucadendra – E. tetrodonta* woodland on south bank	—
Other Notes:				Groundwater macro-pores observed on stream bed	Tall *Eleocharis* sp sedge fringed channel and tidal "lake" behind mangrove band					

Note: "X" indicates positive record of species presence.

The greater perenniality/dominance of freshwater inputs to the Norman Creek estuary is reflected in the mangrove communities of that system in that Cannonball Mangrove, a species characteristic of freshwater reaches of estuaries in the Wet Tropics of north Queensland, is a dominant species in mid upper reaches (Sites MN7-9). This species was not recorded from Ward River sites. The fact that Red mangrove, a species associated with higher salinities, was recorded at all sites to the uppermost estuarine reaches of both systems suggests that salinity regimes in both upper estuarine systems undergo a major swing to a saline phase during the dry season and also that the dominance of freshwater associated Cannonball mangrove in the mid upper reaches of the Norman may be associated with local inflows / seepages of freshwater.

Approximately 400m^2 of mangroves would be removed to construct the Hey River barge/ferry terminal (refer **Section 6.3.3).** At this location there is a narrow band of low-growing mangroves fringing the high tide zone. The mangrove species in the Hey River estuary include:

- *Rhizophora stylosa* (Red Mangrove);
- *Bruguiera gymnorhiza* (Large-fruited Orange Mangrove);
- *Avicennia marina* (Grey Mangrove); and
- *Aegiceras corniculatum* (River Mangrove).

8.6.2 Freshwater and Estuarine Aquatic Plants Communities

In-stream aquatic macrophytes are uncommon and sparse throughout much of the Project area stream network due to shading by closed riparian forests, generally nutrient poor water, leaf litter dominated substrates and high discharge rates. Sparse aquatic plants communities observed at a few perennial stream sites (mainly Site 14A, Site 25A and Site 2A) were predominantly emergent species and included *Eriocaulon setaceum, Limnophila brownie, Nymphoides geminate, Cyperus trinervis* and Sprawling Twig Rush *Dapsilanthus elatior.* The latter is also a common emergent species on elevated stream banks.

The most developed submerged aquatic plant communities occurred in the lower reaches of the perennial streams where channels are broader and host sunlit pools and lagoons with low flow velocities (i.e. the lowermost freshwater reaches of Norman Creek), in seasonal streams with open riparian vegetation and larger open pools (e.g. Winda Winda Creek) and in the seasonal and permanent coastal lake systems.

In the lowermost flowing freshwater reaches of Norman Creek, *Eriocaulon setaceum* and *Blyxa sp.* formed dense mixed submerged beds along bank margins. Dense *Blyxa sp.* beds co-dominant with Water Snowflake *Nymphoides indica* were also observed in the lowermost reaches of the Winda Winda Creek system in areas that had bank vegetation dominated by mangrove vegetation, indicating the sustained post wet season dominance of freshwater discharge within this upper estuarine system. An equivalent macrophyte community was also observed in nearby seasonal lake systems that are seasonally subject to significant inputs of freshwater flows.

The open canopied upper reaches of the seasonal Winda Winda Creek system had one of the most diverse in-stream aquatic macrophyte communities including submerged and emergent beds of *Eriocaulon setaceum*; submerged beds of Water Ribbon *Triglochin multifructum, Cyperus trinervis* and *Blyxa aubertii*; floating beds of Water Snowflake *Nymphoides indica* and Entire Marshwort *N. germinata*; and emergent fringing communities of *Cyperus spp.* Perennial coastal lakes contained a less diverse macrophyte community dominated by Water Snowflake *Nymphoides indica* and marginal beds of emergent spike rushes *E. dulcis* and E. *sundaica.*

Emergent mono specific beds of 'Bulkuru' spike rush *E. dulcis* form one of the most extensive aquatic macrophyte communities in the study area occurring in brackish floodplain areas adjoining the lower reaches of most of the major drainage systems. The brackish salinity regime preferred by these communities appears to be at least partially maintained by groundwater seepage emanating from the toe of adjoining bauxite uplands and, as noted in the

habitat section above, significant ecological values are associated with these spike rush swamps.

Emergent macrophyte species are also the dominant aquatic plants in tree swamps within the bauxite plateau. Deeper central basin areas support spike rush *E. sundaica* stands while bank margins exposed by receding water levels have a "wet meadow" community comprising *Eriocaulon depressum, Cyperus spp., Sclhoenoplectus sp.*, Frogsmouth *Philydrum lanuginosum* and Sprawling Twig Rush *Dapsilanthus elatior*. This "wet meadow" community also occurs within drainage depression areas that retain post wet season flows (e.g. Site 19) with the addition of *Eriocaulon setaceum* and *Cyperus trinervis* in areas exposed to flow.

8.6.2.1 Algae

Filamentous algal films and charophyte algae beds occur throughout freshwater habitats of SoE, although only in rare scattered occurrences in stream reaches with closed riparian forest canopies, forming swaying filamentous clumps in sunlit riffles and cauliflorous beds on the margins of sunlit pools. Submerged aquatic plants are also commonly coated in algal films, particularly in sunlit areas with low flows. In broad sunlit lower catchment stream reaches channels beds are covered with dense stands of both filamentous and cauliflorous charophyte. Similar beds of charophyte algae were also observed during aerial flyovers of coastal lake habitats. Collectively, the biomass produced by these lower catchment algae beds represents a significant source of primary production within these generally nutrient poor systems and is likely to constitute an important foundation of the food chain within these reaches and receiving estuarine ecosystems downstream.

8.6.2.2 Estuarine Seagrass Communities

Extensive seagrass communities including the species *Halophila decipiens, H. ovalis, Halodule uninervis* and *H. pinifolia* are a noted feature of the lower estuaries of the Archer Bay Aggregation, which includes the Ward River estuary (Blackman *et al.* 1999, Bucher and Saenger 1989; Poiner *et al.* 1987). During the current study, estuarine seagrass beds were first observed within the Project area at Norman Creek during water quality investigations in August 2007 and subsequently in the Ward River during December 2008 estuary scoping investigations and in both systems during the February 2009 estuarine water quality sampling program. Given the ecological importance afforded seagrass habitats and their vulnerability to water quality and flow impacts associated with catchment development (Coles *et al.* 2004), formal seagrass surveys and sampling to characterise the seagrass communities and gain baseline data was conducted in May 2009. The objective of surveys was to characterise the estuarine seagrass communities in terms of abundance, diversity and extent within the estuaries as a basis for identifying their broader ecosystem values. An attempt was also made to identify habitat controls such as depth, substrate type and water quality on the distribution and abundance of observed seagrass beds.

Three species of seagrass were recorded by observations preceding the formal surveys: *Halophila ovalis, Halodule pinifolia,* and *Enhalus acoroides* (the latter only in Norman Creek). However, only *Halodule pinifolia* was recorded during surveys of the Ward River and Norman Creek estuary in May 2009.

In the Ward River, seagrass sampling was focussed in the lower estuary within the "Ward Lake" (seagrass Sites SSW1–SSW5) following visual observations and invertebrate grab sampling at upstream sites that indicated that seagrass distribution did not extend upstream of this reach. Two of the sampled intertidal flat sites within the upstream section of the Ward Lake reach (SSW4 and SSW5) also lacked seagrass. Quadrant transects across exposed intertidal flats conducted during low tide in the lower Ward Lake (SSW1–3) established that seagrass occurred patchily on exposed sand bars with cover ranging from 2–65% (average 34%) at Site SSW1, 5–100% (average 56%) at Site SSW2 and 0–40% (average 7%) at Site SSW3. Site SSW3 lies to the north of the main channel in Ward Lake in a shallow backwater area and appeared to have finer grained silty sediment which was readily resuspended by wave action when inundated, possibly imposing a constraint on seagrass bed development. At Sites SSW1 and SSW2 the wet margin areas of exposed beds that were dominated by coarser shell grit sediment, indicative of

higher flow velocities when inundated, also lacked seagrass cover. Cross channel profile grab sampling at these sites indicated that seagrass did not occur in active tidal channels or at depths >1.5m. As reflected in the surveys of the exposed tidal flats, abundance and cover was greatest in the southern sampled portion of the Ward Lake in mid depth areas, not on the central channel but in broad shallow channel areas that experienced good tidal exchange and had sandy grain size substrate (e.g. Site SSW2).

In the Norman Creek estuary seagrass was also patchily distributed and primarily restricted to shallow intertidal flats, most of which occurred on the main channel margins. Seagrass density on sand bars exposed during low tide was generally lower than that observed in the Ward estuary; i.e. from 0–40% (average 5%) at Site SSN1, 0–35% (average 6%) at Site SSN2, 0–30% (average 4%) at Site SSN3 and 0–60% (average 9%) at Site SSN4. On exposed sand bars seagrass cover was greatest in depressions and tidal drainages particularly near mangrove littoral margins that did not dry out during low tide exposure. Grab sampling of central main channel areas indicated hard clay, coarse shell grit or lateritic rock bottom with no seagrass.

Seagrass did occur at two submerged (0.5–1m depth) mid channel sites in the Norman Creek estuary (SSN5 & SSN6) where estimated cover was much greater (~70%) than observed on exposed marginal sand bars. At one of these sites (SSN5) grab sampling produced abundant catches of marine polychaete worms that inhabited the substrate bound by seagrass roots. Both these sites occurred in areas where the estuary channel broadened and shallowed providing greater incident light, lower flow velocities and sandy substrates apparently preferred by *Halodule pinifolia.* Site SSN6 was analogous, albeit smaller sized, to the Ward Lake in that it represented a broad sedimentary basin. No seagrass was recorded upstream of this "Norman Lake" site. Sampling at Site SSN7 indicated fine mud substrate and no seagrass. Dry season observations in the Norman Creek estuary in the vicinity of Site SSN4 have indicated that beds of a taller, broader leaved species *Enhalus acoroides* were established at that time.

The biomass and diversity of seagrass communities is recognised to vary seasonally with the maximum abundance often being obtained late in the dry season (October–December) following months of clear skies, increasing day length and rising temperatures that provide optimal conditions for growth (Coles *et al.* 2004). Summer (wet season) freshwater flows and runoff are known to reduce seagrass abundance.

Seagrass sampling conducted during May 2009 therefore only represents a snapshot of the status of estuarine seagrass communities during the latter stages of the freshwater phase of the estuaries at a time when they are likely to be undergoing recolonisation following the wet season. Seagrass abundance, diversity and overall community extent would be expected to be more developed late in the dry season. Observations on exposed sand bars in the lower Ward River estuary in December 2008 support this as apparently denser seagrass cover, comprising two seagrass species *Halophila ovalis, Halodule pinifolia* was observed, and up to 1m broad flotsam bands of accumulated uprooted *Halodule pinifolia* were also observed in the prop roots of fringing mangrove forest. The observation of Dugong feeding trails within seagrass beds made at this time, but not in May 2009, also suggests that seasonal seagrass abundance and utilisation by herbivores is greatest in the dry season. Green Turtles observed in the Lake reach of the Ward estuary and reported by Traditional Owners to have been captured there are also likely to be feeding on *Halophila ovalis* and *Halodule pinifolia* beds, both of which are preferred food species for Dugong and Green Turtles (Coles *et al.* 2004).

In addition to the value seagrass has as food for fauna such as Dugong and Green turtles, seagrass beds are also recognised to provide important fishery nursery habitats and play key roles in binding sediment, controlling turbidity and in the uptake of nutrients (Coles *et al.* 2004). Although seagrass beds occupied only a limited extent of the Ward River and Norman Creek estuaries at the time they were surveyed, available evidence indicates that they represent an important component of the estuarine ecosystems of the study area and that they would be more extensive during the dry season saline phase of the estuary, due to reduced freshwater inputs.

8.7 Fish and Crustacean Community

8.7.1 Fish Diversity and Community Composition

The methods used to determine the composition and diversity of the fish and crustacean communities within the Project area are summarised in **Section 8.3**. A total of 45 species of fish was recorded from the study area from combined field sampling conducted during May 2008 and 2009. Details of recorded species numbers are summarised by site in **Table 8-6** and by species in **Table 8-7.**

Twenty one (21) species were recorded only from estuarine sites and 10 species from freshwater sites. Fourteen (14) species were recorded from both estuarine and freshwater sampling sites, highlighting the broad salinity tolerances of these species and the prevalence of fish with life history strategies that involve utilisation of both freshwater and estuarine habitat types. Other than visual observations recorded at other times, fish sampling was conducted in May 2008 and 2009. Seasonal variability in fish communities, particularly those associated with the saline dry season phase of estuaries, may not be reflected in sampling results.

The Ward River catchment, the largest of those sampled, had the most diverse fish community with 34 species recorded including 27 from estuarine sites and 16 from freshwater sites. A near equivalent 32 fish species were recorded from the Norman Creek catchment including 24 from estuarine sites and 15 from freshwater sites. Lower numbers of species were recorded from smaller catchments including 18 from Winda Winda Creek (9 from estuarine sites and 9 from freshwater sites), 8 from Ina Creek (6 from estuarine sites, 3 from freshwater sites), 6 from Pera Head Lagoon (a brackish site) and 1 from an isolated tree swamp in the Hey River catchment. Lower species numbers recorded in smaller catchments particularly for estuaries would also reflect less sampling effort expended there.

The proportionally dominant species by sample catch numbers and biomass from freshwater and estuarine sites in each of the three main catchments of the study area are illustrated in **Figure 8-4** to **Figure 8-7**.

Catches from most freshwater sites were numerically dominated by small to medium sized species including rainbowfish (two species), Eel-tailed Catfish (two species), Mouth Almighty and Sailfin Glassfish. Distinctions in the relative dominance and dominance priority of species were observed between catchments. Black-banded Rainbowfish were most common at flowing sites and dominated catches numerically within the semi-perennial to perennial reaches of the Norman Creek catchment. They were absent from the more seasonal Winda Winda Creek system and co-dominant with Chequered Rainbowfish in the freshwater reaches of the Ward River catchment. Sailfin Glassfish, which have a preference for aquatic plant habitats, were the second most numerically dominant species in the Winda Winda Creek system and a prominent component of the catch from Ward River freshwater sites, but were absent from all but the lowermost reaches of Norman Creek.

Other than Tarpon, larger bodied species, including those with estuarine affinities or life history requirements, were largely absent in catches from freshwater sites in the Winda Winda and Norman Creek catchments but were prominent both numerically and in terms of biomass in the lower freshwater reaches of the larger Ward River system. Archerfish dominated freshwater riverine sites in the Ward River, representing more than a third of catch numbers and biomass. Longtom were also prevalent numerically at these sites while large bodied Shovel-nosed Catfish and Barramundi comprised 31 and 21% of catch biomass respectively. While the predominance of larger bodied fish records within the Ward River reflects the larger size of that river system, the absence of these species in Norman Creek freshwater catch data was partially an artefact of sampling site accessibility as most of those species were visually observed (albeit in low densities) in the lowermost freshwater reaches of Norman Creek in areas that were inaccessible with sampling equipment. Many (but not all) of the observed fish community compositional distinctions can be readily explained in terms of the habitat affinities of individual species and the habitat suite available within individual catchments discussed in **Section 8.7.3**.

Table 8-6 Number of Fish Species Recorded in May 2008 and 2009 Combined

Catchment	Site	No. species
Norman Creek Freshwater	1A	9
	2A	8
	7A	5
	5A	6
	11	7
	4	5
	3	6
	8	9
	15	2
Total Freshwater		15
Estuarine	10A	7
	12	18
	13	4
Total Estuary		24
Total Norman Ck		**32**

Catchment	Site	No. species
Winda Winda Creek Freshwater	19	6
	9A	8
Total Freshwater		9
Estuarine	21	9
Total Estuary		9
Total Winda Winda Ck		**18**

Hey Point Tree swamp Freshwater	27	1
Total Hey Pt Tree swamp		**1**
Pera Head Lagoon Freshwater	16A	6
Total Pera Head Lagoon		**6**

Ward River Freshwater	14	11
	22	1
	25A	9
	20	10
	32	5
Total Freshwater		16
Estuarine	28	8
	29	16
	30	15
Total Estuary		27
Total Ward River		**34**

Ina Creek Freshwater	26	2
	36	3
Total Freshwater		3
Estuarine	37	6
Total Estuary		6
Total Ina Ck		**8**

Table 8-7 Distribution of Fish Species at SoE Catchments and Sites

Bold site name = Estuarine site **Bold species name = Species only recorded at estuarine sites**

Family	Species	Common name	Norman Creek												Winda Winda			Pera	Ina Creek			Hey	Ward River							
			7A	5A	4	11	1A	2A	3	8	15	**10A**	**13**	**12**	19	9A	**21**	16A	26	36	**37**	27	14	22	25A	20	32	**28**	**29**	**30**
Ambassidae	*Ambassis agrammus*	Sailfin Glassfish							x	x	x				x	x							x		x	x	x			
	Ambassis c.f. *vachelli*	Vachelli's Glass Perchlet															**x**	x												
Apogonidae	*Glossamia aprion*	Mouth Almighty	x	x	x	x	x	x		x					x	x							x			x	x	**x**		
Ariidae	*Sciades leptaspis*	Salmon Catfish													x															
	Neoarius berneyi	**Berney's Catfish**																												**x**
	Neoarius graeffei	Lesser Salmon Catfish												**x**												x		**x**	**x**	**x**
	Neoarius midgleyi	Shovel-nosed Catfish																							x	x			**x**	
	Cinetodus froggatti	**Small Mouthed Catfish**																												**x**
Belonidae	*Strongylura kreffti*	Freshwater Longtom																					x		x	x				
	Strongylura leiura	**Slender Longtom**												**x**																
	Tylosurus crocodilus	**Crocodile Longtom**												**x**																
Carangidae	***Caranx sexfasciatus***	**Bigeye Trevalley**										**x**																	**x**	
	Scomberoides commersonnianus	**Queensfish**												**x**			**x**				**x**									**x**
Centropomidae	*Lates calcarifer*	Barramundi							x	x		**x**	**x**				**x**				**x**				x	x	x	**x**	**x**	**x**
Chanidae	*Chanos chanos*	Milkfish																x												**x**
Clupeidae	***Nematalosa erebi***	**Bony Bream**																											**x**	**x**
Drepaneidae	***Drepane punctata***	**Spotted Sicklefish**												**x**																

Family	Species	Common name	Norman Creek											Winda Winda			Pera	Ina Creek			Hey	Ward River							
			7A	5A	4	11	1A	2A	3	8	15	**10A**	**13**	**12**	19	9A	**21**	16A	26	36	**37**	27	14	22	25A	20	32	**28**	**29**	**30**
Eleotrididae	*Mogurnda mogurnda*	Northern Trout gudgeon																					x							
	Oxyeleotris nullipora	Poreless Gudgeon	x	x	x	x	x																		x					
	Hypseleotris compressa	Empire Gudgeon					x	x								x		x	x	x			x			x				
Ephippidae	***Platax batavianus***	**Hump-headed Batfish**												**x**																
Epinephelinae	***Epinephelus malabaricus***	**Black Spot Cod**												**x**																
Gerreidae	***Gerres subfasciatus***	**Common Silver Biddy**												**x**																
Haemulidae	***Pomadasys kaakan***	**Grunter**												**x**																**x**
Hemiramphidae	***Zenarchopterus buffonis***	**Buffon's River-Garfish**										**x**	**x**															**x**	**x**	
Leiognathidae	***Leiognathus equulus***	**Common Pony Fish**												**x**																**x**
Lutjanidae	*Lutjanus argentimaculatus*	Mangrove Jack							x	x		**x**		**x**			**x**				**x**							**x**	**x**	
	Lutjanus johni	**Fingermark**																												**x**
Megalopidae	*Megalops cyprinoides*	Tarpon		x			x	x	x	x		**x**		**x**		x	**x**			x	**x**		x		x	x			**x**	
Melanotaeniidae	*Melanotaenia nigrans.*	Black-banded Rainbowfish	x	x	x	x	x	x															x	x	x			**x**		
	Melanotaenia splendida inornata	Chequered Rainbowfish				x	x	x	x	x	x				x	x			x	x		x	x		x	x	x	**x**		
Mugilidae	***Liza subviridis***	**Greenback Mullet**												**x**			**x**													**x**
	Valamugil buchanani	**Bluetail Mullet**										**x**	**x**		**x**						**x**								**x**	**x**
Plotosidae	*Neosilurus ater*	Black Catfish		x		x	x			x						x							x				x		**x**	

Family	Species	Common name	Norman Creek											Winda Winda			Pera	Ina Creek			Hey	Ward River							
			7A	5A	4	11	1A	2A	3	8	15	**10A**	**13**	**12**	19	9A	**21**	16A	26	36	**37**	27	14	22	25A	20	32	**28**	**29**	**30**
Plotosidae	*Neosilurus hyrtlii*	Hyrtl's Tandan	x	x	x	x	x	x								x							x							
Pseudomugilidae	*Pseudomugil gertrudae*	Spotted Blue-eye			x			x																						
Scatophagidae	*Selenotoca multifasciata*	Banded Scat								x				**x**				x											**x**	
	Scatophagus argus	**Spotted Scat**																											**x**	
Siganidae	***Siganus lineatus***	**Goldlined Rabbitfish**												**x**																
Sparidae	***Acanthopagrus berda***	**Pikey Black Bream**											**x**	**x**			**x**												**x**	**x**
Synbranchidae	*Ophisternon bengalense*	Swamp Eel	x			x	x	x							x	x							x							
Terapontidae	*Amniataba caudavittata*	Yellowtail Trumpeter												**x**			**x**	x			**x**								**x**	**x**
	Terapon jarbua	Crescent Perch																x												
Tetraodontidae	***Tetraodon erythrotaenia***	**Red-striped Toadfish**																											**x**	
Toxotidae	*Toxotes chatareus*	Seven Spot Archerfish							x			**x**		**x**			**x**								x	x		**x**	**x**	**x**
Total Number of Species Recorded at Site			**5**	**6**	**5**	**7**	**9**	**8**	**6**	**9**	**2**	**7**	**4**	**18**	**6**	**8**	**9**	**6**	**2**	**3**	**6**	**1**	**11**	**1**	**9**	**10**	**5**	**8**	**16**	**15**

Note: "X" indicates positive record of species presence.

The study area's estuarine fish catch also exhibited unique compositional features and distinctions between sites and catchments.

The combined catch from all three (upper, mid and lower) Ward River estuarine sites were dominated both numerically and in terms of biomass by Archerfish (46% & 39% respectively), a typically freshwater species that also dominated catches in the lower freshwater reaches of the system. Note that at the time of sampling in May 2009, the salinity in the estuarine sites in the Ward River was low (e.g. Site WP8) at sites upstream of the Ward Lake area.

Archerfish, mullet (two species) and Bony Bream comprised more than two thirds of the Ward estuarine fish catch numerically and these species in combination with other larger bodied freshwater associated species, Barramundi and Fork-tailed catfish (two species) comprised 86% of the catch biomass of combined Ward River estuarine samples. The capture of large Black catfish *Neosilurus ater*, a typically freshwater species, within the mangrove fringes of the middle estuary site (29) in the Ward River highlights the "fresh" characteristics of the Ward estuary at the time of sampling.

In comparison to the Ward River, the estuarine catch from Norman Creek was numerically more dominated by typically estuarine and marine species including Silverbiddy, Queenfish and Scats. Of the 22 fish species recorded from Norman Creek estuary sites, 13 were recorded only from estuary sites and of these 9 could be considered marine species not capable of inhabiting lower reach freshwater habitats. Of the 27 fish species recorded from Ward River estuary sites, 16 were recorded only from estuary sites but of these only 4 could be considered marine species not capable of inhabiting lower reach freshwater habitats (**Table 8-6**). The prevalence of freshwater adapted species within the Ward and Norman estuaries is indicative of the influence of freshwater flows within these estuarine ecosystems which extended post-wet season, at least until the main sampling periods of May 2008 and 2009.

The greater proportion of strictly marine species recorded in the Norman Creek estuary was potentially related to the proximity of the main estuarine sampling site to the mouth of the system, and the amount of tidal exchange that occurs within that sampling reach. In comparison, the three estuarine sampling sites within the Ward River all occurred upstream of the expansive, shallow Ward River "Lake" which retards tidal ingress and may lead to a greater dominance by freshwater flows upstream of this point, particularly during active catchment discharges post wet season.

While the Embley River to the immediate north of the study area is characterised by a diverse chondrichthyan (shark and ray) fish fauna (Barletta and Blaber 2007), no sharks or rays were captured in the study area, although stingray impressions were observed on exposed sand bars in lower estuary areas and Cowtailed Rays were observed in the Norman Creek and Ward River lake areas. This result could be partially related to the deployment of gill nets only during daylight hours, to prevent crocodile entanglement. Sharks are more typically captured at night in gill nets, though the complete lack of shark captures would appear to be at least indicative of a genuine low abundance of shark species, several of which were recorded within the upper reaches of the adjoining Embley River estuary (Blaber *et al.* 1990b).

Although fish sampling conducted within the study area could not be considered exhaustive, results suggest that fish communities present were depauperate in comparison to the species diversity recorded from adjoining catchments and estuaries in the Western Cape region. Blaber *et al.* (1990b) recorded a total of 197 species from the adjoining Embley River estuary in the north of the study area including 56 species from upper estuary sites alone. Fish survey results compiled within the North Australian Freshwater Fish Atlas <http://www.jcu.edu.au/vhosts/actfr/Projects/FishAtlas/Index.htm> show freshwater fish species for the Embley River catchment, 45 freshwater fish species from the Archer River catchment which joins the Ward River at its mouth, and 62 freshwater fish species from the Wenlock River catchment which adjoins the Embley River catchment to the north. Comparisons with these regional fish faunas and possible reasons for the lower species diversity observed within the study area are discussed further in **Section 8.7.4**.

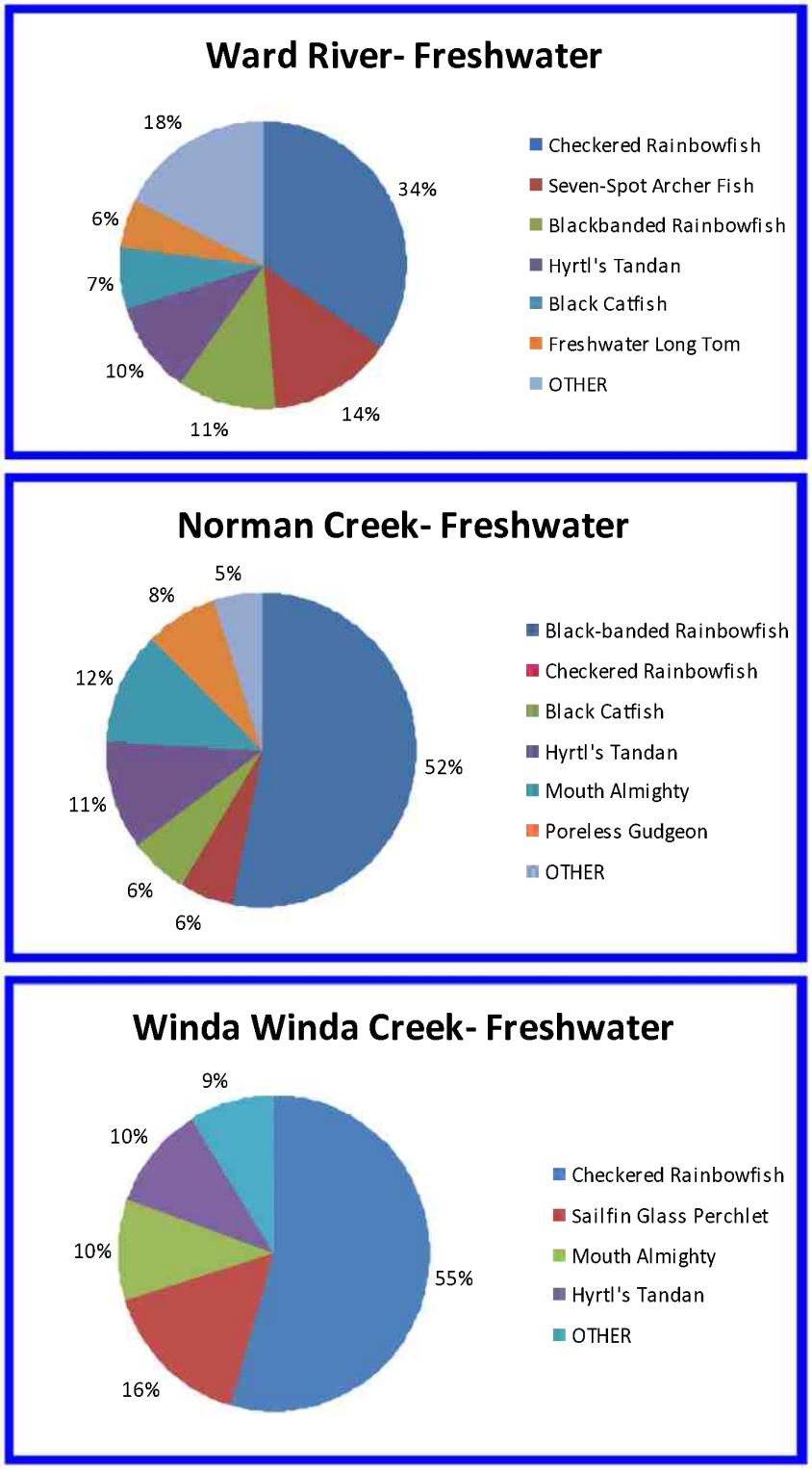

Figure 8-4 Composition of Freshwater Fish Catch from Main Catchments by Numbers

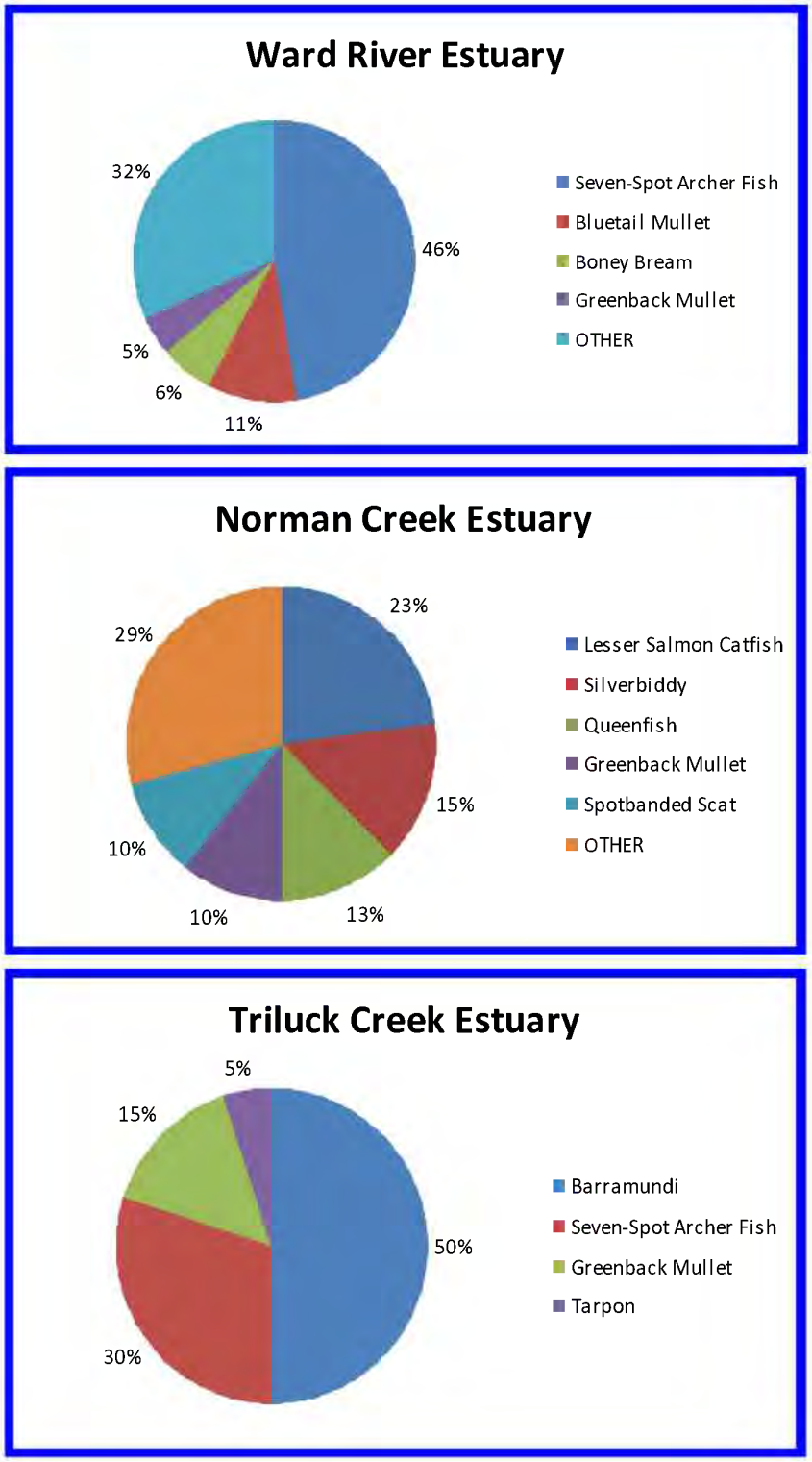

Figure 8-5 Composition of Estuarine Fish Catch from Main Catchments by Numbers

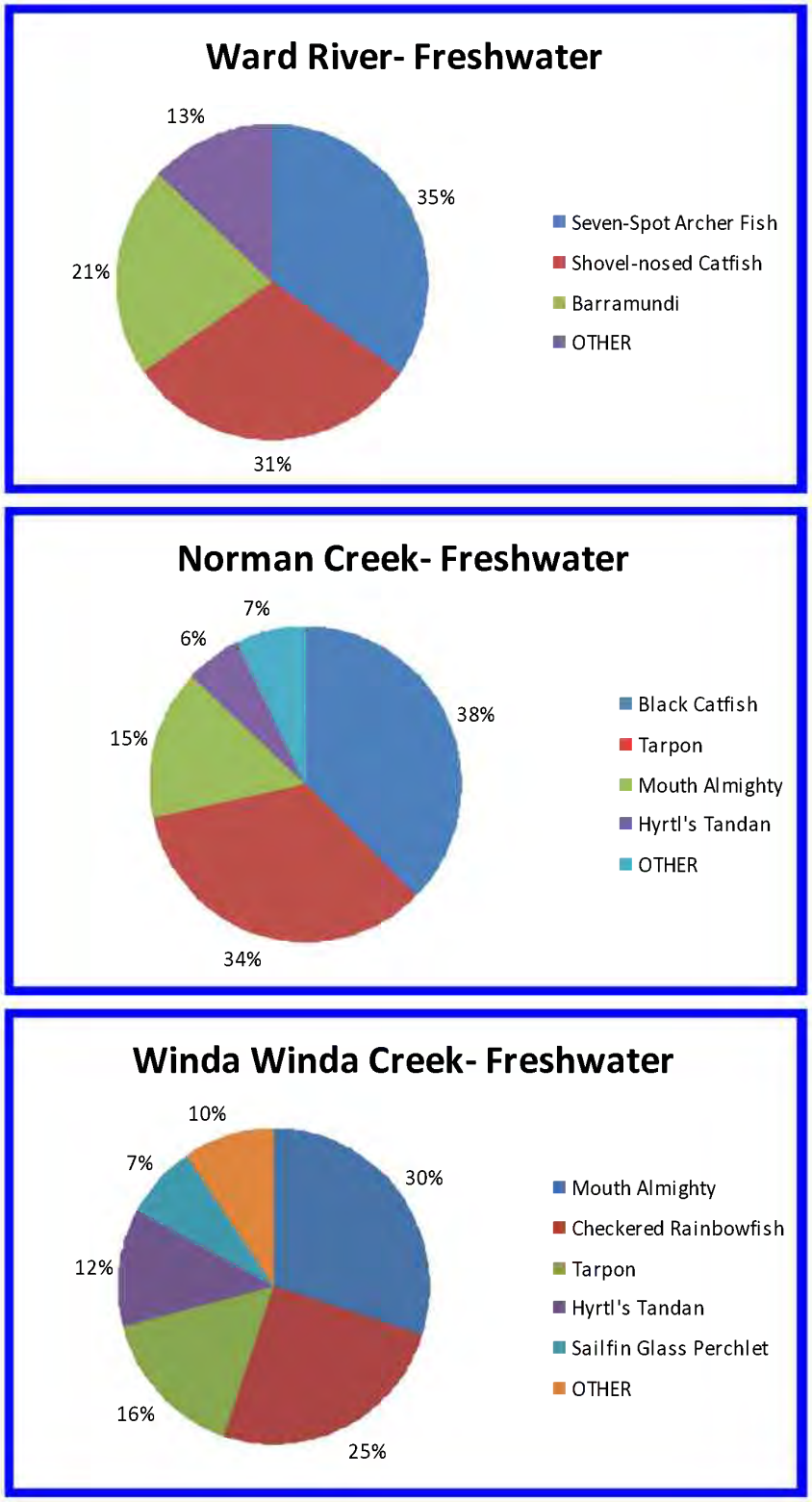

Figure 8-6 Composition of Freshwater Fish Catch from Main Catchments by Biomass

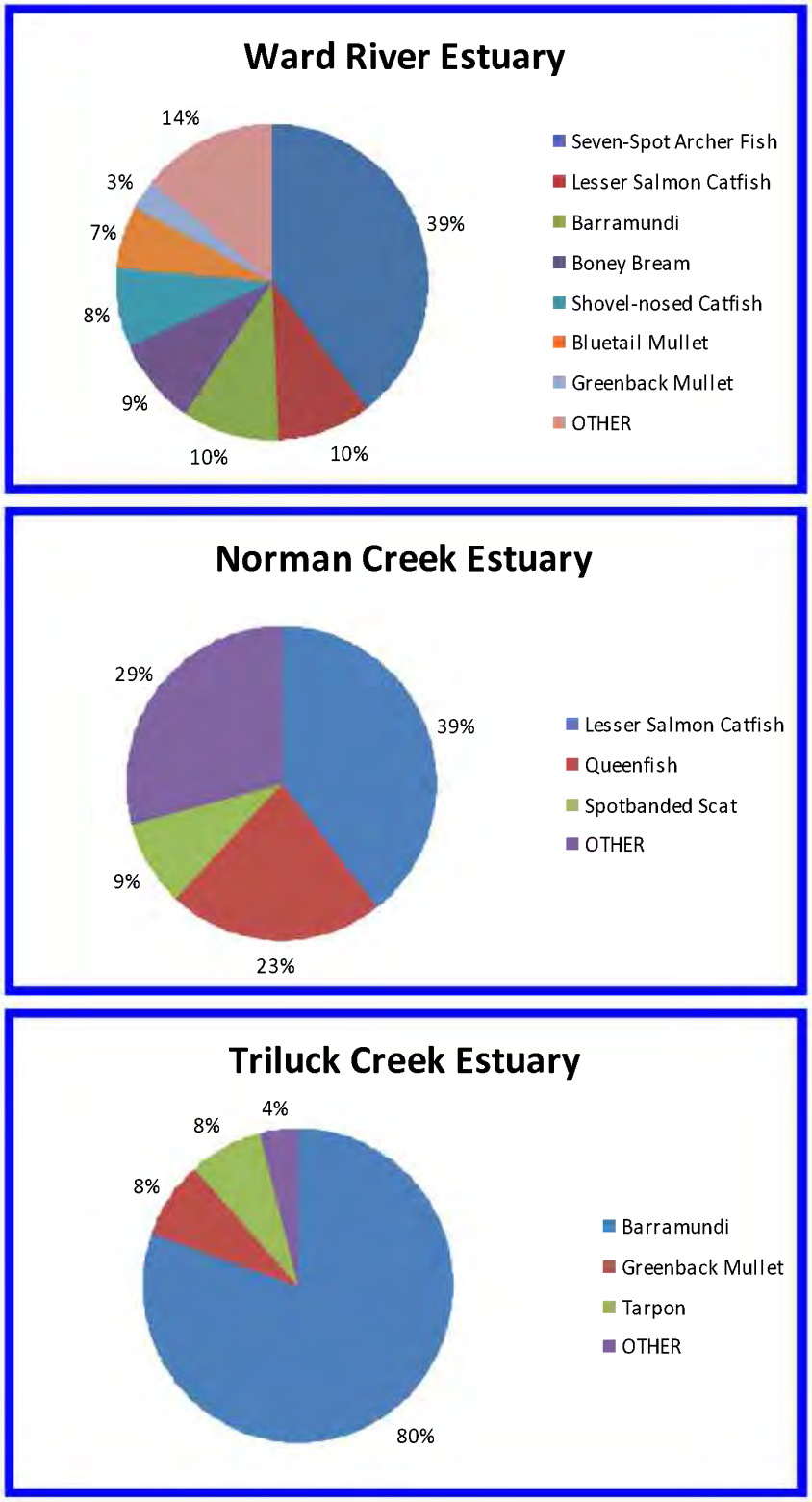

Figure 8-7 Composition of Estuarine Fish Catch from Main Catchments by Biomass

Low species diversity notwithstanding, the survey results, including visual observations and opportunistic angling, indicated a productive fish fauna within the study area including a

substantial biomass of species of importance to recreational, commercial and indigenous fisheries. Several of these species including Barramundi, Mangrove Jack, Fork-tailed Catfish and Archerfish predominantly occurred in the mid and upper estuary and lowermost fresh reaches of surveyed catchments. Large feeding schools of these species were commonly observed in all three catchments in association with drainage confluences from adjoining floodplain swamps. The productivity linkage between these swamps and the estuarine ecosystems is a significant feature of the trophic ecology of the study area's aquatic ecosystems.

8.7.2 Crustacean Catch

Sampling of freshwater sites in May 2008 and 2009 produced a total catch of 360 crustaceans from six species (two each of crayfish, crabs and prawns) with a maximum of three species per site. Details of the catch are summarised by site in **Table 8-8**. Abundances of crustaceans were highest at Winda Winda Creek Site 9A (3 species – Unidentified Freshwater Crab, Swamp Crayfish and Freshwater Prawn *M. rosenbergii*) and Pera Head Lagoon Site 16A (two species – Swamp crayfish, Freshwater Prawn *M. idea*), the former an open seasonal stream with diverse habitats and the latter a coastal lagoon only seasonally occupied by fish. Recorded catch biomass generally reflects specimen abundance. Larger bodied Red Claw Crayfish *Cherax quadricarinatus* dominated crustacean catches from the Norman Creek sites, which also recorded Swamp Crayfish and Freshwater Prawn *M. rosenbergii.* Red Claw Crayfish *Cherax quadricarinatus* were also present in Coconut Creek, though at lower abundances, with Swamp Crayfish *Cherax rhynchotus* subdominant at that site. The Freshwater Prawn *Macrobrachium rosenbergii* was found in all catchments and also in an isolated tree swamp (Site 27) although mostly in lower reaches and in low abundances. An isolated drying tree swamp in the Boyd Bay area (Site 35) was the only site that recorded an abundant population of Freshwater Crab *Austrothelphusa raceki*.

Despite locally dense populations of some crustacean species, particularly Swamp Crayfish, at a few sites, a generally low abundance of crustaceans characterised most freshwater sites (refer **Table 8-9**). A conspicuous absence of families and species usually ubiquitous in tropical freshwaters of northern Australia (i.e. Freshwater Shrimp *Caradina* species and Freshwater Prawn *Macrobrachium australiaense*) is also notable. It is possible the very low conductivity and softness of the study area's freshwaters impose physiological constraints on many crustaceans. Swamp Crayfish *Cherax rhynchotus* were often observed to have a non-rigid exoskeleton, possibly associated with the low availability of calcium in freshwater habitats of the study area.

Although locally abundant at some sites within the Project area, both Swamp Crayfish *Cherax rhynchotus* and the Freshwater Crab *Austrothelphusa raceki* have restricted distributions in a northern Australia context. Swamp crayfish *Cherax rhynchotus* is restricted to northern Cape York and Badu Island, Torres Strait. In the Project area it is largely restricted to bauxite plateau habitats, being replaced by Red Claw Crayfish *Cherax quadricarinatus* in other areas. The Freshwater Crab *Austrothelphusa raceki* is restricted to the area between the Archer and Wenlock Rivers in western Cape York, with an apparently isolated population near Port Stewart on the east coast. The western population appears to be largely restricted to bauxite plateaux. It was recorded from only Site 35 within the Project area.

Table 8-8 Summary of Freshwater Crustacean Catches May 2008 and 2009

Catchment	Site	No. Species	No. Specimens	Biomass (g)
Norman Creek	1A	2	34	612.2
	2A	3	19	122.4
	7A	1	15	154.2
	11	1	14	86.9
	4	1	5	43
	5A	2	43	536.6
Total		**3**	**130**	**1555.3**
Winda Winda Creek	19	1	3	7.6
	9A	3	69	426.6
	33	2	7	–
	34	2	17	–
Total		**3**	**72**	**434.2**
Isolated Swamp Hey Catchment	27	1	1	–
Total		**1**	**1**	–
Boyd Bay Tree Swamp	35	1	30	–
Total		**1**	**30**	–
Pera Head Lagoon	16A	2	68	490.1
Total		**2**	**68**	**490.1**
Ina Creek	26	2	31	223.1
Total		**2**	**31**	**223.1**
Coconut Ck / Ward River	14	3	23	224.8
	25A	3	6	13.6
	20	0	0	0
	32	1	12	56.9
Total		**3**	**29**	**238.4**

An unidentified species of Freshwater Crab *Austrothelphusa* sp. first recorded in 2008 from Winda Winda Creek (Site 9A) has been assessed by the Queensland Museum as possibly representing a new undescribed species (P. Davie Pers. Comm.). Further survey work in 2009 extended the species recorded range beyond the original record site to upstream and downstream locations (Site 33 and Site 34) but not beyond the Winda Winda Creek catchment.

Standard estuarine sampling methods including baited recreational crab pots and finer meshed "opera" traps produced very small catches comprising four species of estuarine crustacea. These species included Mud crabs *Scylla serrata*, unidentified Hermit Crabs, Freshwater Prawn and Greasyback Prawn (refer **Table 8-10**). Several other unidentified crab species were observed at low densities within mangrove habitats but were apparently not attracted to baited traps set in these habitats and were not captured by other methods. Unidentified Mysid shrimps were also observed but not captured in a tidal interface swamp (Site 13) in the mid estuary of Norman Creek.

Table 8-9 Distribution of Freshwater and Estuarine Crustacean Species at SoE Catchments and Sites

Bold site name = Estuarine site **Bold species name = Species only recorded at estuarine sites**

Family	Species	Common name	Norman Creek Catchment									Winda Winda				Boyd Bay TS	Pera Head	Ina	Hey TS	Ward River Catchment					
			7A	5A	4	11	1A	2A	8	**13**	**12**	19	9A	33	34	35	16A	26	27	14	25A	32	**28**	**29**	**30**
Anomuridae	**Anomurid sp.**	**Hermit Crab (unidentified)**									**X**														
Parastacidae	*Cherax quadricarinatus*	Red claw Crayfish	x	x			x	x	x											x	x				
	Cherax rhynchotus	Swamp Crayfish			x	x		x				x	x				x	x		x	x	x			
Palaemonidae	*Macrobrachium idae*	Freshwater Prawn															x								
	Macrobrachium rosenbergii	Freshwater Prawn		x			x	x					x					x	x	x	x				
	Macrobrachium sp.	**Freshwater Prawn**																							**x**
Penaeidae	***Penaeus ensis***	**Greasyback Prawn**																							**x**
Mysidacea	**Unidentified**	**Estuarine Shrimp**								**x**															
Portunidae	***Scylla serrata***	**Mud Crab**																					**x**	**x**	**x**
Sundatelphusidae	*Austrothelphusa raceki*	Freshwater Crab														x									
	Austrothelphusa sp.	Unidentified Freshwater Crab											x	x	x										

Table 8-10 Summary of Estuarine Crustacean Catches from May 2009

Catchment	Site	Species Name	Common Name	No. specimens
Norman Creek	12	*Anomurid sp.*	Hermit Crab	18
Total				**18**
Ward River	28	*Scylla serrata*	Mud Crab	1
	29	*Scylla serrata*	Mud Crab	1
	29	*Macrobrachium sp.*	Freshwater Prawn	1
	30	*Scylla serrata*	Mud Crab	6
	30	*Penaeus ensis*	Greasyback Prawn	1
Total				**10**

Mud Crab abundance as reflected by trap captures at estuarine sites in May 2009 appeared exceptionally low and dominated by sub adults. All of the captured Mud Crabs were smaller than the recreational minimum size limit of 150 mm carapace width. This contradicted expectations as a commercial Mud Crab fisher periodically operates in the lower Ward River estuary and there are anecdotal reports of recreational and Indigenous fisher catches within the Ward River and Norman Creek estuary. Mud Crab catch rates are known to be seasonal and affected by temperature and freshwater flows (Robins *et al.* 2005). As April–June is a recorded peak maturation period for tropical Australasian Mud Crab populations (Le Vay 2001), it is possible that mature crabs were not available for sampling due to moulting or off-shore migration during May 2009. Reduced estuarine abundance and displacement of adult crabs downstream by freshwater flows has been cited as having a positive influence on the recruitment of juvenile Mud Crabs due to reduced burrow competition (Robins *et al.* 2005). In contrast to the small numbers of juvenile crabs captured from upper (freshwater dominated) estuarine sites in the Ward River, no Mud Crabs were captured from the lower estuarine site in Norman Creek, suggesting salinity alone was not affecting catches and that adults were not available for other reasons, i.e. moulting or off-shore movement. The presence of juvenile Mud Crabs in the upper estuarine reaches of the Ward River, the extent and quality of intertidal Mud Crab habitat and anecdotal fishery reports would suggest that estuarine systems of the study area seasonally host substantive Mud Crab populations.

Catch per unit effort (CPUE) data for fish and crustaceans form part of the baseline monitoring dataset being held for future reference. The remainder of the discussion of fish and crustacean catches concentrates on the ecosystem composition and how that relates to potential sensitivity to mining-related impacts.

8.7.3 Habitat Affinities

An interesting finding regarding freshwater fish species diversity and distributions, gained from these survey results and experience in bauxite plateau streams in adjoining regional catchments, is that while a generally equivalent suite of aquatic habitat types is encountered in streams across these areas, fish community composition appears to vary independently of habitat availability. This suggests that biogeographic controls on species distribution and chance species extinction and recruitment events are a more significant driver of community compositional differences at the catchment scale than habitat availability. However, a number of habitat conditions common across these areas still appear to play a role in determining the make-up of the total fish community encountered across this broader geographical area. Reach and sub-catchment scale variability in habitat availability is also reflected in fish community compositional differences at these scales. Understanding these habitat affinities is important for identifying potential Project related impacts that may affect the availability or condition of preferred habitat types.

The high water clarity, low conductivity (refer **Section 5.1.4**) and sustained post wet season flow characteristics of those Project area's aquatic habitats that are fed by groundwater discharge affect the structure and functioning of the fish assemblages. Key features of the fish assemblage include a predominance of species that are visual predators, utilise visual courtship displays, have a dependence upon submerged aquatic plants (macrophytes) as egg laying habitats, and have some affinity to flowing habitats.

In stream reaches where sunlight penetration is not prevented by a riparian forest canopy, macrophyte beds are able to develop. A number of the fish species collected from the Project area have some life history dependence upon macrophyte cover, including Black-banded and Chequered Rainbowfish, Empire Gudgeon, Northern Trout Gudgeon and Mouth Almighty. Macrophyte cover is used by juvenile fish to hide from predators and, in the case of Mouth Almighty, to ambush prey. Black-banded and Chequered Rainbowfish and Sailfin Glassfish eggs are adhesive and are laid so as to attach to vegetation. The Spotted Blue-eye is also commonly associated with vegetation and other forms of cover, and deposits eggs amongst vegetation to mature (Pusey *et al*. 2004).

Macrophytes thus provide important habitat to fish in these ecosystems. However, the predominance of closed riparian forest within the Project area stream network tends to limit the development of substantive submerged macrophyte beds to more open lower reaches and seasonal steams with open riparian vegetation communities (e.g. Winda Winda Creek). This suggests that species that have some macrophyte dependence, particularly for egg laying, require access to reaches where such limited resources are available. In the case of Empire Gudgeons, which are considered to be a facultative amphidromous species (larvae dispersed to downstream estuarine reaches), utilisation of macrophyte rich lower catchment reaches as breeding and recruitment areas is consistent with this optional life history. This strategy may also be employed by Chequered Rainbowfish and Mouth Almighty which have a good capacity for intra catchment recruitment movements during wet season flows. Another strategy that is possibly employed by species that require macrophyte habitats for breeding is the utilisation of seasonally submerged terrestrial and emergent marginal vegetation during the wet season. This ties in with observations of substantial populations of Black-banded and Chequered Rainbowfish and Spotted blue-eyes, including juveniles, within the seasonal aquatic habitats occurring within the inundated margins of drainage depressions, flood runners channels and tree swamps. These species may also use tree roots as spawning sites in the absence of macrophytes. Where species are not as adaptive in terms of meeting their macrophyte habitat dependence, macrophyte habitat availability has a more significant influence on their distribution. This may explain the limited distribution of Sailfin Glassfish within the Project area, which was absent from all but the lowermost reaches of Norman Creek systems but occurred within the seasonal and macrophyte rich Winda Winda Creek and the Coconut Creek – Ward River system, which have more open riparian forest and associated development of macrophyte habitats. The submerged macrophyte habitat affinities and dependencies of these species have implications for managing potential Project related impacts such as increased turbidity and the development of hydrological or physical barriers that could reduce dependent species access to macrophyte (or equivalent) rich stream reaches.

Access to sand/gravel beds for spawning required by Hyrtle's and Black Catfishes (Orr and Milward 1984, Pusey *et al*. 2004) is another example of a potentially limited habitat resource that may require longitudinal connection to enable successful spawning.

The high water clarity of the Project area streams and swamps, with median turbidity commonly below 5NTU and below 1NTU at some sites, also enables the use of visual cues related to mating for several species. The males of the Chequered Rainbowfish perform elaborate courtship displays. Spotted Blue-eye males vigorously court females, flashing dorsal and anal fins. Empire Gudgeon males develop intense red colouring during breeding. Black Catfish change colouration during spawning runs (Pusey *et al*. 2004). Water clarity is also likely to be important in hunting/foraging activities for visual predators. Vision is often important for macroinvertebrate feeders in locating insects, and reduction in visibility could hinder feeding success.

However, all of these species are recorded (Pusey *et al.* 2004) in river catchments known to experience short-term water quality stress in terms of elevated turbidity associated with the initial catchment flushes of wet season runoff. Wet season runoff in streams of the Project area has been observed to clear rapidly following the initiation of wet season flows. Impacts to the ambient turbidity of sustained wet season and post wet season flows would present the greatest risk to these fish species and their habitats. Given the very small component of catchment rainfall that is shed as surface flow and the limited area of cleared catchment that would exist outside of controlled drainage networks, this risk is considered small.

The Project area streamflow persists for variable lengths of time after the wet season, depending on the nature of the surrounding seasonal and perennial aquifers, the topography and the extent of rainfall. One apparently flow-associated species is the Black-banded Rainbowfish which unlike many other rainbowfish has a very fusiform body shape and appears to specialise in inhabiting and utilising shallow flowing waters. This species was common at sites that had perennial to semi-perennial flows (i.e. Norman and Coconut Creeks), but was absent from the more seasonal Winda Winda and Ina Creek systems. Such habitat affinity could make these species susceptible to impacts that affected the seasonal duration of flowing habitats within the study area.

Larger-bodied species, such as Tarpon, Fork-tailed Catfish (Ariidae) and Barramundi, prefer deep water areas with large in-stream cover such as macrophytes, logs, and bank overhangs. Tarpon and Barramundi are catadromous, requiring access to estuaries to breed and longitudinal connection from the estuary to facilitate upstream recruitment of juveniles. Observations of catfish occurrence in other small bauxite plateau streams of the broader region also suggests that they are functionally migratory, moving upstream during the wet season to utilise seasonally available resources and retreating downstream before flows subside and habitat size becomes a constraint. All these species were only found at sites that held larger deep pools and had ready access to lower estuarine or deeper riverine reaches in the lower reaches of the Ward River and Norman Creek.

8.7.4 Zoogeography and Regional Affinities

The Project area is part of the Gulf of Carpentaria drainage division (Pusey *et al.* 2004), which extends from the tip of Cape York west to Gove, NT. From around 40,000 to 12,000 years ago the Gulf of Carpentaria was isolated from the ocean and contained Lake Carpentaria, a large freshwater lake into which flowed all the river systems which now draining to the Gulf of Carpentaria (Reeves *et al.* 2008, Torgersen *et al.* 1983). Between 12,000 and 7,000 years ago sea level rise inundated Lake Carpentaria and eventually formed Torres Strait and the present Gulf shoreline (Reeves *et al.* 2008, Torgersen *et al.* 1983). This resulted in the functional isolation of the formerly contiguous freshwater biota within the river systems draining to the Gulf and reduced the opportunity for the movement and exchange of freshwater biota between them. Where a species has become locally extinct it has remained so within that catchment, unless it has been able to re-colonise from another catchment. The relatively drier conditions of the southern Gulf rivers have exacerbated this, resulting in disjunct distributions of a number of species, with populations in western Cape York and the eastern Northern Territory, but no extant populations in the southern Gulf rivers in between (Hydrobiology 2005).

Examples of species with disjunct and restricted distributions, including the Project area, are Spotted Blue-eye and Black-banded Rainbowfish. Spotted Blue-eye persists as five isolated populations in Australia, including the northern Cape York population which extends from the Project area to the Jardine River system. The nearest populations are on Arnhem Land/Groote Eylandt, the Tully–Murray floodplain and the Trans–Fly system in Papua New Guinea. While locally abundant in the Project area, Spotted Blue-eye tends to be restricted to shallow marginal habitats that are among the more vulnerable to water availability alterations. Black-banded Rainbowfish persists as three geographically separated populations in the eastern Kimberley Region, the northernmost part of the Northern Territory and Groote Eylandt, and northern Cape York/Prince of Wales Island. However, these three populations are locally abundant and spread across a number of habitat types.

The broader fish communities present in the Project area reflect the Gulf's geological history. Each drainage system has a fish assemblage that is a different subset of the species that are otherwise widespread across the broader western Cape York region. The relative isolation of each catchment is demonstrated by the local distribution of Northern Trout Gudgeon. It is absent from the Norman and Triluck–Winda Winda Creeks catchments, and was only recorded at Site 14 in Coconut Creek, despite being prolific in bauxite catchments with equivalent habitat availability to the north of Weipa. It appears local conditions in the catchments of the Project area at some time have been unfavourable for the species' survival, except in Coconut Creek. Similarly, while two species of eel-tailed catfishes were widespread in the creek systems of the Project area (Hyrtl's Tandan and Black Catfish) they have not been recorded in equivalent isolated coastal bauxite catchments of the Pine River catchment to the north.

The distributions of these species indicate that historic events in these small catchments have had a large influence on where individual species now occur. The small size of the local catchments, and their isolation from each other by topographic divides on land and the coastal seawater barrier, means that maintenance of all species within each catchment over millennial timescales is not possible in such a seasonal and inter-annually variable landscape. Chance extinction and re-colonisation events will have contributed to the current variable species distribution patterns.

Norman Creek and Coconut Creek had Poreless Gudgeons and Black-striped Rainbowfish whereas these species were not found in the Triluck – Winda Winda catchment. Several species recorded in the Ward River catchment were not recorded in the Norman Creek catchment including Shovel-nosed Catfish, Longtom and Northern Trout Gudgeon. These differences can be partially explained in terms of the particular habitat and connectivity requirements of species, habitat availability, perenniality and connectivity to larger river systems.

Winda Winda Creek has a more seasonal flow regime than Norman Creek and hence lacks species such as Black-striped Rainbowfish. The more open lagoonal habitats and greater abundance of aquatic macrophytes in Winda Winda and Coconut Creeks support the sustained presence of macrophyte dependent species such as Sailfin Glassfish, which are largely absent from all but the lowermost reaches of Norman Creek. Freshwater Longtom is primarily a species of floodplain habitats. Their occurrence in the Project area is limited to the larger Ward River system that has more extensive floodplain wetlands, has seasonal development of freshwater macrophyte beds in the estuarine zone, and is hydrologically linked to the even more extensive floodplain habitats of the Archer and Watson River systems.

Some floodplain specialists present in adjoining river basins (e.g. Saratoga) were not recorded from the study area. The generally higher site diversity recorded for Coconut Creek / Ward River freshwater sites including larger predatory Ariidae Catfish, Barramundi and floodplain specialists such as Longtom can be related to it being a larger river system, which has a more diverse range of available habitats, more substantial areas of dry season aquatic refugia and a common estuary with the still larger Watson and Archer River systems, the latter of which has one of the most diverse freshwater fish faunas in Australia.

The families and species of freshwater fish recorded from the adjoining Wenlock, Embley and Archer Rivers basins and from within the Project area are presented in **Table 8-11.** Marine or estuarine associated species (Sharks, Sawfish, Stingrays, Soles) that only enter fresh waters periodically and/or are recently derived from predominantly marine ancestors are largely absent from the Project area streams. It is postulated that these species are unlikely to occur above the proposed Dam C location on a freshwater tributary of Norman Creek. This is because of lack of suitable habitat and the very low conductivity water, which would impose a high osmoregulation cost and associated physiological stress. Further discussion on the potential for the Freshwater Sawfish and Speartooth Shark, listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) (Cwlth), to inhabit the freshwater tributary of Norman Creek upstream of Dam C footprint is provided in **Table 8-14** and **Section 8.17**. Similar information on the EPBC Act listed Green and Dwarf Sawfishes is summarised in **Table 8-14**, **Section 6.6.4** and **Section 6.9.5**.

Freshwater fishes that are present in the larger adjoining Archer, Embley and Wenlock Rivers basins but are absent within freshwater habitats of the Project area include the Goby family (Gobiidae), the Grunter family (Terapontidae), Banded Rainbowfish *Melanotaenia trifasciata*, and Threadfin Rainbowfish *Iriatherina werneri.* Gobiide and Terapontidae are generally ubiquitous in tropical Australian River basins. However, the recorded distribution of Banded Rainbowfish and Threadfin Rainbowfish in western Cape York catchments is more variable. In addition to being absent from the Project area, these species have not been recorded in some Wenlock River sub-catchments such as Cox Creek, Arthur Creek and Nimrod Creek. These species and the Gobiidae and Terapontidae families have also not been recorded from other equivalently isolated bauxite dominated coastal catchments of the Pine River catchment in the Andoom area north of Weipa. However, some Gobies and Grunters have been recorded from Tentpole Creek, a Wenlock River sub-catchment that includes a significant area of bauxite.

Factors such as perenniality, connectivity, habitat availability and chance extinction/recruitment events appear to play a role in species distribution within the region and may limit the extent of some species. In addition, the absence of certain generally ubiquitous freshwater fish from bauxite catchments in the Project area, and the Pine River catchment, may also be related to aspects of water quality. A potential causative factor may be aluminium bioavailability and associated avoidance of, or exclusion from, these catchments. Aluminium was the only metal for which the measured concentrations in the surface waters of the Project area regularly exceeded the default ANZECC/ARMCANZ (2000) water quality trigger value of 0.8µg/L. This default trigger value is a conservative figure (refer **Section 8.5.1** and is applicable to waters with pH <6.5). The median aluminium concentrations in the Ward River and Norman Creek were 11µg/L and 22µg/L, respectively (refer **Section 5.1.4**). The median concentration of the aggregated Project area freshwater samples was 18 µg/L. Aluminium concentrations from the Wenlock, Archer and Embley Rivers are not available to enable a comparison between bauxite and non-bauxite catchments. The tolerance of aluminium by the fishes of the area and under the geochemical conditions of the surface waters of the Project area's bauxite streams is not known, and cannot be extrapolated from existing ecotoxicity databases. To determine if certain species may be exhibiting avoidance behaviour, more regional data on stream water chemistry and aluminium concentrations would be required, along with ecotoxicity data derived from regional species.

When considering the biogeographic constraints on the distribution and maintenance of fish communities within the study area and across the broader western Cape York region, it is important to recognise that these same controlling factors also operate on much smaller spatial and temporal scales in determining the distribution and maintenance of fish species within a catchment from year to year. The magnitude of wet seasons affects the perenniality of stream reaches and tree swamps and the connectivity established between them on an annual basis varies with the size of the wet season and affects species compositions between years. The relationship between bauxite plateau fish community composition, species distribution and annual hydrological events means that a mining development driven change in sub-catchment hydrology could potentially affect fish assemblages.

Table 8-11 Freshwater Fish Species Recorded from SoE Catchments and Adjoining River Basins

Family	Species	Common name	Archer River	Wenlock River	Embley River	SoE Catchments
Ambassidae	*Ambassis elongatus*	Elongate Glassfish		x	x	
	Ambassis interruptus	Long-spined Glassfish		x		
	Ambassis macleayi	Macleay's Glassfish	x	x	x	
	Denariusa bandata	Pennyfish	x	x		
	Ambassis agrammus	Sailfin Glassfish	x	x	x	x
Atherinidae	*Craterocephalus stercusmuscarum*	Fly-specked Hardyhead	x	x		
Carcharhinidae	*Carcharhinus leucas*	River Whaler		x		
Centropomidae	*Lates calcarifer*	Barramundi	x	x	x	x
Clupeidae	*Nematalosa erebi*	Bony Bream	x	x	x	x
Dasyatididae	*Dasyatis fluviorum*	River Stingray	x	x		
Eleotridae	*Butis butis*	Crimson-tipped Gudgeon		x		
	Ophieleotris aporos	Snakehead Gudgeon		x	x	
	Ophiocara porocephala	Spangled Gudgeon			x	
	Oxyeleotris aruensis	Aru Gudgeon		x		
	Oxyeleotris fimbriata	Fimbriate Gudgeon	x	x		
	Oxyeleotris lineolatus	Sleepy Cod	x	x	x	
	Oxyeleotris selheimi	Giant Gudgeon	x	x		
	Mogurnda mogurnda	Northern Trout Gudgeon	x	x	x	x
	Oxyeleotris nullipora	Poreless Gudgeon	x	x	x	x
	Hypseleotris compressa	Empire Gudgeon		x	x	x
Engraulidae	*Thryssa scratchleyi*	Freshwater Anchovy	x			
Gobiidae	*Awaous acritosus*	Roman Nose Goby		x		
	Glossogobius circumspectus	Circumspect Goby			x	
	Glossogobius concavifrons	Concave Goby		x		

Family	Species	Common name	Archer River	Wenlock River	Embley River	SoE Catchments
	Glossogobius giurus	Flathead Goby	x			
	Glossogobius aureus	Golden Goby		x		
	Glossogobius sp. 1	False Celebes Goby		x	x	
	Glossogobius sp. 2	Munro's Goby		x		
	Glossogobius sp. 3	Dwarf Goby		x		
	Psammogobius biocellatus	Mangrove Goby			x	
Hemiramphidae	*Arramphus sclerolepis.*	Snub-nosed Garfish		x	x	
	Zenarchopterus novaeguineae	Fly River Garfish		x		
Lutjanidae	*Lutjanus argentimaculatus*	Mangrove Jack			x	x
Melanotaenidae	*Melanotaenia nigrans.*	Black-banded Rainbowfish	x	x	x	X
	Melanotaenia splendida inornata	Chequered Rainbowfish	x	x	x	x
	Iriatherina werneri	Threadfin Rainbowfish	x	x	x	
	Melanotaenia trifasciata	Banded Rainbowfish	x	x	x	
Megalopidae	*Megalops cyprinoides*	Tarpon	x	x	x	x
Osteoglossidae	*Scleropages jardini*	Northern Saratoga	x	x	x	
Plotosidae	*Anodontiglanis dahli*	Toothless Catfish	x			
	Porochilus obbesi	Obbes' Catfish		x		
	Porochilus rendahli	Rendahl's Catfish	x	x		
	Neosilurus ater	Black Catfish	x	x	x	x
	Neosilurus hyrtlii	Hyrtl's Tandan	x	x	x	x
Pristidae	*Pristis microdon*	Freshwater Sawfish	x	x		
Pseudomugilidae	*Pseudomugil gertrudae*	Spotted Blue-eye				
Scatophagidae	*Selenotoca multifasciata*	Banded Scat			x	x
	Selenotoca argus	Spotted Scat	x	x	x	x
Soleidae	*Brachirus salinarum*	Saltpan Sole		x		

Family	Species	Common name	Archer River	Wenlock River	Embley River	SoE Catchments
	Brachirus selheimi	Selheim's Sole		x		
Synbranchidae	*Ophisternon bengalense*	Swamp Eel	x	x	x	x
Terapontidae	*Amniataba percoides*	Barred Grunter	x	x	x	
	Hephaestus carbo	Coal Grunter	x	x	x	
	Hephaestus fuliginosus	Sooty Grunter	x	x		
	Leiopotherapon unicolor	Spangled Perch	x	x	x	
	Pingalla lorentzi	Lorentz's Grunter		x		
Toxotidae	*Toxotes jaculatrix*	Banded Archerfish	x			
	Toxotes chatareus	Seven Spot Archerfish	x	x	x	x

Presence reported in Pusey *et al.* (2004) and/or Fish Atlas of North Australia <http://www.jcu.edu.au/vhosts/actfr/Projects/FishAtlas/Index.htm>

8.8 Macroinvertebrates

8.8.1 Freshwater Abundance and Diversity

The macro-crustacea component of the stream macroinvertebrate community has been discussed in the preceding sections. The focus of other stream macroinvertebrate sampling was on qualitative assessment of presence/absence. While low macroinvertebrate abundance and diversity were recorded across all sites (**Figure 8-8**), it should be noted that quantitative assessment of abundance was not the objective of sampling. The objective of the sampling was to apply AusRIVAS methodological protocols to characterise baseline aquatic macroinvertebrate communities on the basis of the presence or absence of macro invertebrate family taxa, and in terms of ecological functioning as indicated by the proportional representation of functional feeding guilds. Macroinvertebrate community predictive and classification components of the AusRIVAS protocol were not applied as appropriate reference sites and predictive models have not been established for the Cape York region (DNRM 2001), particularly for the distinctive aquatic environments that are representative of bauxite plateau landscapes.

Site 22 (Coconut Creek tree swamp) and Site 5A (Norman Creek) recorded the lowest diversity with nine and eight taxa, respectively. The depauperate macroinvertebrate fauna reflects the very low conductivity and hardness recorded in waterbodies throughout the Project area and possibly natural mineralisation effects (refer **Section 8.15.1**). Low in-stream productivity is also influenced by the high proportion of riparian closed canopy vegetation limiting light penetration, although aquatic productivity and nutrient concentrations were moderate in tree swamp habitats such as Site 22. Riparian shading further reduces habitat availability through limited in-stream macrophyte growth. The simple substrate structure, comprising mobile sandy/gravel beds at most sites, is also likely to contribute to a reduced macroinvertebrate assemblage.

Molluscs including mussels (bivalves) and snails (gastropods) were completely absent from the Project area's freshwaters, which is likely a result of the lack of available calcium for secretion of calcium carbonate shell structures.

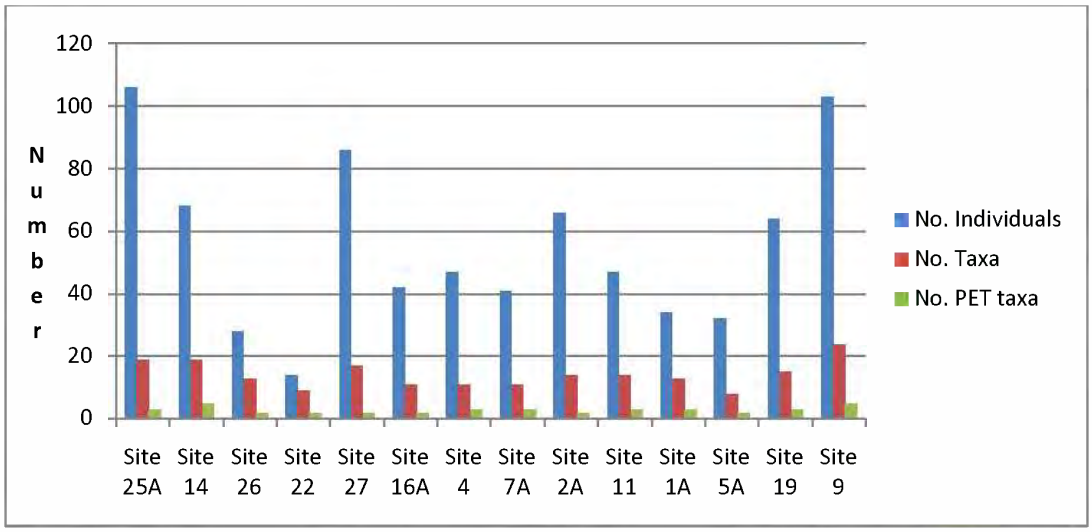

Figure 8-8 Summary of Macroinvertebrate Abundance and Family Richness and PET Taxa Richness

Taxa with external gill filaments, such as Plecoptera (Stoneflies), Ephemeroptera (Mayflies) and Trichoptera (Caddisflies) (collectively referred to as PET taxa) are sensitive to a range of pollutants. PET taxa richness generally ranged between two and three for all sites, with the

exception of Site 9 (Winda Winda Creek) and Site 14 (Coconut Creek), which each recorded five. This low PET taxa richness is also reflective of the above mentioned generally low macroinvertebrate diversity, but it is not clear which potential stressor might be the cause.

Stream Invertebrate Grade Number – Average Level (SIGNAL) is a useful method of assessing the tolerance of macroinvertebrates to pollution. However, this method was originally developed for temperate streams in south-eastern Australia to assess the impacts of sewage effluent on macroinvertebrate communities. While the method has been tested elsewhere in north-eastern Australia, it may not be directly applicable for the naturally depauperate streams that characterise the highly seasonal aquatic habitats in this region. However, the AusRIVAS-compatible data collected by this study indicated some potential disturbance sensitivity within the macro invertebrate community, particularly within seasonal stream habitats, which could have application for future catchment impact monitoring. Given the naturally low freshwater macroinvertebrate diversity and abundance in the study area, abundance weighted SIGNAL scores were calculated according to the methods described in the National River Health Manual (Chessman 2003) (**Figure 8-9**).

The scoring system developed for SIGNAL is based on ranges of impact, whereby scores >6 equate to a healthy habitat, 5–6 mild pollution, 4–5 moderate pollution, and <4 severe pollution. The streams within the Project area are in a relatively pristine state, so it is not appropriate to categorise sites based on levels of impact. Rather, sites have been categorised based on "sensitivity" to pollution, with scores >5 being very sensitive, 4–5 moderately sensitive and <4 moderately tolerant. Abundance weighted scores indicate that streams within the Project area are generally very sensitive to pollution. Sites 26 and 16A are moderately sensitive and Site 22 is moderately tolerant. The lower sensitivity at these sites is consistent with the low diversity, low PET richness (**Figure 8-7**) and high proportion of pollution tolerant predator species (**Figure 8-9**).

In terms of habitat characterisation, the moderately tolerant site (22) was an intermittent (albeit clear, seasonally spring fed) tree swamp, the moderately sensitive sites (26, 16A) were a highly seasonal stream channel and a coastal lagoon, and the very sensitive sites were stream channel and tree swamp sites with more permanent flows and water levels.

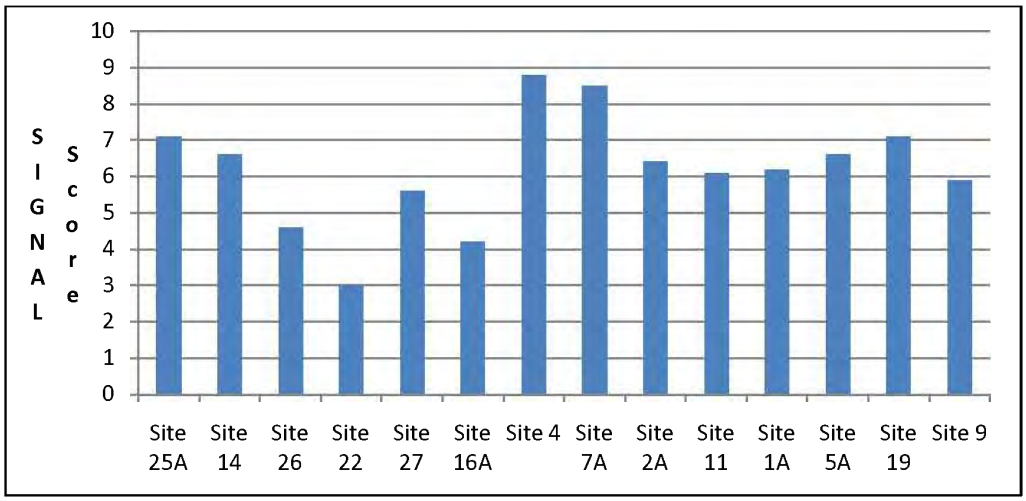

Figure 8-9 Macro Invertebrate Abundance Weighted SIGNAL Scores

8.8.2 Freshwater Macroinvertebrate Feeding Guild Composition

The composition of macroinvertebrate functional feeding groups recorded in May 2008 is provided in **Figure 8-10**. Predators were found to be the dominant feeding taxa in fast flowing

streams in the Coconut and Ina Creek Catchments (Sites 25A, 14A and 26) and the tree swamps and coastal lagoons within the mining lease (Sites 22, 27 and 16A).

Feeding group structure in Norman and Triluck Creeks varied depending on a range of factors such as stream type, flow and habitat/food availability. Predators were found to dominate the feeding group structure in deep, fast flowing and incised streams (Site 1A, Site 5A and Site 9). Filter feeders were dominant in sites characterised by broad drainage depressions with less defined channels (i.e. Site 4, Site 11 and Site 19). This indicates that the ecological processes in these sites are potentially sensitive to sediment inputs, as their ambient water quality is partially determined by filtration and attenuation of suspended sediments by emergent and submerged vegetation.

Shredders dominated the feeding group structure at Site 2A in the Norman Creek catchment and were also well represented in the Coconut and Ina Creek catchments, indicating good availability of Coarse Particulate Organic Matter (CPOM) at these sites. Shredders rely on the input of allochthonous material. The stream reach subject to inundation by the proposed dam is likely to initially experience a loss of fringing riparian vegetation and a shift in macroinvertebrate community structure, including a reduced complement of shredders. However, experience from other water storage dams in bauxite plateau streams suggest that swamp forest tree species (*Melaleuca spp.* and *Lophostemon suaveolons*) present in contributing catchments have the ability to colonise the variable "riparian" zone defined by fluctuating water levels in water storages. These species ultimately establish riparian forest margins capable of supporting shredder macroinvertebrates at least during periods of higher supply water levels when such riparian forest provides an overstorey to water margins.

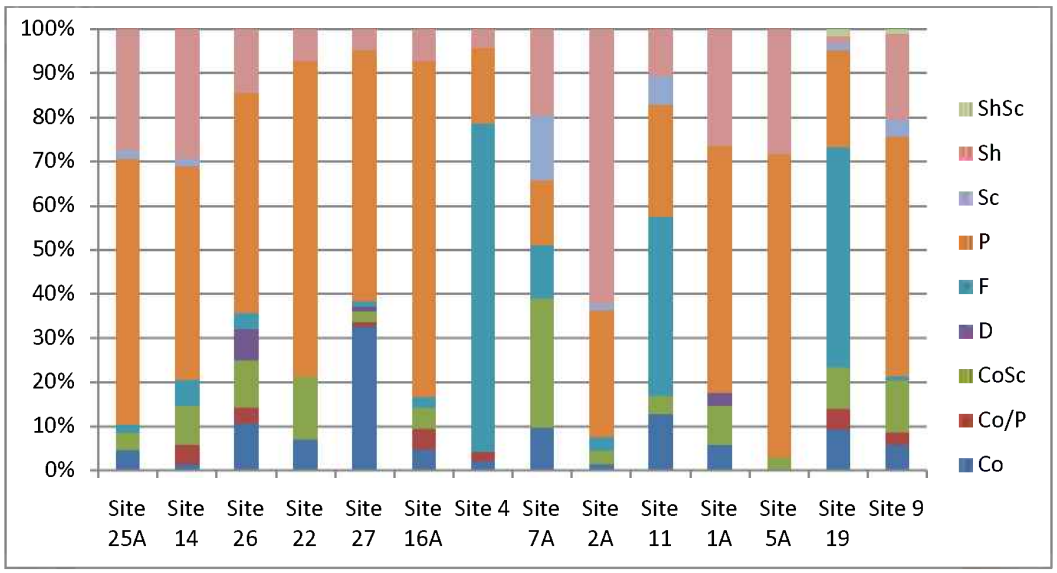

Figure 8-10 Macroinvertebrate Functional Feeding Group Composition

Key: ShSc – Shredder Scrapers, Sh – Shredders , Sc – Scrapers , P – Predators, F – Filter Feeders, D– Deposit Feeder , CoSc – Collector Scrapers , Co/P – Collector Predators , Co – Collectors)

Collector-Scraper taxa were the dominant functional feeding group at Site 7A in the Norman Creek catchment, indicating some importance of algal/detrital in-stream food resources and sensitivity to sediment inputs at this site. These taxa are typical of shallow, rocky bottom streams with good light penetration. Site 7A is the most perennial of all surveyed stream sites and due to its non-alluvial upper catchment setting has only a narrow band of riparian vegetation which facilitates in-stream light penetration. Benthic algal processes or cycling of terrestrial vegetative material through the aquatic ecosystem is likely to represent an important

basis to ecological functioning at this site. The low proportions of Scraper taxa found at other sites throughout the study area are likely due to a combination of habitat availability (i.e. riparian shading restricting algal production) and the sampling method employed (i.e. edge sweep sampling only). The substrate is more likely to have formed part of the sampled habitat in the narrow and shallow stream channel at Site 7A.

8.8.3 Estuarine Benthic Macroinvertebrates

The macro-crustacea component of the estuarine macroinvertebrate community has been discussed in preceding sections. The focus of estuarine benthic macroinvertebrate sampling was on characterising the composition of the benthic community between estuaries and between sites along the salinity gradient within an estuary with a qualitative assessment of taxa presence/absence at the family level. Grab sampling was conducted at upper, mid and lower estuarine sampling sites within the Ward River estuary (Site 28, Site 29 and Site 30) and at the lower estuarine sampling site (Site 12) in the Norman Creek estuary.

Sampling was conducted in May 2009 at a time when the estuary was dominated by freshwater inflows. Further sampling would be required to characterise benthic invertebrate communities during the dry season saline phase of the estuary. Given the dry season changes observed in estuarine salinity, water chemistry and other benthic habitat characters such as seagrass species composition and extent, changes in the benthic invertebrate community could also be expected to occur.

Three replicate grab samples were collected from littoral margins, channel edge, mid channel and, where present, sand bars and beds. However, only samples from littoral margins were chosen as a standardised habitat present across all sites for processing (binocular microscope identification and counting of specimens) for reporting. Observations on other samples that have been archived are also reported.

While generally low benthic macroinvertebrate abundance and diversity were recorded for all reported sites (**Table 8-12**), it should be noted that quantitative assessment of abundance was not the objective of sampling. The objective of the sampling was to characterise baseline aquatic macroinvertebrate community on the basis of the presence or absence of macro invertebrate family taxa and in terms of its ecological functioning indicated by the proportional representation of functional feeding guilds.

The low abundance of fauna is indicative of an oligotrophic (low nutrient, low primary productivity) estuary, which would be expected given the low nutrient status of freshwater inputs derived from groundwater sources. It is also likely to reflect the dominance of freshwater inflows within the estuaries at the time they were sampled, particularly the upper and mid estuary sites on the Ward River. Estuarine benthic invertebrate communities are recognised to be more depauperate in low salinity / brackish and upper estuary environments.

Littoral sampling sites were amongst mangrove roots, commonly characterized by accumulated leaf litter from overstorey mangroves and had fine organic mud or silty sand substrates. These sites appeared to be anoxic environments, based on odours released by sample grabs and anaerobic sulphitic bacteria observed at some sites. Few invertebrate specimens visible to the naked eye were apparent during sieving of littoral grab samples.

Table 8-12 Number of Specimens of Estuarine Benthic Macroinvertebrate Families Recorded in Grab Sample Replicates

			Norman Creek lower (Site 12)			Ward River lower (Site 30)			Ward River mid (Site 29)			Ward River upper (Site 28)			Total
Phylum	**Class**	**Family**	#1	#2	#3	#1	#2	#3	#1	#2	#3	#1	#2	#3	
Annelida	Polychaeta	Ampharetidae		1											**1**
		Capitellidae		1	1										**2**
		Goniadidae			1										**1**
		Lumbrineridae	1	1	1										**3**
		Nereididae			1					6	1	3	2	1	**14**
		Oenonidae	1												**1**
		Pilargidae				1	1	1							**3**
		Sternaspidae	21												**21**
Arthropoda	Arachnida	unidentified								1					**1**
	Insecta: Diptera	Chironominae							2		2				**4**
		Orthocladiinae										1			**1**
	Insecta: Ephemeroptera	Leptophlebiidae											1		**1**
	Insecta: Hemiptera	Cicadellidae										1			**1**
Crustacea	Amphipoda	Aaoridae	2			5	1	5							**13**
		Ischyroceridae				3	3								**6**
	Brachyura	Grapsidae		1											**1**
	Isopoda	Cirolanidae							1						**1**
	Mysidacea	Lepidomysidae											1		**1**
	Tanaidacea	Apseudidae					1								**1**
Mollusca	Bivalvia	Ostreidae			1										**1**
	Gastropoda	Naticidae	1												**1**
		Total	**26**	**4**	**5**	**9**	**6**	**6**	**3**	**7**	**3**	**5**	**4**	**1**	**79**

The greatest abundance and diversity of benthic macroinvertebrates recorded from processed littoral samples was in the lower estuary sites of both the Ward River and Norman Creek. The lower Norman Creek samples were dominated by marine worms (Polychaetes) and a few individual crustaceans and molluscs. The lower Ward River samples had a few individual marine worms, no molluscs and were dominated by crustaceans, primarily Amphipods. Upper catchment littoral sites had a lower diversity and abundance of invertebrates and a greater representation of classes and families (i.e. Arthropods, Insecta) more typical of freshwater fauna, reflecting the influence of freshwater inflows at these sites. Freshwater Charophyte algae *Chara spp.* were commonly recorded in channel grab samples from the mid and upper estuary sites of the Ward River.

Within lower estuary sites, visual observations made during sample sieving suggested a greater abundance of macroinvertebrates in channel edge and sand bar samples, particularly within seagrass *Halodule pinifolia* beds, where a substantial biomass of marine (Polychaete) worms was observed within the seagrass rooted silty-sand substrate. Deeper and coarser grained sand /shell grit bars and channel sites appeared to support a greater mollusc fauna. Central channel sites commonly had hard scoured clay substrates which were hard to grab sample and lacked obvious invertebrate fauna.

One of the most noteworthy finds from a littoral grab sample in the upper Ward estuary was a single specimen of a Mysid (shrimp) Crustacean tentatively identified by macroinvertebrate taxonomists, including the senior curator of Crustacea at the Queensland Museum and an expert in mysid taxonomy from the Smithsonian, as belonging to the family Lepidomysidae. This family is only known from Italy, India, Cuba and Mexico and has not previously been recorded in Australia. If correctly identified, this specimen is considered to represent a finding of national and international phylogenetic and biogeographic significance (L. Walker, Ecowise, pers. comm.). This Family is also generally known to be stygofauna (groundwater/cave dwelling organisms), although they can occur in brackish water away from caves. Its appearance in a grab sample may suggest the upper estuary sample site was in a groundwater upwelling location, as upwellings are common in the upper estuary, and such an upwelling would be a likely habitat for a stygobiont able to survive in open water.

Direct inflows of groundwater to the Ward estuary in the upper catchment were first recorded by salinity profiling and visual observations in the 2008 (December) dry season. The finding of stygofauna further establishes the significance of groundwater inflows in the upper estuary of the Ward River and highlights a subterranean component to the perennial groundwater aquifer dependent ecosystems.

In summary, the benthic invertebrate community of the study areas estuaries can be characterised as far as practicable by the limited data set as being depauperate, most likely on account of the generally low nutrient status of the estuaries and their broad seasonal fluctuations between fresh wet season and saline dry season phases. Ambient dissolved aluminium concentrations and the bioavailability of aluminium in the soft water chemistry of the catchment (refer **Section 8.15.1**) could also theoretically be a causative factor in low benthic invertebrate abundance and diversity.

8.9 Introduced Species

The only introduced plant or animal species observed in aquatic ecosystems of the Project area was the Cane toad (*Bufo marinus*). Observed densities in seasonal aquatic habitats within Darwin Stringybark (*Eucalyptus tetrodonta*) woodland dominated areas and stream riparian corridors were generally low. However, large aggregations were observed at coastal wetland sites on several occasions, particularly just prior to the wet season although observed densities were not as high as can be encountered on the east coast of Queensland. This species has been established in Cape York for two decades and observed densities probably represent equilibrium populations for the habitat types concerned.

The complete absence of any other introduced aquatic plant or animal species is a key value of the SoE area.

Potential sources of introduction to the area include:

- live bait (fish or crustaceans) brought to the site for recreational fishing purposes;
- intentional stocking of constructed storages with recreational species;
- keeping of exotic aquarium species on site, e.g. in administration offices, and their subsequent accidental or deliberate release into natural waters; and
- via machinery or other equipment that has previously operated in aquatic ecosystems in other areas containing introduced species before coming to site, e.g. salvinia or other macrophytes attached to boats used on water storage dams.

While no exotic aquatic plant or animal species risks have been identified for the Weipa area, which is where most equipment coming to the SoE area is likely to be sourced, there are some risks posed by terrestrial or semi-aquatic species present in the Weipa and adjoining Aurukun areas. These primarily include potential grass weeds of riparian and aquatic habitats, e.g. Gamba Grass *Andropogon gayanus* and Guinea Grass *Panicum maximum* (both present in Weipa and potentially severe weeds of riparian areas), Para Grass *Brachiaria mutica* (present in Aurukun area, a severe weed of wetland habitats) and also Rubber Vine *Cryptostegia grandiflora* (present in Aurukun area, a severe weed of riparian habitats). Other aquatic or semi-aquatic exotic species are known to occur further away, but in areas from which machinery may be sourced, such as the Cairns / Mareeba area.

Recreational activities will be limited in the Project area and the potential for any additional aquatic species to be introduced to the area in association with mining development is unlikely.

The implementation of appropriate machinery and equipment wash down and quarantine protocols should serve to limit the risk of introductions. Weeds will be monitored and controlled through a weed management program (refer **Section 7.10.2**).

8.10 Threatened Aquatic Species

This section identifies the species listed as "matters of national environmental significance" (MNES) under the EPBC Act, and species listed as threatened under the Queensland *Nature Conservation Act 1992* (NCA), that potentially occur in the vicinity of the Project area.

A search of the Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) (formerly the Department of Environment, Water, Heritage and Arts (DEWHA)) Protected Matters search tool was conducted. The search area is shown in **Figure 7-2** and detailed in **Table 7-1**. **Table 8-13** summarises the search results with respect to aquatic ecosystems and species.

Table 8-13 Summary of Aquatic Ecosystem EPBC Act Protected Matters Search

Matters of National Environmental Significance	Result for aquatic ecosystems
Wetlands of International Significance:(RAMSAR Sites)	None
Threatened Species	3 (3 fish)
Migratory Species	7 (Dugong*, Estuarine Crocodile, 5 wetland birds)

* Dugong may utilise upper estuary habitats.

Three species of threatened fishes were identified in the EPBC Act search as potentially present within the lower freshwater and estuarine habitats considered in this assessment of aquatic ecosystems in the Project area, namely:

- Freshwater Sawfish (*Pristis microdon);*
- Green Sawfish (*Pristis zijsron*); and
- Dwarf Sawfish (*Pristis clavata*).

An additional threatened species listed under the EPBC Act, the Speartooth Shark *(Glyphis* sp A.), has been included in this assessment as a potential inhabitant of the Project area. There is limited knowledge regarding the habitat and requirements of these species; however, available information is summarised in **Table 8-14**.

No EPBC Act listed Threatened aquatic fish species were confirmed as present within the Project area. **Table 8-14** describes both the likelihood of each EPBC Act listed Threatened fish species occurring within the very large Project area, and the likelihood of each occurring within the much smaller aquatic ecosystems potentially disturbed by the proposed Project

The Freshwater Sawfish (*Pristis microdon)*, Dwarf Sawfish *(Pristis clavata),* Green Sawfish (*Pristis zijsron*) and Speartooth Shark *(Glyphis* sp A.) are considered likely to occur in the estuarine and lower brackish reaches of the Project area's main drainage systems due to the suitability of the habitats present and their similarity to where these species have been recorded at sites elsewhere on Cape York (including the Wenlock–Dulcie River system). There are also anecdotal reports from Traditional Owners of Freshwater Sawfish observations in the lower Norman Creek and Ward River systems (H. Marmoss – Kalinda pers. comm.). Estuarine fish sampling conducted in May 2008 and 2009 recorded no elasmobranchs (sharks and rays) of any species from estuarine sites in the Project area.

The Green Sawfish and Dwarf Sawfish are listed as critically endangered, and the Speartooth Shark is listed as endangered, under the International Union for Conservation of Nature and Natural Resources (IUCN) Red List of Threatened Species (IUCN 2008).

Dugongs (*Dugong dugon*) are known to occur in marine habitats in the Project area and are addressed in **Section 6.6.3** and **Section 6.9.4**. The Estuarine Crocodile (*Crocodylus porosus*) was recorded during field surveys. However, this species is largely terrestrial and is addressed in **Section 7.15.5**. One of the five EPBC Act listed migratory wetland bird species (Great Egret (*Ardea alba*)) was recorded during field surveys. All EPBC Act listed migratory bird species identified from the EPBC Act database search, recorded during field surveys, or assessed as potentially occurring based on available habitat, are addressed in **Section 7.15.5**.

Several species listed as threatened under the NCA that may be considered semi-aquatic or dependent upon aquatic ecosystems of the Project area were recorded during field surveys, including the Estuarine Crocodile (*Crocodylus porosus*), Black-necked Stork (*Ephippiorhynchus asiaticus*) and Radjah Shelduck (*Tadorna radjah*); however, these species are also substantially terrestrial and are addressed in **Section 7.15.6**.

Project related disturbance of aquatic ecosystems would be limited to the following:

- Construction and operation of Dam C on a freshwater tributary of Norman Creek; and
- Activities (including dredging and the clearing of 400m^2 of mangrove habitat) associated with the construction and maintenance of the ferry/barge terminals within the estuarine reaches of the Hey and Embley Rivers.

Descriptions of these activities and infrastructure are provided in **Section 2.7.2** and **Section 2.7.3**. A description of the location and size of Dam C on a freshwater tributary of Norman Creek is presented in **Section 5.2.3**.

Table 8-14 Threatened Fish Species Listed under the EPBC Act Potentially Occurring in the Project Area

Common Name	Scientific Name	EPBC Status	Key Requirements	Preferred habitat in the Weipa/Cape York Region	Likelihood of occurrence within the Project Area and Areas of Proposed Disturbance within the Project Area
Freshwater Sawfish	*Pristis microdon*	V	Preferred habitat is mud bottoms of river embayments and estuaries, but they are also found well upstream (Allen 1997). They are usually found in turbid channels of large rivers over soft mud bottoms (Allen 1991) more than 1m deep, but they will move into shallow waters when travelling upstream or while hunting prey (Wilson 1999). Anecdotal evidence suggests that the freshwater sawfish may be found in closed systems (Thorburn *et al.* 2003). Small specimens of this species have also been caught in remote ponds that have been isolated for a number of years (DSEWPaC 2010) Pupping occurs during the wet season, which is also when this species moves into freshwater reaches (DEWHA 2005).	This species occurs in drainages in northern Australia, including the adjoining Archer, Embley and Wenlock – Dulcie River basins, occurring in freshwater and upper estuarine areas.	**Project Area** ***Likely*** This species may occur in estuarine and the lowermost freshwater reaches within the Project area. Suitable habitat present in the brackish reaches of Norman Creek and the Ward River, though generally low abundance of all elasmobranchs species have been observed at these sites. Anecdotal records of sawfish within lower Ward River estuary (which would not be disturbed by Project related activities) and Norman Creek estuary (downstream of Dam C) reported by Traditional Owners may include this species. **Dam C on Norman Creek and Upstream of Dam C** ***Unlikely*** Anecdotal records of sawfish species have only been recorded in the lower reaches of Norman Creek, which is downstream of Dam C. The freshwater tributaries of streams like Norman Creek have extremely low conductivity due to their catchments being highly weathered bauxite landscapes, which do not contribute salts. Recorded conductivity values approach those of distilled water. It is hypothesised that these extremely low conductivity values present an osmoregulation constraint on the freshwater fish community that occur in these systems. This is evidenced by the complete absence of records in the freshwater tributaries of Norman Creek for otherwise ubiquitous families, genera and species of freshwater fishes found throughout tropical Australia, including in adjoining river systems to the Project area. It is suggested that the extremely low conductivities of Norman Creek's freshwater tributaries would present an osmoregulation constraint on the Freshwater Sawfish as it possesses a more primitive osmoregulation capacity than modern ray finned fishes. While the estuarine and possibly lower tidally influenced freshwater reaches of the Norman Creek system do provide potentially suitable habitat for this species, the seasonal freshwater tributaries of Norman Creek, upstream of the proposed Dam C do not. Combined with the abovementioned water quality constraints, the small size and seasonality of Norman Creek would also be a constraint, as the Freshwater Sawfish generally inhabits larger perennial river systems as opposed to small seasonal creeks like Norman Creek. **Ferry/Barge Terminals – Hey and Embley Rivers** ***Possible*** Although this species has not been recorded in either of these rivers, the footprints of the ferry/barge terminals would be within the estuarine reaches of these rivers that this species may traverse. The extent of disturbance within these areas would be minimal in relation to the total estuarine environment available within these rivers. Disturbance would consist of the clearance of 400m^2 of mangroves (0.008% of the associated vegetation community within the Project area) and 2.1ha of riverbed. The dredging in these areas would only be to a depth of -2m LAT.

Common Name	Scientific Name	EPBC Status	Key Requirements	Preferred habitat in the Weipa/Cape York Region	Likelihood of occurrence within the Project Area and Areas of Proposed Disturbance within the Project Area
Green Sawfish	*Pristis zijsron*	V	Across its range, the Green Sawfish has been reported to inhabit marine inshore waters, estuaries, lagoons and less saline environments (though not purely freshwater) occurring in areas with a muddy substrate and frequently in shallow water (Stead 1963). Sawfish may move into marine waters after the wet, and during the wet season enter estuarine or less saline environments (though not freshwater) to breed (Peverell 2005 and DSEWPaC, 2010).	Most records are from marine and estuarine areas (Thorburn *et al.* 2003; Peverell *et al.* 2004). Closest records to the study area are from marine waters of Albatross Bay and Mission River (Blaber *et al.* 1990b, Thorburn *et al.* 2004).	**Project Area** ***Likely*** Most records from northern Australia are from shallow marine inshore waters (c/f estuaries). Adults are known to seasonally frequent inshore waters and rivers during the monsoonal months to pup (Peverell 2007). Records from Albatross Bay adjoining the mouth of the Embley River make occurrence within the northern estuarine section of the Project area likely. **Dam C on Norman Creek and Upstream of Dam C** ***Unlikely*** This species is not found within freshwater environments. Dam C would be located on a freshwater reach of Norman Creek. Therefore this species is unlikely to occur within the footprint of the proposed Dam C or upstream of this dam. **Ferry/Barge Terminals – Hey and Embley Rivers** ***Likely*** Records from Albatross Bay adjoining the mouth of the Embley River make occurrence of this species within the estuarine sections of the Hey and Embley Rivers likely. The extent of Project related disturbance of these areas would be minimal in relation to the total estuarine environment available within these rivers. Disturbance would consist of the clearance of 400m^2 of mangroves (0.008% of the associated vegetation community within the Project area) and 2.1ha of riverbed. The dredging in these areas would only be to a depth of -2m LAT.
Dwarf or Queensland Sawfish	*Pristis clavata*	V	The Dwarf Sawfish usually inhabits shallow (2–3m) coastal waters and estuarine habitats. The species prefers highly turbid environments (DSEWPaC, 2010) and are only usually found in silt sections of an estuary which are completely devoid of instream structure (Thorburn *et al.* 2003). However DSEWPaC (2010) does note that this species may rest either side of high tide in inundated mangrove forests. Restricted to brackish and salt water (Thorburn *et al.* 2007). Juveniles more commonly encountered in coastal foreshores and embayments; adults in marine waters (DEEDI 2009). Estuarine habitats are used as nursery areas by Dwarf Sawfish, with immature juveniles remaining in these areas up until three years of age (Thorburn *et al.* 2007a). Adults are known to seasonally migrate back into inshore waters (Peverell 2007).	Preferred habitat identified on the basis of capture locations include open estuarine channels and silty sand flats lacking structure with fine substrates (mainly silt), high turbidity and often with low dissolved oxygen. This species has been confirmed from the Pine River on the western coast of Cape York Peninsula (DEHWA 2010) which lies 20km to the north of the study area.	**Project Area** ***Likely*** This species may occur in estuarine reaches within the Project area. Suitable habitat is present in near coastal areas and estuaries of Norman Creek the Ward River and Embley River, though generally low abundance of all elasmobranchs species were observed at Norman Creek and Ward River sites. Records for this species exist for an estuarine system (Pine River) 20km to the north, although this system is at least anecdotally thought to have higher turbidity levels. Anecdotal records of sawfish within lower Ward River and Norman Creek estuaries reported by Traditional Owners may include this species. **Dam C on Norman Creek and Upstream of Dam C** ***Unlikely*** This species is not found and does not breed within freshwater environments. Dam C would be located in a freshwater reach of Norman Creek. Therefore this species is unlikely to occur within the proposed footprint of Dam C or upstream of the dam. **Ferry/Barge Terminals – Hey and Embley Rivers** ***Likely*** Suitable habitat for this species is present in near coastal areas and the estuary of the Embley River. Disturbance in the Embley River associated with the Project would be limited to a small amount of dredging activities related to the construction and maintenance of the Hornibrook Ferry Terminal. This species may also utilise as a resting place either side of high tide, the 400m^2 of mangrove forest that would be cleared for the construction of the Hey River ferry/barge terminal. The area of mangroves that would be cleared only represents 0.008% of this mangrove community within the Project area. Therefore there would be sufficient remaining mangrove habitat in the surrounding area which the species would be able to utilise for resting.

Common Name	Scientific Name	EPBC Status	Key Requirements	Preferred habitat in the Weipa/Cape York Region	Likelihood of occurrence within the Project Area and Areas of Proposed Disturbance within the Project Area
Speartooth Shark	*Glyphis sp.* A	CE	Relatively shallow, turbid, upper freshwater, and possibly brackish, reaches of rivers and associated floodplains. Seem to be particularly adapted to low oxygen environments. The potential area of occupancy of *Glyphis* species in creek and river systems is restricted from the mouth of a river to the point where the river ceases to be perennial (Stevens *et al.* 2005). *Glyphis* species do not utilise ephemeral reaches.	This species occurs in freshwater and estuarine areas of northern Australia, including the Wenlock River basin (Peverell 2005).	**Project Area** ***Likely*** This species may occur in estuarine and the lowermost freshwater reaches within the Project area below the perennial extent of the creeks and rivers. Records exist for the Wenlock River and similar habitat is present within the Project area, though generally low abundances of all elasmobranchs species have been observed (Peverell, McPherson, Garrett and Gribble 2006). **Dam C on Norman Creek and Upstream of Dam C** ***Unlikely*** The potential area of occupancy of the Speartooth Shark in creek and river systems is restricted from the mouth of a river to the point where the river ceases to be perennial (Stevens *et al.* 2005). Regional records for the species come from large perennial river systems i.e. the Wenlock River. The species is not known to utilise small seasonal creek reaches. The proposed Dam C would be on an highly seasonal freshwater tributary of Norman Creek, which although perennial dries to small, shallow pools which are isolated except for connecting trickling flows in the dry season. Therefore, it is unlikely that the Speartooth Shark, if present in Norman Creek would require passage past the proposed site of Dam C. The freshwater tributaries of streams like Norman Creek have extremely low conductivity due to their catchments being highly weathered bauxite landscapes, which do not contribute salts. Recorded conductivity values approach those of distilled water. It is hypothesised that these extremely low conductivity values present an osmoregulation constraint on the freshwater fish community that occur in these systems. This is evidenced by the complete absence of records in the freshwater tributaries of Norman Creek for otherwise ubiquitous families, genera and species of freshwater fishes found throughout tropical Australia, including in adjoining river systems to the Project area. It is suggested that the extremely low conductivities of Norman Creek's freshwater tributaries would present an osmoregulation constraint on the Speartooth Shark as it possesses a more primitive osmoregulation capacity than modern ray finned fishes. While the estuarine and possibly lower tidally influenced freshwater reaches of the Norman Creek system do provide potentially suitable habitat for this species, the seasonal freshwater tributaries of Norman Creek, upstream of the proposed Dam C do not. **Ferry/Barge Terminals – Hey and Embley Rivers** ***Unlikely*** Although there has been an unverified report of the presence of the Speartooth Shark in the Embley River in 1985, Stevens et al (2005) notes that ongoing fish surveys over 20 years in the Embley River have not recorded this species. Stevens et al (2005) therefore suggests that this species is restricted to the Wenlock and Ducie Rivers in this region, which are large tropical river systems. From this evidence, it is unlikely that this species would occur in either the Embley or Hey Rivers. However if this species was to occur within these rivers, the extent of disturbance associated with the ferry/barge terminals would be minimal in relation to the total environment available within these rivers.

Key to EPBC Status: CE = Critically Endangered V = Vulnerable

8.11 Fish and Invertebrate Tissue Metals

The concentrations of metals in tissue samples (flesh, hind and gill, cephalothorax, tail and whole body) in representative species of aquatic biota are summarised in **Appendix 8B**. The metal concentrations were compared to the Australian and New Zealand Food Association (FSANZ 2009) Food Standards and generally expected levels (GEL) (FSANZ 2009). These values are presented as an indication of what metal concentrations may be expected or tolerable in a tissue type for human consumption.

The metal concentrations were also compared with the Lowest Observed Effects Concentration (LOEC) for post-larval organisms derived from the database of Jarvinen and Ankely (1999). These concentrations are the lowest metals concentrations found in the body of an organism that were observed to co-occur with a recorded effect – for example, reduced survival, affected behaviour or reduced fecundity.

The majority of metal concentrations were well below the appropriate food standard or GEL. The exceptions are listed in **Table 8-15**. It should be noted that as mining has not commenced, these tissue metal concentration results represent the baseline condition. That is, some tissue types from some specimens naturally exceed the food standards, GELs or LOECs.

Several total arsenic measurements for flesh samples of *Neoarius graeffei* were more than ten times the food standard, but the food standard for arsenic is for inorganic arsenic, not total arsenic. The total arsenic concentration for flesh samples of three other fish species were less than the food standard. Edmonds and Francesconi (1993), in their review of the ratio of inorganic to organic arsenic in marine organisms found that inorganic arsenic proportions above 1% occurred only in low total arsenic concentration samples, for which there was no human health risk. Therefore, although the ratio of inorganic to total arsenic was not measured in any specimens, all recorded values would be below the food standard.

Arsenic is naturally higher in sea water than in fresh waters, and in some instances samples from the two lower estuary sites had higher average arsenic concentrations for flesh and gill samples from *Neoarius graeffei*, gill samples for *Toxotes chatareus* and claw flesh samples for Mud Crabs, *Scylla serrata*, than for the sites further upstream in each catchment.

The differences in concentrations of metals in tissues between sites were examined graphically and statistically (using a stepwise analysis of covariance procedure) to examine the pre-existing patterns of difference. Constituents for which there were statistically significant differences indicating consistent within-catchment or between-catchment differences are discussed below. It is important to note that although several statistically significant differences were identified between sites, all concentrations remained low in terms of risk of adverse impacts to organisms or humans consuming them, and should therefore be treated in that context. Also, as no species was caught consistently across all sites, multiple species comparisons between sites were limited; and, while some other, inconsistent patterns of difference between sites were found, without further sampling events it is not possible to determine their possible relevance to future patterns of metal bioaccumulation.

Tissue from fish collected from Site 14A on Coconut Creek had the highest aluminium concentrations of all fish samples (**Appendix 8B**). However, this does not appear to have been related to aluminium concentration in water as the median concentration of Site 14A was 5µg/L while that of other sites where tissue concentrations are low have higher concentrations of aluminium in water (Site 9 on Triluck Creek is 7.5 µg/L and Site 11 on a tributary of Norman Creek is 35 µg/L). The observation of some higher levels of bioaccumulation at Site 14 may reflect previous exposure to aluminium as fish move around the catchment (Site 14 dries up early in the dry season). Individual Dytiscidae beetles from Sites 4 on Norman Creek and 14A on Coconut Creek had much higher aluminium concentrations than were typically found in specimens from the other sites. These results show natural variability in aluminium bioavailability within and between catchments in the study area.

Table 8-15 Tissue Samples (2008 and May 2009) above Food Standard or Generally Expected Levels

Metal	Samples Above Standard	Samples Above GEL	Samples Above LOEC
Silver	No std	No standard	No std
Aluminium	No std	No standard	No std
Antimony	No std	1 *Cherax sp.1* cephalothorax sample above 0.1mg/kg GEL	No std
Arsenic	Nil	6 *N. graeffei* flesh samples above 20mg/kg GEL	Nil
Cadmium	No std	Nil	Nil
Copper	No std	Nil	8 *L. calcarifer* liver samples above LOEC of 4.3mg/kg 4 *T. chatareus* gill samples above LOEC of 0.64mg/kg
Mercury	3 samples above USFDA Guidance (1.0mg/kg) and 1 above proposed CODEX standard (0.5mg/kg) in *N. midgleyi* liver samples	No standard	No std
Manganese	No std	No standard	No std
Lead	9 *C. quadricarinatus* cephalothorax samples above ANZFA Food Standard (0.5mg/kg) 5 *Cherax sp.1* cephalothorax samples ANZFA Food Standard (0.5mg/kg) 3 *N. midgleyi* liver samples above proposed CODEX standard (0.2mg/kg) 1 *N. graeffei* liver sample above proposed CODEX standard (0.2mg/kg)	No standard	No std
Selenium	Nil	22 *T. chatareus* liver samples 5 *N. midgleyi* liver samples 5 *L. calcarifer* liver samples 9 samples of *N. graeffei* liver samples. Above GEL of 2mg/kg	Nil
Zinc	1 *N. midgleyi* flesh sample above ANZFA Food Standard of 15mg/kg	Nil	Nil

Note: No std. indicates no appropriate standard or GEL available.

Lower than typical average copper concentrations at the other sites were found in samples from Site 1A in Redclaw tail flesh samples and Hyrtl's tandan hind body samples, for Site 16 for Redclaw cephalothorax samples and Sites 16 and 11 for abdomen flesh samples, and Site 4 and Site 16 in whole Dytiscidae beetle samples (refer **Appendix 8B**).

The Project area is currently undeveloped and therefore differences in bioaccumulation of metals between sites, catchments and/or species are not the result of any mining activities. There is natural ecosystem variability in metal bioavailability within the Project area.

As expected, there is some enhanced bioaccumulation of aluminium in an aluminium mineralised area. The baseline metal concentrations in tissue samples were low, and not indicative of any human or animal population health risks.

8.12 Summary of Aquatic Ecosystem Environmental Values

While the Project area has a landscape that is seasonally saturated by wet season rainfall and runoff, it has only self-contained, short surface drainage networks and is not endowed with the more diverse and productive aquatic ecosystems associated with larger Cape York river systems. Nonetheless, its aquatic ecosystems have environmental values of national, state and regional significance that can be summarised by non-exclusive reference to both geographically specific sites and generic ecological values including:

- high value wetland aggregations;
- aquatic refugia in a seasonally dry landscape;
- species listed under conservation legislation;
- a representative bauxite plateau freshwater fish community; and
- species with restricted distributions.

These are described in the following sections.

8.12.1 Larger "Interface" Wetland Aggregations

There are three relatively larger wetland aggregations partially or wholly contained within the Project area, referred to here as "interface" wetlands due to their location at the interface between tidal influence and catchment freshwater discharge. These include lower Winda Winda–Triluck Creeks, lower Norman Creek and lower Ward River. These sites are continuous, complex wetland aggregations (Blackman *et al.* 1992). Each comprises an aggregation of different wetland habitat types including perennial and seasonal stream reaches, perennial channel hosted lagoons, tree swamps, seasonal coastal lakes, spike rush swamps and tidal mangrove forested estuaries. The lower Ward River is included within the Directory of Important Wetlands In Australia listed as QLD056 Archer Bay Aggregation (DEWHA 2004, Blackman *et al.* 1999) which is listed on the basis of meeting five (Criteria 1, 2, 3, 5 and 6) of the six possible criteria used to determine wetlands of national significance (refer **Table 8-16**).

Results of this study indicate that the two other major wetland aggregations identified within the Project area, lower Winda Winda – Triluck Creeks and Norman Creek, would also meet these criteria albeit with smaller sized aggregations. High values associated with these wetland aggregations are discussed in the following sections.

Table 8-16 Criteria for Wetlands of National Significance

Criteria	Basis for Criteria	Description of Criteria
1	Biogeographic Representativeness	The wetland is a good example of a wetland type occurring within a biogeographic region of Australia
2	Functional Importance of Wetland	The wetland plays an important ecological or hydrological role in the natural functioning of a major wetland system/complex
3	Value as an ecological refuge	The wetland is important as the habitat for animal taxa at a vulnerable stage in their life cycles, or provides a refuge when adverse conditions such as drought prevail
4	Value as a population refuge	The wetland supports 1% or more of the national population of any native plant or animal taxa
5	Value as endangered species habitat	The wetland supports native plant or animal taxa or communities which are considered endangered or vulnerable at the national level
6	Human Social Importance	The wetland is of outstanding historical or cultural significance

Shaded rows indicate criteria met by QLD056 Archer Bay Aggregation (DEWHA 2004, Blackman *et al.* 1999)

8.12.1.1 Primary productivity exports to downstream ecosystems.

Within these wetland aggregations sunlit perennial shallow freshwaters supporting macrophyte and algal growth, extensive seasonal spike rush swamps and mangrove forests generate the

carbon biomass that supports the food chain and productivity of downstream aquatic ecosystems within catchments that are otherwise characterised by relatively low nutrient waters and limited in-stream primary productivity. Nutrient concentrations in surface waters associated with wetland complexes were substantially higher than for streams without substantial associated wetland vegetation, demonstrating that in the Project area wetlands are sources of nutrients, not sinks. Tidally influenced seasonal lakes adjoining the Norman Creek estuary contained significant populations of detritivorous prey species including mullet and shrimps. During field investigations aggregations of Barramundi and other marine fish species commonly observed to be feeding on prey species at the discharge confluences of seasonal lakes and spike rush swamps in the upper Ward River, Norman Creek and Winda Winda – Triluck Creek estuaries.

8.12.1.2 Fishery nursery habitat

The seasonal lakes and perennial channel hosted lagoonal habitat that occurs within these wetland aggregations are recognised to be nursery habitat for fish species of importance to commercial, recreational and Indigenous fisheries, particularly Barramundi.

8.12.1.3 Fisheries

In addition to providing fishery nursery areas these wetland aggregations, particularly estuarine and lower freshwater reach main channels, are important areas for recreational and Indigenous fisheries, particularly for Barramundi but also for a host of other estuarine species sought by these fisheries e.g. Mud crabs.

8.12.1.4 Seasonally Important nesting and feeding habitat for waterbirds

The seasonal lakes and *E. dulcis* 'Bulkuru' spike rush swamps within these wetland aggregations are recognised as significant roosting, feeding and breeding areas for the Magpie goose *Anseranas semipalmata* and a host of other waterbird species including flocks of Brolga *Grus rubicundus* and the NCA "near threatened"-listed Black-necked Stork *Ephippiorhynchus asiaticus* (DEWHA 2004, Blackman *et al.* 1999). Observations of large flocks of waterbirds were particularly noted on the seasonal lakes of the lower Ward River and Winda Winda – Triluck Creek estuaries.

8.12.1.5 Aquatic refugia

The lower reaches of freshwater drainages supplying these wetland aggregations include perennial habitats that function as refugia for freshwater aquatic biota during the dry season, most importantly in years of below-average rainfall when freshwater habitats higher in the catchment are less likely to persist through the dry season.

8.12.1.6 Habitat for threatened species

A number of EPBC Act and NCA listed threatened species (discussed in **Section 8.10**) are known or predicted to occur within these wetland aggregations.

8.12.1.7 Cultural significance

Wetlands are often sites of importance to Traditional Owners due to values associated with both hunting and gathering resources and spiritual significance. The lower Ward River wetlands are part of the Archer Bay Aggregation which is cited as having very high cultural significance to Aboriginal clans associated with the Aurukun community (DEWHA 2004). Traditional Owners have also indicated similar significance is associated with the two other identified larger wetland aggregations.

There are four smaller wetland aggregations within the Project area that collectively share the same range of values as the larger aggregations identified above, but do not have the full suite of values within any individual aggregation. These include the Leithen to Franjum Point Aggregation, False Pera Head Aggregation, lower Ina Creek Aggregation and Waterfall Creek Aggregation.

The Leithen to Franjum Point Aggregation includes an estuary associated with Leithen Creek but lacks a significant freshwater catchment or discharge to support the productivity export or

aquatic refugia values associated with the larger wetland aggregations. However, this aggregation does contain areas of freshwater seepage that support small areas of seasonal tree swamps and *E. dulcis* Spike Rush swamps, the latter having associated waterbird habitat values. It also provides suitable habitat for the full suite of threatened species known or predicted to occur within the study area.

The remaining smaller wetland aggregations (i.e. the False Pera Head Aggregation, lower Ina Creek Aggregation and Waterfall Creek Aggregation) have more extensive catchment areas and/or greater freshwater inputs/discharge but lack extensive estuarine habitats due to elevated lateritic outcrop outlets that prevent or limit the capacity for tidal intrusion. Consequently these aggregations have more limited productivity and fishery values associated with their brackish estuarine interfaces and the lower waterbird habitat values associated due to the absence of *E. dulcis* 'Bulkuru' spike rush swamps. However, perennial freshwater habitats within each of these aggregations do have aquatic refugia values, which are essential for providing freshwater fish recruits to seasonal stream habitats within their catchments. These systems have also been specifically identified by Traditional Owner informants as having high spiritual and harvestable resource values (Geraldine McGuire Pers comm.).

8.12.2 Aquatic Refugia

In a seasonally dry environment such as the Project area, the persistence of aquatic biota, such as non-migratory fish, is tied to the perenniality and extent of freshwater habitats and the access and recruitment of biota to them. In this context the most permanent, extensive and connected freshwater habitats are provided by perennial stream reaches, some of the most significant occurrences of which are contained within wetland aggregations described above. Outside of the named wetland aggregations, perennial stream reaches are primarily limited to the mid and lower reaches of the two major tributaries of the Norman Creek system which also contains perennial reaches in some of its more deeply incised eastern upper catchment tributaries. The lower reaches of the Ward River also has aquatic refugia partially maintained by groundwater discharge but these reaches become dominated by tidal ingress and brackish in the late dry season. The lower Winda Winda and Ina Creek systems contain perennial freshwater habitats restricted to channel hosted pools (discussed below). Perennial stream reaches represent the habitat epicentre for obligate freshwater biota survival within the study area.

Other than stream reaches, other forms of perennial freshwater habitats that provide aquatic refugia values for freshwater biota within the SoE study area, include semi-perennial coastal lakes and lagoons, perennial channel hosted lagoons and permanent pools and soaks within tree swamps, coastal swales, drainage depressions and flood runners and within short coastal spring drainages. However, these other habitats do not provide the same level of population security or recruitment/dispersal capacity as that provided by stream reaches. In some instances the relative isolation of these habitats is in itself a refugial value allowing populations of macroinvertebrates to flourish and be maintained in the absence of significant fish predation pressure, e.g. the greater than average densities of Swamp crayfish *Cherax rhynchotus* encountered within the coastal freshwater lagoon at Pera Head.

8.12.3 Species of Conservation Significance

A number of EPBC Act and NCA listed threatened and migratory species (discussed in **Section 8.10**) are known, or possibly occur, within the aquatic ecosystems of the Project area including sites outside of the wetland aggregations described above. All of these species have a statutory underpinning for their protection, which confers an additional environmental value to the ecosystems they occur in, in terms of the opportunities they provide for meeting these species conservation needs.

Although these species are likely to occur within the Project area, the extent of these habitats within the Project area that would be disturbed is limited to a small area. The potential for these species to occur within Project related disturbance areas is summarised in **Table 8.14**. Potential impacts on these species associated with Project related disturbance are discussed in **Section 8.17** for freshwater species, **Section 7.15** for largely terrestrial species (Estuarine

Crocodile and migratory wetland birds), and **Section 6.9.5** for marine species (Dugong, Green Sawfish and Dwarf Sawfish).

8.12.4 Bauxite Plateau Freshwater Fish Assemblages

The Project area freshwater fish community is characterised by catchment-specific assemblages of mostly widespread species, although it is noted the goby and grunter families have not been recorded (refer **Section 8.7**). Species diversity in tropical Australia has been shown to be very strongly correlated with catchment size (Pusey and Kennard 1996). Typically, nature conservation evaluation frameworks emphasise species rarity and diversity and are not as well equipped to identify values associated with naturally occurring species-poor assemblages or low diversity. The low diversity of freshwater fish within the Project area has been attributed to small catchment size, catchment isolation, a limited spatial and temporal extent of perennial freshwater habitat and physiological constraints associated with the very low conductivity of freshwater emanating from the bauxite plateau (**Section 8.5.1** and **Section 8.7.4**). The naturally high bioavailability of aluminium is also a potential limiting factor, although there is currently insufficient evidence to determine the extent of its effects, if any.

Field surveys in small drainage systems of the Project area, and the Pine River basin which drains bauxite plateau landscapes near Weipa, indicate that such low-diversity fish communities are typical of small stream systems within bauxite plateau landscapes and may characterise a definable "Bauxite Plateau Freshwater Fish Assemblage". The retention of representative examples of these fish communities is a legitimate nature conservation aspiration and one that attributes value to such communities.

The catchment-specific species mixes found within the Project area catchments have been attributed to stochastic events determining recruitment success and/or extinction events and to variable connectivity to larger drainage systems and associated larger species pools. As such, each catchment's freshwater fish community provides a snapshot of an active freshwater fish biogeographic laboratory that is of interest to science in terms of improving the understanding of controls and processes underpinning fish biogeography in the seasonal tropics of northern Australia, and biogeographical and evolutionary genetic processes more generally. They represent isolated freshwater "islands" that have been separated from other freshwater systems since the last sea level rise 7,000 to 9,000 years ago. The systems have experienced limited opportunities for recolonisation via overland flows and coastal freshwater lenses in extremely wet years, and occasional severe stress periods and probable local extinction events in extremely dry years. The processes by which these isolated assemblages have been able to maintain themselves and the extent and rate of genetic divergence from their neighbours are of particular potential scientific interest.

The patchwork of species presence in the various catchments suggests that over longer time periods, and certainly since last sea level rise, the persistence of all the currently present species will have been dependent on the availability of perennial habitats among all catchments, and could not have been maintained by persistence of surface waters within any single catchment. Therefore, conservation management of the "Bauxite Plateau Freshwater Fish Assemblage" requires management of habitat availability across a substantial proportion of all the habitats in the broader western Cape York bauxite areas. The Project area catchments are an integral part of this larger assemblage of inter-dependent freshwater "islands". These aquatic ecosystems would need to be managed carefully to maintain their unique ecosystem values, as various large parts of the bauxite landscape in northern Australia are currently being mined or being proposed for mining. The patchy distribution of species across the bauxite catchments means that the catchments cannot be adequately managed in isolation, but rather should be managed as an inter-related set of aquatic ecosystems, dependent upon one another to maintain the full species set that currently inhabits them.

In terms of maintaining ecological sustainability over the timescale of mining development in the Project area, the freshwater fish communities of SoE stream networks represent the most ready source of recovery recruitment for stream reaches that may be potentially impacted by mining operations. This need to maintain the recovery potential of in-stream biota within the Project area also attributes environmental value to the freshwater fish community. In summary,

the freshwater fish community of the Project area has significant nature conservation, scientific and environmental management values.

8.12.5 Species of Restricted Distribution

Several freshwater species found in the Project area are not currently listed in any conservation management lists or legislation, but nonetheless have patchy or restricted distributions that confer conservation value and suggest they are worthy of specific management within the Project area. These include:

- Spotted Blue-eye *Pseudomugil gertrudae*;
- Black-banded Rainbowfish *Melanotaenia nigrans*;
- Swamp Crayfish *Cherax rhynchotus*; and
- Freshwater Crab *Austrothelphusa raceki.*

In addition, a new species of Freshwater Crab, *Austrothelphusa sp. nov.* was collected from Winda Winda Creek (Site 9A) during the May 2008 sampling. Specimens sent to the Queensland Museum for identification confirmed the status of this new species. No formal description of this species has yet been made. Further survey work in 2009 extended the species recorded range beyond the original record site to upstream and downstream locations (Site 33 and Site 34) but not beyond the Winda Winda Creek catchment. *Austrothelpusa sp.* was not located in other catchments within the Project area during aquatic surveys, although it may be more widespread than the three confirmed sites on Winda Winda Creek.

8.13 Aquatic Ecosystems – Overview Potential Impacts

Other than the proposed water supply storage (Dam C Norman Creek catchment), the direct impact footprint of proposed mining and infrastructure development within the Project area, defined in terms of native vegetation clearing, primarily occurs within terrestrial ecosystems (refer **Section 7**). Implementation of an environmental buffer system as outlined in **Section 7.9.2** would ensure that riparian, wetland and estuarine habitats are buffered from direct impacts associated with vegetation clearing other than where they occur within narrow infrastructure and access corridors that cross drainage lines (**Figure 7-8**), or in Dam C**.** Other indirect potential impacts that commonly affect terrestrial as well as riparian, wetland and estuarine vegetation – including altered fire regime, weed invasion and feral animal disturbance – have also been identified along with mitigation measures in **Section 7.10.2.**

The nature and condition of aquatic ecosystems is largely determined by the integrated outcome of catchment functional processes. All of the Project area acts as a catchment for surface and groundwater that underpins aquatic ecosystem sustainability. Therefore all development that alters catchment conditions to the extent that the behaviour or quality of water within the Project area's catchments is modified has some potential to generate indirect impacts on receiving aquatic ecosystems.

The greatest potential for impact to the behaviour and quality of water within the Project area's catchments is associated with:

- 27,290ha of catchment area that is to be progressively subject to a cycle of vegetation clearing, bauxite mining and rehabilitation over a 40-year mine plan;
- the proposed water supply dam with storage capacity of up to 29GL and a cleared footprint area of 700ha on a tributary of Norman Creek, the most perennial drainage system within the Project area; and
- an infrastructure footprint of 1,360ha on non-mining areas including beneficiation plants, ore stockpiles, tailings storage facility, roads and transport and shipping facilities (includes some infrastructure constructed within or across drainage lines, i.e. stream road crossings).

Potential impacts on aquatic ecosystems due to these proposed developments could be realised via:

- changes in catchment hydrology;
- elevated sediment and other contaminant loads in catchment runoff; and
- loss of aquatic habitat connectivity.

These three primary sources of potential impact to aquatic ecosystems in the Project area and mitigations options are discussed below. Potential impacts associated with underwater noise from pile driving activities on marine and aquatic fauna is discussed in **Section 10.5**.

8.14 Potential Impacts and Mitigation Measures – Altered Catchment Hydrology

8.14.1 Potential Impacts

8.14.1.1 Catchment Hydrological Changes due to Mining

Discussion of the potential interaction of mining operations on surface and sub surface hydrology is provided in **Section 5.2.4** and **Section 5.4** respectively. Changes in the partitioning of incident rainfall to catchment discharge volumes within each of the sub-catchments of the Project area was analysed using the AWBM rainfall-runoff model through four stages of mine development:

1. Undisturbed catchment
2. Active mining area
3. Immature mine rehabilitation (<15 years old)
4. Mature mine rehabilitation (>15 years old).

Modelled outputs indicate overall changes to mined catchment discharge volumes will be very small on account of the naturally high infiltration rates for rainfall in the bauxite landscape and the very low percentage (<1%) of rainfall that is discharged as surface runoff, factors largely unaffected by mining-based alteration of surface cover, topography and drainage lines. For undisturbed catchments in the Project area, monitoring and modelling outputs indicate that almost half (~48%) of the rainfall received by a catchment infiltrates and is conveyed via the lateritic profile and discharged to streams as base flow. A slightly smaller proportion (~42%) is lost to evapotranspiration. The remaining ~9% contributes to "deep base flow", or water that moves as saturated flow beneath the level of the stream bed and which may discharge as surface water (including streamflow) at a lower point in the catchment, or as upwelling in estuaries (refer **Section 5.1.1**).

Another key finding from groundwater bore monitoring indicates the potential for mining-related alteration of catchment hydrology within the Project area is limited since fluctuations in groundwater levels, including rises through the wet season, only occasionally reach or exceed planned mine pit floor levels (refer **Figure 5-26 to Figure 5-29, Table 5-23)**. Consequently, the removal of bauxite from the lateritic profile would have limited potential impact on the storage volume and residence time of the seasonal shallow groundwater aquifers that contribute to stream base flow via discharge from the lateritic profile.

The greatest change to catchment hydrological behaviour indicated by modelling of the mining disturbance cycle is during periods with the greatest active mining area footprint (refer **Table 5-21**). Removal of vegetation cover results in reduced in-pit evapotranspiration losses (down to 35.3% from 42.2% for undisturbed) and pit compaction increases surface runoff within the pit, although pit geometry causes runoff to pond and ultimately infiltrate within the pit and contribute to increased base flow in streams (52.0% c/f 48.4% for undisturbed).

Modelled water balance partitioning responses to mine pit rehabilitation indicate catchments return to near pre-mine hydrological behaviour with the regeneration of mature vegetation cover, except:

- the lowered post-mining landscape topography is reflected in reduced direct surface runoff to streams (0.2% c/f 0.6%); and
- deep base flow / recharge is increased by the greater detention of surface runoff in the post-mined landscape (10.9% c/f 8.8%).

Overall changes to mean annual catchment discharge are predicted to be small, ranging from increases of 0.1% to decreases of 0–1.4% per Project area drainage catchment during the maximum footprint of mining development (refer **Table 5-22**). The long-term rehabilitated post-mining landscape is predicted to have reductions of between 0–3.2% per Project area drainage catchment with a mean overall reduction of 1% for the Project area. These reductions in catchment discharge are predicted to be associated with the increased direct accession of ponded runoff to deep base flow / recharge in the lowered post-mine landscape. The proportion of rainfall that will be expressed as stream base flow is also predicted to be less than the undisturbed situation (46% versus 48% pre-mining) due to the increased accessions to deep base flow. However, it should be recognised that at least some of the extra 1.1% deep base flow will be expressed lower in affected catchments as an increased groundwater contribution to surface waters.

While overall post-mining catchment discharge volumes would be largely unaffected by mining, there is some potential for stream flow duration curves to be affected by the increased detention and re-routeing of surface runoff during the active mining phase. The increased within-pit runoff arising from the compacted mine surface flows to the lowest topographical point and is retained in the pit. Overall net infiltration is higher than the undisturbed situation, as indicated by the increased base flow component in streams. To the extent that the topographical low point within a pit is closer to a stream than the centroid of the pit, there would be a shorter transmission path through the in-situ lateritic profile and hence stream base flow would rise more quickly in response to rainfall than it would in the undisturbed situation. At a catchment scale, these effects would be limited by the relatively small active mining area at any one time.

The relative contributions of surface runoff, base flow to streams and deep base flow have been quantified at a catchment scale but not at a reach scale. Reach scale impacts would be determined by factors including:

- the percentage of contributing catchment that is subject to active mining;
- reach elevation relative to land surface, adjacent mine pit floors and seasonal groundwater levels; and
- the pre-mine partitioning of reach flow sources between surface runoff, stream base flow and deep base flow.

In higher elevation reaches or those lacking perennial flow contributions from deeper aquifers, mining may generate one or more of the following impacts:

- reduced surface runoff flow peaks due to surface flow detention in mine pits;
- increased infiltration through the ground potentially generating a greater base flow peak; and/or
- an earlier post rainfall base flow cessation.

Impacts driven by alteration of surface runoff patterns would be limited by the small percentage of rainfall that is conveyed as surface runoff. Earlier cessation of stream base flow would be limited in most catchments by the small extent and volume of the seasonal aquifer intersected by mine pit floors.

In lower catchment reaches receiving a contribution to surface waters from a perennial deeper aquifer (deep base flow), the alteration due to mining may (assuming sufficient aquifer storage

volume) result in increased dry season flows. However, the extent of this increase is likely to be limited and modelling shows the proportion of incident rainfall that ends up as deep base flow would increase from 8.8 to 10.9% on average. This change is unlikely to be sufficient to lead to water quality changes.

These mining-related catchment hydrological alterations could have the following ecosystem consequences at a reach scale:

- The more rapid ("peakier") delivery of the direct groundwater flow component to surface drainage networks during and immediately following wet season rainfall may result in an extended duration of greater depth inundation of wetland basins and "sumps" within the drainage network than previously experienced. This may result in some waterlogging associated riparian tree death and landward wetland ecotone boundary movement in affected wetland systems.
- In reaches not supplied by deep base flow, reduced and potentially shorter duration groundwater contributions to stream base flows may result in truncated post wet season base flow duration in some stream reaches. However, given the limited interception of the seasonal shallow aquifers by mine pits, indicated by groundwater bore monitoring, this impact is likely to be generally negligible for most catchments, though may be more significant in upper catchment reaches and/or sub-catchments where a substantial proportion of the catchment is proposed to be mined (e.g. Ina Creek ~57%). If this hydrological change occurred, impacts could include: loss or downstream movement of perennial aquatic refugia within the stream drainage network, some alteration of the dry season soil moisture regime adjoining drainage lines and the associated extent of fire refugia dependent riparian vegetation, and inland migration of wetland fresh/brackish ecotonal boundaries due to increased tidal intrusion post wet season (but only where the lower catchment of a drainage network is not supplied by deep base flow).
- Changes to small local catchment discharge points due to the modified surface and internal (lateritic layer) drainage associated with mine pit areas, including redirection of water that may have flowed via groundwater conduits from one catchment into another catchment or drainage reach.
- Where lower catchment reaches or ecosystems experience increased stream base flow volume or duration due to increased contributions from deep base flows, there could be seaward shifts of the tidal–freshwater interface ecotone and increased pool water levels and/or reduced rates of water level recession in receiving tree swamps and wetlands may be promoted. Freshwater wetlands may experience outwards shift in the wet–dry ecotonal boundary via waterlogging tree deaths associated with altered inundation patterns and changes in seedling survival and recruitment conditions due to altered dry season soil moisture conditions and associated fire refugia distribution.
- In the lowermost freshwater reaches of the mined catchments with larger, more valuable wetland complexes (i.e. Winda Winda–Triluck Creeks, Lower Norman Creek, lower Ward River) an extended base flow duration is the most likely impact, though only of a magnitude that would promote ecotonal shifts at a rate within the range of the inter-decadal variability experienced naturally by these systems. A small seaward extension of ecotonal boundaries defined by freshwater-associated mangrove communities may occur at some sites not affected by the water storage dam construction.
- The increased detention capacity of the mined landscape is likely to reduce surface runoff flow peaks (experienced after the catchment is "wetted up" by early wet season rainfall) and their associated geomorphic influences on stream channel form and sediment carrying capacity including pool flushing and scouring effects. However, this effect is likely to be small given the small proportion of direct runoff (<1%) and more than partially offset by peakier contributions to stream base flow and, in reaches receiving deep base flow, by increased dry season flow durations. While the

geomorphic outcomes for any specific reach are hard to predict, some minor changes in stream channel form, possibly including changes to the depth of scour pools that function as perennial/refugial aquatic habitats, could be expected.

In summary, mining impacts to catchment surface and groundwater hydrology are unlikely to significantly alter catchment discharge volumes but may alter streamflow durations in either direction, depending on the partitioning of incident rainfall in each individual catchment or reach. Any such bias would be overlain on any natural patterns of variability in rainfall and flows. The net changes are anticipated to be relatively small and neutral in terms of ecological values at the catchment scale, although detectable changes may occur at the reach scale. While the changes may be directional over the life of the mine they are expected to occur at a rate within the range of the inter-decadal variability currently experienced by these systems and to largely rebound following the rehabilitation of mature vegetation cover post mining.

Aquatic ecosystem impacts are expected to be neutral at a catchment scale but may include:

- impacts to existing wetland and riparian vegetation stands due to altered inundation patterns, changes in preferred recruitment conditions and fire regime exposure;
- small boundary shifts in wetland–terrestrial and freshwater–tidal wetland ecotones. These shifts are likely to be of the order of one to tens of metres and at a rate within the range of the inter-decadal variability experienced by these systems;
- redistribution of aquatic habitat and riparian vegetation fire refugia potentially including both decreases in upper reaches and increases in lower reaches; and
- altered seasonal/inter-annual aquatic biotic community composition associated with localised reach scale losses of species or reduction in access to aquatic refugia or, alternatively, increased persistence/perenniality of freshwater habitats.

Management and mitigation measures to minimise the extent of such hydrological disturbances to aquatic ecosystems over the life of mining development and beyond are discussed below.

8.14.1.2 Catchment Hydrological Changes from Dam C

Infrastructure proposed within the Project area includes a water supply dam on a freshwater tributary of Norman Creek (Dam C). The location and hydrological performance of this proposed storage is described in **Section 5.2.3**. Summary dimensions and flow impacts of the proposed storage is presented in **Table 8-17** (below). The potential aquatic ecosystem impacts associated with the construction and operation of this water storage dam would include:

- clearing and inundation of riparian/wetland vegetation (discussed in **Section 7.9**);
- altered connectivity in riparian (discussed in **Section 7.9**) and aquatic (discussed below in **Section 8.16**) habitats;
- changes to the flow regime and associated water quality, physical habitat and ecological conditions in the receiving reach and estuary downstream of the water storage dam; and
- creation of a large perennial lake habitat above the water storage dam wall.

The potential of the proposed water storage dam to generate altered catchment hydrology associated impacts in downstream reaches would vary with the storage volume and utilisation levels proposed for each development stage.

"Impact benchmarking" methods that assess levels of change from modelled or measured predevelopment annual flow statistics have been used to consider risk to flow-dependent ecological assets including estuaries in subtropical Queensland (Brizga *et al.* 2000, Hydrobiology 2008). These methods considered changes of >20% in mean annual flow and other annual flow statistics as having the potential for "class 2" impacts on flow-dependent ecological assets, i.e. they represent "values above which assessed sites are more likely to have major / very major impacts of water resource development on geomorphological and/or ecological conditions" (Brizga *et al.* 2000). The relevance of this benchmarking method to tropical aquatic ecosystems

in the Project area has not been demonstrated but, in the absence of more specific science, it may be considered indicative.

Dam C would have a maximum storage capacity of 29GL and could be constructed in either in two stages or a single stage. If constructed in two stages, the first stage would provide 10.9GL storage capacity and, later, the wall would be raised to provide 29GL storage capacity. The dam would be constructed in a single stage (29GL storage capacity) should expansion of production above 15Mdptpa be anticipated to occur quickly, or should an initial production capacity of 22.5Mdptpa be adopted. This is the subject of ongoing feasibility studies. This EIS has assessed the impact of the dam at minimum, intermediate and maximum production rates of 15Mdptpa, 30Mdptpa and 50Mdptpa.

The 10.9GL dam would have an 8m wall (at spillway level) and capture approximately a third of the catchment area on the most perennial tributary stem of the creek system (refer **Table 8-17**). At 15Mdptpa, annual mean flows immediately downstream of the dam wall would be reduced by 23.7% and reduced by 6.5% to the estuary under a 15Mdptpa production scenario. The 29GL dam would have a wall height of 12m (at spillway level). At 30Mdptpa, annual mean flows downstream of the dam wall would be reduced by 32.9% and by 9.8% to the estuary. At the 50Mdptpa production rate, annual mean flow downstream of the dam wall would be reduced by 50.5% and mean flow to the estuary reduced by 15.1%.

Annual mean flow volume reductions would also be reflected in reductions of individual and seasonal flow magnitudes with the greatest changes occurring in the wet season onset period when the dam is filling and in the early dry season when spillway overflows decline and base flows would be reduced by diversion for mine use. A summary analysis of the hydrological performance of the water storage dam (refer **Table 5-17)** indicates that modelled annual 10^{th} percentile, median and 90^{th} percentile flows downstream of the dam wall would be reduced under the 15Mdptpa production scenario to 66.7%, 77.3% and 83.3% of pre-dam flows respectively. The corresponding reductions for the 30Mdptpa production scenario are 43.9%, 63.7% and 80.4% of pre-dam flows. For the 50Mdptpa production scenario, reductions are 19.2%, 46.9% and 63.6% of pre-dam flows respectively.

Modelled annual 10^{th} percentile, median and 90^{th} percentile flows to the estuary would also be reduced but to a much smaller extent. Under the 15Mdptpa scenario they would be reduced to 90.1%, 93.5% and 95.0% of pre-dam flow conditions respectively. Under the 30Mdptpa production scenario flow is reduced to 83.1%, 89.2% and 90.2% of pre-dam flow conditions respectively and at 50Mdptpa production to 75.9%, 84.1% and 89.1% of pre-dam flows respectively.

Table 8-17 Summary Dimensions and Flow Impacts

	Dam C	
Norman Creek System	**At 10.9GL capacity**	**At 29GL capacity**
Norman Creek system catchment (to estuary) area (km^2)	259	259
Dam C catchment area (km^2)	77.3	77.3
Dam catchment as % of Total catchment	29.8%	29.8%
Maximum Dam Volume (GL) (at spillway)	10.9	29
Clearing area (km^2) (at clearing limit mRL)	4 (14.5)	7 (18.5)
Dam wall height (m) (at spillway)	8.0	12.0
Downstream of dam wall flows (annual mean) as % of inflows 15Mtdptpa	78.3%	
Downstream of dam wall flows (annual mean) as % of inflows 30Mtdptpa		67.2%
Downstream of dam wall flows (annual mean) as % of inflows 50Mtdpata		49.5%
Estuary flow input (annual mean) as % of pre-mine 15Mtdptpa	93.5%	
Estuary flow input (annual mean) as % of pre-mine 30Mdptpa		90.2%
Estuary flow input (annual mean) as % of pre-mine 50Mdptpa		84.9%

The post-dam impact on mean monthly flows relative to pre-dam conditions under the three development stage scenarios is illustrated in **Figures 5-12** to **5-14.**

Currently the predictive capacity for potential impacts is not sufficient to make clear distinctions between those that would be associated with the 10.9GL dam and 15Mdptpa production scenario as opposed to the proposed 29GL dam and a 30Mdptpa and subsequent 50Mdptpa production scenario. However, application of the >20% change threshold for mean annual flow and other annual flow statistics used for impact benchmarking in studies of subtropical flow dependent ecological assets including estuaries (Brizga *et al.* 2000, Hydrobiology 2008) is indicative of the greater potential for more substantial changes to ecological and geomorphological conditions with the 29GL dam scenarios. A general conclusion is that the water resource demands at 15Mdptpa production would produce impacts that are measurable within the receiving reach but not the estuary, while the 29GL dam and 30Mdptpa production rate would generate more pronounced changes in the receiving reach, but still probably undetectable change to the estuary. The 29GL dam at a 50Mdptpa production rate is likely to cause significant change to the receiving reach and lead to measurable change in the estuary.

In effect, each subsequent water resource development stage would accentuate the aquatic ecological impact of the annual dry season via earlier cessation of dry season flow, later onset of larger early wet season freshwater flows and seasonally reduced freshwater flow volumes to the affected receiving reach.

In the absence of specific flow-linked ecological or physical habitat response data, a monthly flow volume of 1GL is useful for illustrating relativities between water resource development stage scenarios. Under pre-dam conditions, mean monthly flow volumes at the dam site of less than 1GL are only associated with the four months of the latter dry season (Aug–Nov). Under the 10.9GL dam scenario this increases to five months (Jul–Nov), under the 29GL dam and 30Mdptpa production rate scenario it increases to six months (Jun–Nov) and under the 29GL dam and 50Mdptpa production rate scenario it increases to seven months (Jun–Dec).

Each subsequent water resource development stage would also reduce the aquatic ecological impact of the annual wet season within the receiving reach, effectively emulating a smaller wet season with reduced frequency and duration of larger monthly flows and an overall reduction in seasonal flow volume. A threshold monthly flow volume of 2GL is useful for illustrating relativities between water resource development stage scenarios. Under pre-dam conditions, mean monthly flow volumes at the dam site of greater than 2GL occur from the onset of the wet season in January through a post wet season flow recession period extending to June (six months), reaching a monthly peak of 18.1GL in March (refer **Figure 5-12**). Under the 10.9GL dam scenario this decreases to five months (January–May) with a monthly peak of 17GL in March. Under the 29GL dam and 30Mdptpa production rate scenario it decreases to four months (February–May) with a monthly peak of 16.02GL in March, and under the 50Mdptpa production scenario it remains at four months (February–May) but has a more substantially reduced monthly peak of 12.9GL in March.

Considering the magnitude and seasonal distribution of modelled flow regime changes the following two broad groupings of impact would be predicted for the downstream stream reaches and the receiving Norman Creek estuary.

1. *Habitat modification in the receiving tributary stem to the confluence with the Norman Creek estuary.*

The extent of reduction of mean annual flow volume and individual flow magnitude and frequency downstream of Dam C indicated by the flow modelling will potentially generate a range of habitat responses in the ~5km of stream reach that extends from the proposed dam wall to the confluence with a tributary stem of the Norman Creek estuary. The lower half of this receiving reach is tidally influenced and mangrove lined while the upper half has a relatively steep gradient that, when field inspected in May 2009, hosted a range of flowing freshwater habitats including riffles and runs. Downstream of the proposed dam wall the reach comprises: incised flowing channel through open woodland, braided channel through swamp forest, riffle

and run sequences through outcropping lateritic bedrock and riparian forest / woodland, broader channel hosted lagoons within swamp forest, and narrow shallow flowing channel through open claypan "interface" swamp with isolated mangroves. No significant tributary catchment channel joins the main channel of the affected reach until approximately 3.4km downstream of the proposed dam wall, so flow reductions in the freshwater reach below the dam would not be significantly mitigated by tributary flow contributions. Subject to the magnitude of pre and post dam contributions of deep base flow to the receiving reach, the adopted environmental flow regime, spillway overflows, and the extent of dam seepage that could occur through or around the dam wall foundation, the following habitat changes could potentially occur:

- Changes in receiving reach channel geomorphology: Current hydrological modelling and geomorphological understanding limits the accuracy of potential impact predictions. Changes are likely to include deepening and armouring of the stream channel immediately below the dam wall due to reduced sediment supply from above the storage. The extent to which such changes would extend further downstream would depend on the degree to which the loss of sediment supply (mainly bed load) from above the storage is compensated by local catchment supply, potentially increased ingress of estuarine sediment with tidal inflows in lower reaches and the unknown potential of large flow events to deliver sediment from the water supply dam over the spillway. Incised run-in channels in the stream bank and dendritic drainage networks within the interface swamp mid section of the affected reach suggest local sediment inputs may be consequential despite the generally very low suspended solids loads of Norman Creek upstream of the proposed dam site. Reduced total flow volumes and individual flow magnitude, particularly in the early summer (December–January) and winter (June–July) periods, could lead to some shallowing and narrowing of the lower stream channel due to reduced sediment transport capacity and increased riparian vegetation growth, particularly paperbarks *Melaleuca spp*. and/or mangroves (in lower tidally influenced reach sections) into the stream channel. The maintenance of near pre-dam magnitude peak individual flows and monthly flow volumes in late summer – early autumn (February–April) following the filling of the water supply dam under most development stage scenarios would still provide significant "re-setting" of the receiving reach channel and would serve to mitigate geomorphological impact potential associated with overall reductions in wet season flow volume and duration. Geomorphic impact potential would be greatest with the 29GL dam and 50Mdptpa production rate scenario, given the near 50% reduction in annual mean and median flows, 80% reduction in 10^{th} percentile and 37% reduction in 90^{th} percentile flows. It is predicted that receiving reach channel narrowing, shallowing and occlusion by riparian vegetation encroachment are likely to be an apparent habitat change under this development scenario;
- Greater seasonality variability in channel hosted lagoon/pool water levels including potentially greater recession earlier in the dry season;
- A reduced surface freshwater lens in the upper estuary with reduced freshwater hydraulic damming of tidal inflows, the extent of which would be proportional to the reduction in freshwater inflows throughout the year. In contrast, there may be enhanced groundwater discharge into the bottom of the water column (associated with mining increasing deep baseflow). Resultant changes within the receiving reach would include greater seasonal variability and increased maximum salinity levels in the lower section of the affected reach in the early and late dry season with concomitant impacts on freshwater associated mangrove and *Melaleuca* species. The more significant expression of this type of impact would be associated with the 29GL dam, particularly at the 50Mdptpa production rate, and potentially include dieback of some riparian vegetation as ecotonal boundaries defined by salinity regimes shift;
- Decreased abundance of freshwater macrophyte communities in the lower mid-section of the affected reach and reduced occurrence of flow-associated freshwater macrophytes;

- Increased colonisation of the mid-section of the affected reach by mangroves (compared to freshwater associated riparian vegetation i.e. paperbarks) and upstream movement / increased domination by lower estuary associated mangrove species and compression of the freshwater associated mangrove community zones; and
- Potential water quality impacts associated with dam seepage if it occurs and/or elevated dissolved aluminium concentrations in the upper estuary associated with increased proportion of groundwater inflow compared to surface water inflow (both discussed further below).

The extent of some of these potential impacts can be mitigated by environmental flow strategies (refer below), although the mitigation capacity of environmental flows would be ultimately limited by engineering and water resource utilization constraints. Some changes (i.e. salinity regime) would occur immediately following dam construction while other vegetation community and channel geomorphic changes would generally develop over a decadal time scale. Other than the potential water quality impacts that could result from dam seepage, modified habitats would be expected to be healthy and functional and to fall within the range of variability encountered in the existing estuarine habitat aggregation and to continue hosting the range of existing faunal communities albeit with some redistribution of their preferred habitat niches and a reduction within the affected reach of flow and freshwater associated communities under the more intensive development scenario.

2. Alteration of magnitude and timing of wet season flow to the Norman Creek estuary

Under pre-dam conditions the onset of wet season flows to the Norman Creek estuary is experienced in the December–January period, though peak wet season flows don't occur until the bauxite catchment has been "wetted up" usually in March with a symmetrical rising and recessionary flow hydrograph through February and April (refer **Figure 5-12**). Under the modelled post-dam flow regimes, the onset of surface freshwater flows greater than 2GL/month in the estuarine tributary stem below Dam C is effectively delayed by three weeks at 15Mdptpa production, four weeks at 30Mdptpa production and five weeks at 50Mdptpa production (refer **Figure 5-12, 5-13** and **5-14** respectively). However, deep base flow contributions to this reach are predicted to increase as a consequence of mining. Impacts associated with changes in the seasonal timing and volume reductions of surface freshwater flows below the dam would be most felt in the 3.4km of reach downstream of the dam before its confluence with the next major tributary.

While specific causal mechanisms are variable between fisheries, estuaries and regions, the timing and magnitude of freshwater flows into tropical Australian estuaries has generally been demonstrated to correlate strongly with coastal fisheries production (Robins *et al.* 2005, 2006, Halliday *et al.* 2007). Likely causal mechanisms in terms of potential fisheries productivity impacts include delayed and reduced inputs of nutrients, delayed inundation and reduced extent of prey and nursery wetlands and reduced downstream displacement of freshwater prey species and/or competing adults (Robins *et al.* 2005).

Considering the magnitude of flow timing deferrals and volume reductions within the dammed Norman Creek estuary tributary stem, there is some potential for these types of impacts downstream of Dam C. However, catchment hydrological behaviour characteristics would serve to mitigate the potential for impact. The bauxite-dominated Norman Creek catchment exports very little stream flow until the lateritic profile is "wetted up", at which time the base flow increases gradually to a peak, generally in March. This contrasts with "hard" catchments in which onset of wet season rainfall events translate as flow pulses to receiving estuaries, usually with significant associated ecological responses. Consequently the diversion of early wet season flows to the filling of Dam C would not alter the nature of the main freshwater flow pulse experienced by the estuary though it would defer the onset of wet season freshwater flows and increase late dry season salinity levels within the affected estuary stem. These potential impacts would be mitigated to some extent by environmental flow releases, increased deep base flow and, potentially, dam seepage.

Modelling of peak flow behaviour pre and post dam construction indicates that the deferral of pre-dam bank-full flow (associated with back levee wetland inundation events) timing in February (Day 52 i.e. 21 February) would on average be only one day under the 15Mdptpa production scenario, six days under the 30Mdptpa production scenario and nine days under the 50Mdptpa production scenario (refer **Figures 5-16 to 5-18**). This is because the dam is full and overflowing up to a month, on average, before bank-full flow volumes are reached and hence presence of the dam has a limited impact on when bank-full flow first occurs. Peak catchment discharge at Dam C for March is predicted to decline from 18.1GL to 17.0GL under the 10.9GL dam and 15Mdptpa production scenario, to 16.0GL under the 29GL dam and 30Mdptpa production scenario and to 12.9GL under the 50Mdptpa production scenario. Consequently there is some potential for impacts to downstream wetland primary productivity and fishery nursery and recruitment values associated with higher late dry season salinities, delayed and reduced inputs of nutrients and delayed floodplain / back levee wetland inundation, particularly under the more intensive development scenario. The significance of bank-full flow deferral for back levee wetland inundation timing would be mitigated by catchment run in downstream of the water supply dam which would be unaffected.

The implications of impact within the dammed freshwater tributary stem to the broader Norman Creek estuarine ecosystem would depend upon the impact of Dam C on the flow regime experienced by the broader estuary and the maintenance of geomorphic, wetland productivity and fishery recruitment processes throughout the broader estuary. The use of flow statistics to predict estuarine ecology and fisheries production impacts is in its infancy in tropical Australia (Robins *et al.* 2005). The relevance of impact benchmarking methods (i.e. Brizga *et al.* 2000, Hydrobiology 2008) that have used changes of mean annual flow and other flow statistics to indicate the potential impacts on geomorphological and ecological conditions in sub-tropical estuaries to tropical estuaries, particularly oligotrophic ones such as those in the Project area, has not been demonstrated but in the absence of more specific science it may be considered indicative. These methods use changes of >16% in mean annual flow and other flow statistics to indicate the potential for "class 1" (no/minor) impacts and changes of >20% in annual flow statistics to indicate the potential for "class 2" (major / very major) impacts. Flow conditions immediately downstream of Dam C and flows to the whole Norman Creek estuary have been modelled under 15Mdptpa, 30Mdptpa and 50Mdptpa production scenarios (refer to **Tables 5-17 to 5-19**). Modelling for the 15Mdptpa, 30Mdptpa and 50Mdptpa production rates show mean annual flow to the whole Norman Creek estuary declining by 6.5%, 9.8%, and 15.1%, respectively. Only the latter annual mean flow reduction of 15.1% approaches the indicative threshold (16%) for "class 1" (no/minor) impacts to downstream ecological and geomorphological conditions used by Brizga *et al.* (2000).

To examine the nature of flow impacts further it is also useful to identify the distribution of changes across the duration of the wet season (**Tables 5-17 to 5-19**). During months of higher flow (>1000L/s, January to June) residual monthly 10^{th} percentile, median and 90^{th} percentile flows to the estuary do not drop below 80% of pre-dam flow conditions under the 15Mdptpa production scenario, other than the monthly 10^{th} percentile (71.6%) and median (74.1%) flow for January and 10^{th} percentile flow for June (72%). During the January to June period of higher flow at 30Mdptpa production, the residual 10^{th} percentile flow falls below 80% of pre-dam flow in January, February, May and June (in the range ~71 to 76%). Residual median monthly flows are also below 80% of pre-dam flows in January (71.6%) and June (72.8%). At the 50Mdptpa production rate, the residual 10^{th} percentile flow falls below 80% for all months of higher flow other than April (in the range 71.6 to 73.5%). Residual median monthly flows are also below 80% of pre-dam flows (in the range 71.6 to 77%) for all months other than March and April and the 90^{th} percentile flow also drops below 80% for January (72.1%) and June (73.2%).

Where there are reductions of >20% magnitude for annual flow statistics for total flows to the estuary for the months prior to the March flow peak, there is an increased likelihood of some impact to wet season primary productivity and fisheries recruitment within the Norman Creek estuary. Mechanisms could include detention of upper catchment organic load inputs, reduced nutrient exports from the affected tributary stem, reduced displacement of prey populations to

the downstream estuary and higher salinity constraints on prey or larval recruitment or freshwater macrophyte habitats. "Late" wet seasons are associated with significantly reduced recruitment in some estuarine fisheries, particularly Barramundi (Robins *et al* 2006).

However, given the timing and relative magnitude of the March peak flow event is maintained despite the presence of the dam, and that mean monthly flows to the receiving estuary are generally maintained above 80% of pre-impact flows for the core wet season period, such impacts to fishery productivity, if they occur, are predicted to be small.

In wetter years it is likely that the impact of any reduced primary productivity and fisheries recruitment associated with reduced flows from the affected estuary stem would be swamped and masked by the productive potential of the broader estuary ecosystem. The magnitude of impact experienced by the broader estuary would be expected to be within the range of variation naturally experienced during annual wet seasons due to El Niño – La Niña rainfall cycles, and variable monsoonal trough and cyclonic rain depression formation; however, these impacts would be directional over the longer term and are likely to be measurable under the 50Mdptpa development scenario.

Dam Seepage

The lateritic landscape of the Project area has relatively high levels of permeability as demonstrated by observed rates of rainfall infiltration and the commonly observed contributions of groundwater to streamflow via multiple macro pores within and on the margins of drainage channels. Water storage impoundments constructed in this landscape give rise to elevated head pressure and have the potential to cause seepage to shallow groundwater aquifers hosted in the lateritic profile of the host material in which the dams are constructed. If such seepage moved under or around the dam wall cut-off trench and extends to topographic lows on the downstream side of the water storage dam there is a high likelihood that it may express as groundwater discharge to receiving stream reaches downstream, potentially at a level of contribution that may exceed surface flow inputs. Experience gained from water quality monitoring in bauxite landscapes north of Weipa indicates that when groundwater inputs are the dominant component of stream flows, low dissolved oxygen concentrations and elevated iron concentrations often occur and can result in an up to one unit decrease in surface water pH when the iron oxidises. Such anoxic and low pH conditions can drive significant changes in habitat and aquatic community composition. The dominance of groundwater flows also increases the bioavailability of manganese, as evidenced by increased bioaccumulation of manganese in aquatic organisms downstream of such groundwater inputs. Where these influences of dominant groundwater inflows have been observed in other bauxite catchments (Pine River), observed water quality and habitat changes have been limited to relatively restricted (<1km) extents of the receiving stream reach and conditions beyond that point are indistinguishable from other surface flow dominated reaches. The potential for water quality and habitat impacts associated with dam seepage to occur at Dam C would depend upon the suitability of host basement rock from a permeability and structural engineering perspective to prevent downstream seepage. If dam seepage emerges as a likely risk during geotechnical investigations for water storage dam construction, specific environmental flow release strategies would need to be devised to mitigate potential water quality and habitat impacts.

Released Dam Flows Water Quality

Flow releases from Dam C are a potential source of water quality impact to receiving downstream ecosystems. If the water storage dam is stratified, deeper water layers may be significantly cooler than the surface and be low in dissolved oxygen and high in dissolved nutrients and metals (Fe, Mn). The risk of impact to water quality is usually greatest following the initial inundation period post construction when submerged vegetation and organic material decomposes and provides a source of biological oxygen demand that can create anoxic bottom layers that may "roll over" during cool weather events or possibly in response to cooler temperature inflows. This risk would be mitigated by clearing and burning of vegetation prior to dam inundation. Water quality monitoring results in a 12m deep water storage dam constructed in a bauxite catchment north of Weipa (Ely Dam, Pine River catchment) indicate that the clear water conditions associated with an established water storage dam in a bauxite catchment

promotes mixing throughout the 12m water column and limits opportunities for thermal and water quality stratification. Outlet works design, water quality monitoring and environmental flow strategies provide mitigation opportunities to manage potential impacts to water quality associated with flow releases from Dam C.

Artificial lakes

From a habitat perspective one of the potentially positive ecological impacts of the water storage dam construction would be the creation of perennial lake habitat that would increase the extent of perennial freshwater habitat available within the impounded catchment. This would act as aquatic refugia for obligate freshwater biota that may be exposed to increased habitat stresses elsewhere in the developed catchment. Maintenance of aquatic habitat connectivity with downstream reaches (**Section 8.16**) is prerequisite for the realisation of the full productive potential of such artificial habitats which would still be limited by water resource utilisation needs and associated water level fluctuations. Experience gained from other water storage dams constructed in bauxite catchments in the Weipa area indicates that their ecological function is comparable to natural lagoons in the area, due in part to the natural affinity of the local aquatic fauna and flora to seasonal tree swamp and lake conditions.

8.14.1.3 Catchment Hydrological Changes From Ward River Pumping

To supplement the water supply provided by Dam C on a freshwater tributary of Norman Creek under the 30Mdpatpa and 50Mdptpa production scenarios, it is proposed that a pumping station be established on the lower Ward River, above the tidal influence (see **Figure 1-3**). The pumping would be subject to the following constraints:

- pumping would only occur when river flow is above 1000L/s;
- extraction rate not to exceed 20% of river flow at any time;
- maximum extraction rate not to exceed 1200 L/s; and
- overall annual extraction not to exceed 1% of mean annual flow (2.67GL) at pump location.

The daily water balance model was used to model the change to downstream flow at the 30Mdptpa and 50Mdptpa production rates (see **Section 5.2.3**). The changes to flow under both production rates are very similar and the results at 50Mdptpa are summarised in **Table 5-20.**

The modelling shows that the annual extraction from the Ward River at maximum production comprises no more than 1% of the mean, median or 90th percentile flow volume and no more than 1.4% of the 10th percentile flow. Flow to the whole Ward estuary would be reduced by no more than 0.6% of mean, median, 10th and 90th percentile flow. This level of extraction is considered to present no potential for observable impact to the Ward River estuary.

The volume of water extracted varies throughout the year with 88% (2.21GL) of the annual total being pumped on average from December to July. Water would be pumped in the drier months only if the preceding wet season was well above average and sufficiently wet to maintain a minimum 1000L/s flow in the river. Mean monthly extraction does not exceed 5.3% of mean monthly river flow in any month except July (16.6%). Mean monthly flow to the whole Ward estuary is not reduced by more than 2.5% in any month except July (7.8%).

The potential for downstream impact due to the peak extraction in July is mitigated by four factors:

- the small change in the months before and after July (i.e. the change is short-term);
- the decline is well within normal seasonal variation (e.g. the 10th percentile natural July flow is 80% less than the mean July flow);
- there is no pumping when river flow is <1,000L/s; and
- there is only a short downstream freshwater reach below the pump station

The only potential impact that could occur may be an upstream retraction of the freshwater–mangrove riparian vegetation community ecotone in the longer term. Such impact, if it did emerge, is likely to fall within the range of inter-decadal variation naturally experienced during annual wet seasons due to El Niño – La Niña rainfall cycles, and variable monsoonal trough and cyclonic rain depression formation. RTA would monitor river flow at the pump station using flow meter as described in **Section 5.5.1** and the position of the freshwater–mangrove ecotonal boundary by using aerial photography as described in **Section 8.14.2.1**.

8.14.2 Mitigation Measures

8.14.2.1 Catchment Hydrological Changes due to Mining

Progressive mining and rehabilitation of 27,290ha of the Project area over a 40-year mine plan represents a significant disturbance to the catchments hosting the Project area's aquatic ecosystems. The extent to which this catchment disturbance generates downstream hydrological impacts would be mitigated by commitment to mine development and rehabilitation approaches that are informed by the hydrological behaviour and requirements of the catchment's surface and groundwater systems. The principal mitigation commitment is to mining operations and post-mine rehabilitation strategies that ensure developed catchments still effectively deliver the groundwater recharge and surface runoff needed to sustain downstream aquatic ecosystems.

Pre-mining Definition of Sub-catchment Hydrology

The ability to define potential hydrological impacts at a reach or sub-catchment scale is currently limited by the resolution of surface and groundwater hydrological data for the Project area. To improve the understanding of the Project area's hydrology and the capacity for adaptive management responses, the establishment of baseline hydrological data for representative sub-catchments draining proposed mining blocks would form part of the environmental monitoring regime adopted for mining development. These hydrological investigations would effectively establish the pattern of surface drainage, seasonal groundwater profiles, partitioning of surface runoff and groundwater base flow, and seasonality of downstream flow hydrograph and perenniality / aquatic refugia within receiving surface drainage systems.

Mine Pit Drainage and Detention Management

Active mining pits represent the maximum hydrological disturbance footprint of the proposed mining development cycle in terms of the potential alteration of the downstream flow duration curve and of the relative contribution and partitioning of surface and groundwater flows to the catchment. Hydrological impact mitigation options during this stage of catchment development are primarily limited to the layout of mine drainage systems. As far as practicable drainage would be routed to match the discharge characteristics of the pre-mine surface drainage networks at the overall sub-catchment scale in order to emulate the pre-mining hydrograph and runoff flow characteristics.

Hydrologically Informed Post-Mining Rehabilitation

Emulating the pre-mining runoff flow characteristics and flow duration curve at the sub-catchment scale would be an aspirational objective of post-mining landscape rehabilitation strategies. Specific measures would include: ripping of compacted pit floors to facilitate infiltration to groundwater, contouring of mine pit and final land surfaces to route surface runoff to match pre-mining drainage networks where possible and the incorporation of seasonal wetland basin detention areas (revegetated with appropriate wetland species) where required in the post-mining landscape. Hydrological data from control sub-catchments (described above) would be used to assess the performance of post-mining landscape rehabilitation techniques and to support adaptive management improvements in subsequent cycles of mine block development.

Monitoring and Assessment of Hydrological Performance

Specific ecological monitoring activities would be implemented over the life of the mine to assess the performance of hydrological impact mitigation strategies and to inform ongoing and future mine development. Detailed (~1:10,000 scale) mapping of vegetation ecotonal boundaries including: terrestrial–freshwater, freshwater–tidal, and sclerophyll–fire sensitive interfaces in mined sub-catchments would be mapped from aerial photographs (with ground-truthing) and input to a Geographic Information System (GIS) and monitored and remapped on a decadal (10-year) frequency. This data would provide an ability to assess the relative contribution of both natural and mining-induced changes to catchment hydrological conditions to vegetation boundary movements that emerge over longer-term (decadal) time scales. Dry season monitoring surveys of freshwater aquatic refugia extent and distribution within mined sub-catchments and the aquatic organism communities they contain would also be used on a 3–5 yearly frequency to provide ongoing assessment of catchment hydrological impact mitigation effectiveness.

8.14.2.2 Catchment Hydrological Changes Generated by Dam C and Ward River Pumping

Four groups of mitigation measures can be identified for the potential impacts associated with catchment hydrological changes generated by the construction and operation of proposed water infrastructure.

Dam Wall Construction

Thorough geotechnical investigations and construction methods that ensure as far as practicable that the constructed dam wall is keyed into impermeable basement and batter foundations would provide the best opportunity to mitigate the water quality and hydrological impacts that could be associated with dam seepage to downstream reaches. If geotechnical investigations indicate that dam seepage would be a significant issue for water storage dam management, specific environmental flow strategies would be needed to mitigate potential water quality impacts. The reach downstream of the proposed dam wall site includes riffle and run features that would serve to re-oxygenate dominant groundwater inflows if they develop and would effectively limit the downstream reach of potential water quality impacts and the volume of environmental flow release required to counter groundwater inflow dominance.

Design of Outlet Works

Experience with other water storage dams in bauxite dominated catchment in the region (Ely Dam, Pine River Basin) suggests that impoundment stratification is not a significant management issue for dams up to 12m deep. However, the behaviour of the proposed water storage dam in the Project area cannot be predicted confidently enough to entirely dismiss the potential for stratification. While the proposed off-take from the dam is a low level one, the design would allow for the future retro-fitting of a variable higher level off-take should dam stratification emerge to be a significant management issue.

RTA proposes that the outlet works will be designed to accommodate a release flow rate of up to 1000L/s.

Environmental Flow Strategies

Dedicated environmental flow releases in addition to spillway overflows have been identified as a mitigation measure for a range of potential impacts associated with the proposed water supply dam including:

- maintenance of some downstream flow while there are still upstream inflows into the dam;
- allowance for some early "onset of wet" season flows otherwise delayed by dam filling;
- maintenance of seasonal salinity regimes within natural ranges in upper estuarine / tidally influenced freshwater reaches;
- maintenance of geomorphic features associated with post wet season base flows; and

- dilution of groundwater dominance and associated water quality impacts where dam seepage (or enhanced groundwater recharge/discharge associated with mined catchments) generates increased groundwater inputs to reaches downstream of the dam.

There is currently insufficient system understanding to detail all operational characteristics of environmental flow regimes that could deliver the impact mitigation aspirations listed above or whether certain mitigations might be needed at all. Monitoring and adaptive management responses (below) would be a prerequisite for the ongoing assessment of effectiveness and development of such mitigation capacity. RTA proposes that Dam C would be fitted with a low level outlet pipe which would permit the controlled release of environmental flows (up to a maximum of 1,000L/s) when required. Continuous streamflow gauging stations would be installed upstream and downstream of the dam in order to assess the impact of the dam on flow and allow information on inflows to inform decisions on environmental flow releases.

RTA proposes the following initial operating criteria for dry season environmental flow releases:

- sufficient water in each dam would be reserved for environmental flows to enable releases of up to 25% of inflows during the mid to late dry season (August–October) and 5% of inflows at other times; and
- when dam inflows cease, environmental flow releases would cease.

The above criteria would be subject to change based on operating experience and the results of monitoring.

Modelling shows that once the dam is full following the onset of the wet season, the spillway would typically overflow continuously throughout the rest of the wet season. Environmental flow releases are unlikely to be necessary during this period and, if they are, they are likely to be infrequent.

It is necessary for the maintenance of the reliability of the Project water supply that the dam fills quickly at the start of each wet season. This mitigates releasing significant volumes of water during the dam filling period (which would typically take four to eight weeks depending on the residual water level and climatic conditions). The dam has been sized to allow for environmental flow releases equal to 5% of dam inflows during the dam filling period. If larger volumes were to be released, the dam wall would have to be raised to maintain the same reliability of supply, with consequential increases in the surface area of inundation. However, the release of up to 25% of inflows during the mid to late dry season (August–October) is proposed in order to mitigate the potential development of ecologically critical salinity levels in the receiving estuary stem during this period.

With regard to pumping from the Ward River, potential impacts associated with extraction of streamflows would be effectively mitigated by restricting pumping to (a) 1% of mean annual flow in any one year, (b) less than 20% of river flow at any time, and (c) times when flow is >1,000L/s. The primary focus of this pumping regime is to ensure maintenance of seasonal salinity regimes in upper estuarine / tidally influenced freshwater reaches.

Monitoring and Adaptive Management

Further monitoring and characterisation of the receiving reaches downstream of the proposed water supply dam is recommended to support a responsive, adaptive management capacity for potential impacts. Continuous streamflow gauging stations would be installed upstream and downstream of the dam in order to assess the impact of the dam on flow. Key areas for further investigation include:

- magnitude and temporal patterns of post wet season extended base flows (monitor and characterise up to dam construction);
- seasonal salinity regimes in upper estuarine reaches and their relationship to surface base flows, groundwater inflows and reach habitats (quarterly vertical salinity profiling and macrophyte community monitoring at upper estuary water quality sampling sites);

- existing groundwater inflow rates in receiving reaches and their relationship to ambient dissolved oxygen levels, soluble aluminium, iron and manganese concentrations (at least quarterly water quality monitoring);
- measurement of water table levels in vicinity of Dam C (at least quarterly);
- maintenance of aquatic faunal communities in receiving reaches (fish and other aquatic fauna surveys on a 3–5 yearly frequency); and
- mapping of fine scale zonation of freshwater dependent riparian and wetland vegetation communities in tidally influenced lower freshwater reaches (aerial photography interpretation, mapping and GIS input on a decadal frequency).

It is proposed that such monitoring activities be established and maintained on the tributary stem to be affected by Dam C.

The following monitoring is proposed in relation to the Ward River pumping station:

- Continuous flow monitoring of the river and monitoring of pumped volumes.
- Mapping of fine scale zonation of freshwater dependent riparian and wetland vegetation communities in tidally influenced lower freshwater reaches (aerial photography interpretation, mapping and GIS input on a decadal frequency).

8.15 Potential Impacts and Mitigation measures – Elevated Sediment and Contaminant Loads

8.15.1 Potential Impacts

8.15.1.1 Elevated catchment sediment loads

Clearing vegetation cover for mining and infrastructure development, including road corridors, in a seasonal tropical environment subject to monsoonal and cyclonic rainfall events may result in elevated sediment loads in catchment runoff from the Project area at some stages of the development cycle, albeit a minor consideration given that direct surface runoff is less than 1% of incident rainfall.

Sediment can act as a stressor in aquatic systems both in suspension (turbidity/total suspended solids) and when it settles out (sedimentation). Impacts associated with long-term elevation in turbidity on stream flora and fauna typically include:

- loss of faunal diversity on a local, and perhaps more widespread, scale, as many species are intolerant of elevated turbidity;
- migration impediment or prevention for sediment intolerant fauna;
- loss of aquatic macrophytes and algae due to smothering by sediment and/or loss of instream primary production due to light attenuation and scouring; and
- loss of benthic habitat due to smothering and infilling by sediment.

The mechanisms of action of TSS are typically indirect and, therefore, may be very complex in their details. Consequently, the responses of different aquatic species to different types of solids are highly variable. The streams of the Project area generally have very low turbidity. This is due in part to (a) the very small proportion of direct surface runoff, (b) the filtering effect of water passage through the lateritic groundwater aquifers to streams, and (c) the charged surface structure of the alumino-silicate matrix of most particles enhancing flocculation and settlement rates. In some circumstances these drivers of surface water clarity can be over-ridden for short periods by the high intensities of local rainfall.

The tolerance of the local ecosystems to suspended sediment is unknown. Many species present in the Project area are widespread in the Western Cape region and occur in other, more turbid, catchments. However, as is noted above, the Project area assemblages include species that favour clearwater conditions. The aquatic floras are likely to be highly dependent on the

current water clarity. Given the habitats and biology of the fish, plant and macroinvertebrate communities, they are assumed to be intolerant of long exposure to elevated suspended sediment concentrations and sedimentation. The following points summarise the sensitivities of the local aquatic communities:

- A number of the fishes in the Project area are visual predators susceptible to elevated turbidity reducing the effective visual range.
- Many macroinvertebrates feed by shredding, scraping or collecting plant matter or by filtering organic matter from the water. These organisms are susceptible to abrasion and clogging of delicate feeding and breathing apparatus. They are also susceptible to alterations in the organic content of bed sediments. The most sensitive macroinvertebrates are those that are adapted to feed on fine food particles in clear water. These species are present in higher numbers in the catchments in the Project area than is typical for stream systems, suggesting a strong dependency on the current low TSS conditions.
- Aquatic macrophytes and algae are photosynthetic organisms that are susceptible to alterations in the light levels reaching the creek surface and light levels penetrating through the water column. Plants and algae are also susceptible to sedimentation and scouring. Macrophytes are important habitats for many faunal species and the high taxonomic proportion of scrapers among the macroinvertebrates testifies the importance of algae to aquatic food chains in the Project area.
- Deep pools are important perennial refugia and the infilling of pools due to potentially increased sediment loads could be highly detrimental.
- Benthic macroinvertebrates also have specific fine-scale habitat requirements and are susceptible to alterations in interstitial space abundance and sizes and coatings of bed surfaces due to sedimentation.
- Some of the fish species recorded from the Project area are very brightly coloured and colour displays can play an important role in their breeding behaviour. Elevated turbidity may adversely affect the ability of fishes to sense these visual displays and, therefore, the success of breeding.
- Some fish species are known to spawn in gravel/sand beds. These species would be expected to be susceptible to alterations in creek-bed substrate grain size and composition that may arise due to potential sedimentation. Other species lay adhesive eggs on creek-side vegetation, aquatic macrophytes or hard substrata. These spawning modes are susceptible to impacts from habitat smothering or dieback of macrophytes.

The above characteristics, in the absence of established measures of sediment tolerance, indicate that the local aquatic ecosystems are likely to be highly sensitive to elevated sediment inputs underpinning the required commitment to effective sediment runoff mitigation measures (**Section 8.15.2**). Exposed soil and subsoil surfaces created after vegetation clearing during the mine development phase are at risk of contributing to rainfall-derived sediment load spikes, including from haul road crossings of drainage lines. Mining pits retain overland flow due to their lower topographical position in relation to the relatively flat surrounding landscape. Clearing and soil stripping is scheduled in the dry season so that pit development is underway by the onset of the wet season, thus minimising the risk of runoff from disturbed areas entering creeks. The experience gained at existing operations in managing sediment runoff risks posed by mining operations in this environment (e.g. the use of internally draining mine pits) would serve in mitigating the potential impacts associated with possible elevated sediment loads.

In the absence of established measures of sediment tolerance the local aquatic ecosystems are likely to be highly sensitive to elevated sediment inputs underpinning the required commitment to effective sediment runoff mitigation measures (**Section 8.15.2**).

8.15.1.2 Contaminants derived from Mining, Processing and Handling Operations

Metalliferous mining necessarily occurs in mineralised catchments. The mineralisation is natural and the local aquatic ecosystems must be adapted to the natural levels of exposure to the constituents of that mineralisation. However, mining has the potential to enhance the inputs of metals into ecosystems as a result of increasing the exposure of the mineralisation to the air and rainfall.

There may be the potential for increased dissolved metal concentrations in recycled process water from the beneficiation plant including tailings liquid, in runoff from mine workings and possibly in runoff from ore stockpiles. Mining and beneficiation of ore would expose new surfaces that have not necessarily been as exposed to leaching in-situ as is otherwise typical of the lateritic deposits. Subsequent washing in the beneficiation plant or exposure to rainfall in the stockpiles may mobilise metals from those fresh surfaces into solution.

The following has been considered in terms of potential impacts on aquatic ecosystems as a result of altered metals concentrations that could occur from mine development:

- There may be a risk of further increasing the exposure of organisms to aluminium due to construction and, to a lesser extent, operation activities mobilising additional sediment to waterways or altering groundwater – surface water interactions.
- Toxicity and environmental tolerance in fishes is a "concentration × duration" relationship that is non-linear. That is, the biological response to metal concentrations does not increase in a consistent fashion with increasing concentrations; rather, once a tolerable threshold value has been reached, small additional increments in metal concentrations can result in greatly increased detrimental responses. The concentrations that can be tolerated in short-term exposures tend to be much greater than the concentrations that can be tolerated in the long term. Under baseline conditions, organisms may be exposed to short periods of elevated aluminium concentrations, particularly in the late dry season and wet season. However, the key point is that there are periods of reduced aluminium concentration ("recovery" periods). The toxicity risk to aquatic organisms has the potential to be increased by altering the "concentration" or the "duration" component of their exposure; by altering both, the risk increases substantially.

Background dissolved aluminium concentrations in the surface waters are naturally above default ecosystem protection guidelines and should, in a precautionary framework, be regarded as potentially imposing some natural toxicity to aquatic organisms.

The natural aluminium concentrations in freshwaters were generally substantially higher than estuarine waters. The median for freshwater streams was 18µg/L and that of tree swamps 40µg/L, compared with 2.5 to 4µg/L for estuarine and marine waters, respectively. The percentage of taxa that might be at risk under natural conditions in freshwaters may be greater than for estuarine waters, and the potential implication of an increase in median aluminium concentration to the 80th percentile concentration could also be substantially greater.

Bauxite is an oxidised and leached material, not prone to acid generation and thus acid drainage. However, the nature of the aluminosilicate structure of bauxite is such that it will tend to scrub ions from solution in waters passing through the laterite layers; hence, the freshwaters of the Project area have been found to have very low hardness, a characteristic that can enhance the toxicity of some metals (ANZECC/ARMCANZ 2000, Markich *et al.* 2001, Waller *et al.* 2005, Markich and Camilleri 1997).

Crude ore from the Project area, and ore and tailings solids from existing Andoom and East Weipa operations, have been analysed for metals (Rio Tinto 2009b). In addition, tailings liquid, water from tailings recovery slots, shallow aquifer groundwater, and runoff from existing product stockpiles were also analysed. The results and implications are summarised below.

- Aluminium concentrations in runoff from the Lorim Point bauxite stockpile indicated a relatively low (compared with Project area surface water samples) filterable aluminium concentration of 7µg/L.

- The tailings liquid for East Weipa had a mean aluminium concentration of 25µg/L, within the background SoE Project range for surface waters (the median for freshwater streams was 18µg/L and that of tree swamps 40µg/L). The Andoom tailings liquid had a mean aluminium concentration of 216µg/L owing to the increased use of artesian water, which is above the 80th percentile calculated for any freshwater site in the Project area but within the range found in late dry season sampling of site waters (refer **Table 5-9**).
- The concentration of aluminium in recovery slot water is less than or similar to that of the tailings liquid.
- The results, while a limited dataset, suggest that bauxite stockpiles may not be a significant contributor of aluminium to surface water ecosystems via runoff, but that tailings liquid and some tailings seepage waters may contain aluminium concentrations of potential environmental significance.
- The following metals were not detected in tailings liquid at concentrations greater than the reporting limit: arsenic, boron, cobalt, copper, lead, nickel, selenium, zinc and mercury. This, combined with the lack of enrichment in the ore, indicates these elements are not considered potential constituents of concern for the Project area.
- Tailings solid and ore samples were collected for leach analyses using two analytical methods. A de-ionised water bottle leach procedure was completed (AS4439.3) over a period of 18 hours and a 1:5 solid/water dilution leach test using deionised water over a 1-hour period. The bottle leach procedure presents a more conservative result. Results of both methods are presented in **Table 8-18** and **Table 8-19** respectively. The concentration of aluminium in tailings leachate was 10µg/L as a result of method AS4439.3, less than the median of Project freshwater streams (18µg/L); the concentration of aluminium in ore leachate was less than the laboratory limit of reporting and the 80th percentile (40µg/L). Based on these results, leaching from ore is not anticipated to have an adverse effect on surface or groundwaters.

Aluminium, iron and manganese would be monitored and results compared to the Project trigger values (refer **Section 5.5.1**).

Table 8-18 Tailings and Ore AS4493.3 Bottle Leach Procedure Results September 2009

			Location			
Analyte	**Units**	**LOR**	**East Weipa Tailings**	**Andoom Tailings**	**Lorim Point Stockpile (Ore)**	**SoE Ore**
Aluminium	mg/L	0.01	0.01	0.01	<0.01	<0.01
Arsenic	mg/L	0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	mg/L	0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	mg/L	0.001	<0.001	<0.001	<0.001	<0.001
Copper	mg/L	0.001	0.002	0.004	<0.001	<0.001
Lead	mg/L	0.001	<0.001	<0.001	<0.001	<0.001
Manganese	mg/L	0.001	<0.001	<0.001	<0.001	<0.001
Nickel	mg/L	0.001	<0.001	<0.001	<0.001	<0.001
Zinc	mg/L	0.005	0.014	0.015	0.011	0.006
Zirconium	mg/L	0.005	<0.005	<0.005	<0.005	<0.005
Boron	mg/L	0.05	0.06	0.07	0.06	0.06
Iron	mg/L	0.05	<0.05	<0.05	<0.05	<0.05

Table 8-19 Tailings and Ore 1:5 Solid/Water Leach Test Results September 2009

			Location			
Analyte	**Units**	**LOR**	**East Weipa Tailings**	**Andoom Tailings**	**Lorim Point Stockpile (Ore)**	**SoE Ore**
Final pH	pH Unit	0.1	6.2	6.9	7	7.2
Arsenic	mg/L	0.002	<0.002	<0.002	<0.002	<0.002
Cadmium	mg/L	0.002	<0.002	<0.002	<0.002	<0.002
Chromium	mg/L	0.002	<0.002	<0.002	<0.002	<0.002
Copper	mg/L	0.002	<0.002	<0.002	<0.002	<0.002
Manganese	mg/L	0.002	<0.002	<0.002	<0.002	<0.002
Nickel	mg/L	0.002	<0.002	<0.002	<0.002	<0.002
Lead	mg/L	0.002	<0.002	<0.002	<0.002	<0.002
Zinc	mg/L	0.002	<0.002	<0.002	<0.002	<0.002
Aluminium	mg/L	0.02	<0.02	<0.02	<0.02	<0.02

Notes:

LOR = Limit of reporting

1:5 leach test results reported in mg/kg, converted back to mg/L based on dilution factor of 5 not accounting for the moisture correction

8.15.1.3 Estuarine Water Quality

The higher water use scenarios planned for Stage 2 development for production rates of 30Mdpta and above are estimated to reduce mean annual flow to Norman Creek estuary by 9.8% at 30Mdpta and 15.1% at 50Mdptpa. The corresponding 10th percentile annual flow reductions are predicted to be 16.9% and 24.2%, respectively. It has also been predicted that shallow groundwater inflows to the estuary would increase. Samples taken from the Ward River estuary in the late dry season (December 2008) showed that under conditions of low or no surface water inflows, but strong groundwater inflows, the concentrations of aluminium, iron and manganese in estuarine waters were greatly enhanced compared with other times of the year, and also higher than those found for the Norman Creek estuary at the same time of the year (Section 5). The altered downstream flow regime that would result from the Stage 2 dam development is likely to be analogous to having lower late dry season surface water flows for longer than would otherwise be the case under any given rainfall scenario. Aluminium, iron and manganese concentrations in Norman Creek estuarine waters would likely remain within natural ranges, but at the upper end of that natural range for an increased period. Some alteration of the ecosystems in response to this change to the aluminium regime cannot be ruled out.

The available data on the metal content of SoE ore, and Andoom and Weipa ore and tailings, was evaluated in terms of enrichment of metals (refer **Section 13.3.4**; Rio Tinto 2009a). The Geochemical Abundance Index (GAI) was assessed using the Average Crustal Abundance described in Bowen (1979). The DME/DEH (1995) guideline *Assessment and Management of Acid Drainage* states "a GAI of greater than 3 indicates significant enrichment to a level that warrants further examination". From this assessment, there are no elements that have a GAI greater than 3. Therefore, the following metals are not considered enriched in the Project area and thus not potential constituents of concern: arsenic, chromium, copper, cadmium, lead, nickel, zinc and selenium.

The Project would require the movement and use of large quantities of hydrocarbons in the form of fuel and lubricants during construction and operations. Material would be transported in road tankers via barge to the mine infrastructure areas in accordance with Australian Standard *AS 1940* (refer **Section 19.1**). Potential impacts of hydrocarbons must also be considered – both acute impacts resulting from substantial spills and chronic impacts via low-level releases

and spills from operating machinery, workshops and storage facilities. It should be noted that wetlands, which are key, high value ecosystems in the Project area, tend to be particularly sensitive to hydrocarbon spills. Other toxicant risks, such as sewage effluents would be largely concentrated around the major infrastructure such as the proposed port and beneficiation plant. These areas would largely be remote from any substantial natural watercourses or wetlands, but the potential for impacts from these areas on aquatic ecosystems should be considered in environmental management planning.

8.15.2 Mitigation Measures

8.15.2.1 Elevated catchment sediment loads

The Project proponent's experience in managing sediment runoff risks posed by mining operations in this environment provide the foundation for mitigating the significant risks that are associated with the inherent vulnerabilities of the Project area's aquatic ecosystems. The persistence of aquatic communities equivalent to the Project area's in drainage systems of the Weipa Peninsula to the north of the Project area attests to the impact mitigation capacity of appropriate management approaches for sediment runoff. These mitigation measures include three key areas of operation:

Buffer Maintenance

The retention of effective development "setback" vegetation buffer systems (refer **Section 7.9.2**) around and adjoining surface drainage lines and wetland features represents the frontline in the effective management of elevated sediment load risks confronting aquatic ecosystems. The buffer retention practices currently employed in the Weipa area to the north and proposed for the Project area generally out-perform those associated with many other land uses including agriculture and urban development.

Controlled Drainage Systems

The very high water clarity in most Project area surface waters and the dependence of the existing aquatic ecosystems on this water clarity require that high standards of sediment retention would be required for any discharges. All mine pit development would be required to adhere to sediment run-off management practices including the retention of surface runoff from mine pits within the pit before it reports to surface drainage networks. In limited situations where the topography does not facilitate internally draining mine pits, sediment control would be maintained by use of sediment retention ponds and vegetation buffers. Where haul roads and other infrastructure intersect sensitive environmental areas, environmental management planning would require the implementation of sediment control traps to intersect surface runoff before it reports to surface drainage systems. Clearing of riparian vegetation to facilitate infrastructure crossings of surface drainage lines would be minimised by careful route selection in association with mine planning. These mitigation measures are expected to effectively reduce catchment sediment loads.

Development Cycle Timing

Native vegetation removal presents soil erosion risks; however, these can be managed in a seasonal environment by careful consideration of development timing and location. All clearing of vegetation for development would be controlled by contractor permit requirements for "ground disturbance". Clearing and soil stripping would be scheduled in the dry season so that mine pit development is generally underway by the onset of the wet season, providing a basin to capture surface runoff, which minimises the risk of runoff from disturbed areas entering stream drainage networks.

Monitoring of Performance Measures

Environmental management planning would be underpinned by effective monitoring of performance measures and adaptive management. Monthly monitoring of turbidity in receiving waters of the Project area throughout the wet season would be undertaken (refer **Section 5.5.1** and **Table 5-32**). It is proposed to set a Project trigger value for turbidity based on the 80th percentile baseline value (refer **Section 5.5.1**).

8.15.2.2 Contaminants derived from Mining, Processing and Handling Operations

Mitigation options to address aquatic ecosystem risks posed by catchment runoff containing potential contaminants derived from mining, processing and stockpiling include minimisation at source, containment using infrastructure layout design and controlled drainage, effective monitoring and adaptive management responses.

Source Management

Leachate analyses of metals in SoE crude ore samples show that none are elevated to a degree that would pose a risk to the natural environment (Rio Tinto 2009b). However, if elevated metal levels were to be found in ore, the primary management approach would be the use of internal drainage routes for mine pit runoff. The routeing of mine runoff via groundwater aquifers would provide opportunities for potentially elevated soluble metals to be reabsorbed by the aluminosilicate structure of bauxite in the host laterite. Monitoring of surface waters in receiving drainage systems would provide ongoing assessment of this management approach.

Mitigation measures for other potential contaminants primarily relate to refuelling, fuel/chemical storage and spill response protocols, structures and procedures and are discussed in **Section 19.1** and **Section 19.3.1**. These measures would include bunded fuel storage and refuelling areas, spill emergency response measures and controlled drainage of runoff from industrial plant areas.

Infrastructure Layout and Controlled Drainage

Key considerations from a runoff contaminant management perspective include the locations of potential contaminant sources in relation to contributory catchment area, wet season runoff rates and inundation levels. Runoff from industrial plant areas would be controlled via collection to the site water management system. The design criteria and operation of the system is discussed in **Section 5.2.2**. The tailings storage facilities are located within previously mined and internally draining pit areas and are remote from major drainage lines; this mitigates the potential risks associated with runoff potentially high in soluble aluminium to receiving surface waters.

Performance Monitoring

The locations, parameters and frequency of the proposed surface water and groundwater monitoring program are detailed in **Section 5.5**, which concentrates on pH, EC, dissolved oxygen, turbidity, certain metals and hydrocarbons (in specific locations). If water quality monitoring or other evidence indicates that elevated metal bio-availability has occurred due to mining activities then bio-monitoring of tissue metal concentrations in selected tissue of fish and other aquatic organisms (i.e. crabs, crayfish) would be used to identify possible sources.

8.16 Potential Impacts and Mitigation measures – Loss of Aquatic Habitat Connectivity

8.16.1 Potential Impacts

8.16.1.1 Water Supply Dam Wall and Stream Crossing Infrastructure

The reasons why a freshwater tributary of Norman Creek was chosen as a dam site for water supply for the Project over other alternatives is summarised in **Section 5.2.3**. While the majority of the freshwater fish communities within the Project area have been found to comprise few migratory species, the extreme seasonality of freshwater habitats imposes a requirement for movement and recruitment from restricted dry season refugia and suitable nursery areas to seasonally abundant aquatic habitats. A few species, including the Plotosidae catfish are potamodromous, i.e. migrate within freshwater reaches to find suitable spawning habitats (in their case flowing riffle reaches), and several others including key fishery species (e.g. Tarpon, Barramundi and Mangrove Jack) are catadromous and move between estuarine and/or marine spawning and/or nursery areas and freshwater reaches. The limited availability of some spawning habitats, such as aquatic plant beds utilised by some species within the

Project area, may also require otherwise sedentary species to move between reaches for recruitment and spawning success.

Infrastructure constructed within or across stream drainage lines including the proposed water supply dam wall (8m for 10.9GL storage capacity, 12m for 29.0GL storage capacity) and more innocuous haul road stream crossings has the potential to create fish passage barriers and to disrupt the recruitment and movement of species from dry season refugia or downstream estuarine habitats, therefore impacting the distribution of fish species and the composition of fish communities within the Project area. In the case of some cornerstone species (e.g. key predators some of which, including Barramundi, are also species of fishery importance) impacts of reduced fish passage may cause flow-on effects in terms of changes in fish community structuring or reduced recruitment levels to fisheries. However, the potential for the latter is very limited given the relatively small component of the fish community above the proposed water supply dam site was observed to comprise catadromous species such as Barramundi. Alternatively, the artificial habitat created by the water supply dam would be suitable for species such as Barramundi and the maintenance of fish passage access to this habitat would provide an opportunity to support fishery recruitment (helping to balance other potential impacts to fishery recruitment) and to maintain naturally structured prey communities.

8.16.1.2 Hydrological and Geomorphological Impacts to Connectivity

Besides physical structures associated with in-stream infrastructure, altered hydrological and/or geomorphological conditions that may potentially occur at a sub-reach scale due to impacts associated with catchment development (e.g. shorter duration stream base flows, less perennial aquatic refugia, sedimentation of stream channels and/or pools) could also potentially impact upon aquatic habitat connectivity and fish passage opportunities in the Project area. This could generate similar natured impacts (though at an order of less magnitude) to those described above for physical passage barriers including localised extinctions of some aquatic community members associated with reach scale losses of or reduction of access to aquatic refugia. Importantly, it needs to be recognised that not all potential impacts on aquatic habitat connectivity would be unidirectional. Predicted increases in deep base flow and potentially increased or more rapid catchment discharges associated with mining impacts could also serve to extend perenniality of some pools and reaches and generate deeper stream channels and scour pools which improve aquatic habitat perenniality and/or connectivity between aquatic refugia. Ultimately, aquatic habitat connectivity impacts associated with altered hydrological and geomorphological conditions are not anticipated to be significant at a catchment scale due to the limited magnitude of predicted changes and the likelihood for compensatory impacts.

8.16.2 Mitigation Measures

8.16.2.1 Water Supply Dam Wall and Stream Crossing Infrastructure

To mitigate the potential for impacts to aquatic habitat connectivity associated with the dam wall and stream crossing infrastructure there would need to be a fish passage structure incorporated into the water supply dam and other in-stream infrastructure, sensitive management of surface drainage and implementation of potential hydrological impact mitigation measures (described above). Any structure that may act as a fish barrier needs a permit from the Department of Employment, Economic Development and Innovation (DEEDI) under the *Fisheries Act 1994* (Qld). The requirements for maintaining fish passage through road crossings in Queensland have a legislative basis under the Act, and are well described in available technical literature (e.g. Cotterell 1998). The design of the spillway for the water storage dam would be at low gradient (<3%) and incorporate an allowance for fish passage (refer **Figure 5-11**). Road culverts would be designed so as to avoid becoming a fish barrier and design would consider the technical literature on maintaining fish passage (e.g. Cotterell 1998).

The design of Dam C would be required to address fish passage needs as part of required waterway barrier permits under the *Fisheries Act.* The fish passage needs of the fish community at the dam wall location are not considered to be overly critical to the community as a whole. This is because the dam is likely to form large artificial refugia rich in macrophyte habitat that

would suit the majority of obligatory freshwater fish species present; these species would be able to recruit to upstream habitat during flow events and downstream during spillway overflows and/or environmental releases (assuming appropriate outlet works design). Catadromous species (Barramundi, Tarpon, Mangrove Jack) are currently only a small component of the fish community above the proposed dam wall location, though other large bodied species including some of interest to Traditional Owners and recreational fishers, such as Fork-tailed catfish, are observed to seasonally move from lower reaches (predominantly below the proposed dam location) to upper freshwater reaches. While the ecological impacts of not facilitating fish passage at Dam C may not be substantial, there is still sufficient justification to seek to do so from both ecological and social/fishery perspectives.

The proposed water supply dam wall height is too great for the effective use of vertical slot fishways commonly employed for Australian fish communities and engineering constraints and cost prohibitions would prevent the use of other mechanical fishways (i.e. locks, lifts) considered for high dam walls (Worley Parsons 2008). A "hybrid" low gradient rock ramp / constructed channel (Wildman *et al.* 2005) bypass is currently being developed as part of the spillway design. Observations at the Ely Dam spillway constructed on a bauxite catchment stream in the Pine River basin to the north of Weipa indicate that at least one catadromous species (Tarpon) was capable of moving up spillway flows through the hydrological environment created by spillway flow energy dissipaters formed by gabion rock baskets steps. Further development of this type of spillway design to incorporate the lower gradient, turbulence and flow velocity needs of other fish species would appear to offer the best prospect of serving fish passage at these sites. Although such a fishway would only facilitate fish passage during spillway overflow events, this passage opportunity is considered adequate to maintain full representation of potential upstream migrant species in upstream fish communities.

The proposed low gradient rock ramp fishway is considered an effective and adequate mitigation measure for migratory species occurring or potentially occurring within Norman Creek freshwater reaches, including the threatened Sawfish *Pristis microdon.* All catadromous fish species recorded in Norman Creek are known to negotiate rock ramp fishways in eastern Qld drainages (Kapitzke 2010) and the hydraulic conditions provided by the fishway will at least match or exceed the fish passage opportunity provided by higher gradient riffle run bedrock controlled reaches of Norman Creek downstream of the proposed impoundment. Sawfish *Pristis microdon* are also recognised to be capable of negotiating bedrock controlled riffle run sequences (Thorburn *et al.* 2003), and rock ramp fishways are a recommended fish passage barrier mitigation option in drainages occupied by Sawfish *Pristis microdon* (Marsden and Stewart 2005).

8.16.2.2 Hydrological and Geomorphological Impacts to Connectivity

Viable mitigation options for the potential hydrological and geomorphological impacts to aquatic habitat connectivity that may be associated with mining and infrastructure associated changes to catchment hydrology are limited to the range of options generally nominated for minimising the driving hydrological changes, i.e. considering hydrological aspects in post-mine rehabilitation in the case of altered catchment hydrology and environmental flow strategies for water supply dam construction and operation.

8.16.2.3 Monitoring of Impacts to Aquatic Habitat Connectivity

To monitor the potential impacts to aquatic habitat connectivity within the Project area over the mine life RTA would undertake periodic (3–5 year) survey-based monitoring of the freshwater aquatic community within the Project area. Specific foci for such monitoring would include community composition within each drainage system, particularly within dry season refugia. Compositions of the fish community above and below the water supply dam wall prior to construction and following commissioning of the spillway incorporating the fish passage structure would also be undertaken to assess fishway effectiveness and to facilitate adaptive design management if required.

8.17 Summary of EPBC Act Significance of Impact Assessments for Threatened Fauna

The summary "assessments of significance of impact" in this section are based on the *Significant impact guidelines* (DEWHA 2009a) and draws on discussion provided in **Sections 8.13 to 8.16**.

Individual significant impact assessments based on the proposed disturbance of aquatic habitat within the Project area are provided for each of the EPBC Act listed threatened aquatic fauna species assessed as likely to occur in the Project area (as identified in **Section 8.10)**.

These include:

- Critically Endangered species
    - Speartooth Shark (*Glyphis* sp A)
- Vulnerable species
    - Freshwater Sawfish (*Pristis microdon*)
    - Green Sawfish (*Pristis zijsron*);
    - Dwarf Sawfish (*Pristis clavata*).

Key definitions from the DSEWPaC guidelines that apply to this assessment are as follows:

- "Population of a species" is an occurrence of the species in a particular area. In relation to critically endangered, endangered or vulnerable threatened species, occurrences include but are not limited to:
    - a geographically distinct regional population, or collection of local populations; or
    - a population, or collection of local populations, that occurs within a particular bioregion.
- "Habitat critical to the survival of a species or ecological community" refers to areas that are necessary:
    - for activities such as foraging, breeding, roosting, or dispersal;
    - for the long-term maintenance of the species or ecological community;
    - to maintain genetic diversity and long-term evolutionary development; or
    - for the reintroduction of populations or recovery of the species or ecological community.

  Such habitat may be, but is not limited to:
    - habitat identified in a recovery plan for the species or ecological community as habitat critical for that species or ecological community; and/or
    - habitat listed on the Register of Critical Habitat maintained by the Minister under the EPBC Act.
- An "invasive species" is an introduced species, including an introduced (translocated) native species, which out-competes native species for space and resources or which is a predator of native species. Introducing an invasive species into an area may result in that species becoming established. An invasive species may harm listed threatened species or ecological communities by direct competition, modification of habitat or predation.

Due to their utilisation of marine habitats, the Green Sawfish (*Pristis zijsron*) and the Dwarf Sawfish (*Pristis clavata*) are discussed in further detail and an assessment of the significance of impacts provided in **Section 6.9.5.1**. An assessment of the significance of impacts on the Freshwater Sawfish and the Speartooth Shark are provided below.

Freshwater Sawfish (*Pristis microdon*), and Speartooth Shark (*Glyphis sp.)* have not been recorded in surveys of the Project area but are considered likely to occur in the estuarine and lower brackish reaches of the Project area's main drainage systems. If present, these species could potentially be affected by:

- physical disturbance of sedimentary habitats and fauna from dredging for the barge/ferry terminals in the Embley and Hey Rivers; and
- creation of a turbidity plume, spoil deposition and re-suspension of fine sediments.

The fish assemblage is exposed to periodic but significant physical disturbance and elevated turbidity during extreme weather events. Fish species are also mobile and as such can move away from any local areas that are affected by a disturbance (e.g. dredging and dredge spoil deposition). Given the minor scale and short duration of dredging, at each of the barge/ferry terminal facilities it is unlikely that habitat in the Embley and Hey Rivers would be significantly affected.

Freshwater streams within the Project area have extremely low conductivity as their catchments are highly weathered bauxite landscapes which do not contribute salts (Tait 2011). Recorded conductivity values approach those of distilled water. It is hypothesised that these extremely low conductivity values present an osmoregulation constraint on the freshwater fish community that occur in these systems. This is evidenced by the complete absence of records within the Project area for otherwise ubiquitous families, genera and species of freshwater fishes found throughout tropical Australia including in adjoining river systems of the Project area. It is suggested that the extremely low conductivities of the Project area's freshwaters would present an osmoregulation constraint on both the Freshwater Sawfish and Speartooth Shark as they possess a more primitive osmoregulation capacity than modern ray finned fishes.

While the estuarine and possibly lower tidally influenced freshwater reaches of the Norman Creek system do provide potentially suitable habitat for both species, the seasonal freshwater reaches upstream of the proposed Dam C do not. Freshwater reaches of Norman Creek upstream of the proposed impoundment wall have been assessed as not suitable habitat for threatened elasmobranch species, including the Sawfish *Pristis microdon.* They are small and highly seasonal habitats that lack large permanent pools required for these species, lack known prey species particularly schooling fish such as freshwater herring, grunters or mullets (Thorburn and Morgan 2005, Thorburn *et al*. 2003, 2004) or an abundance of even potentially suitable prey species. Further information relating to listed threatened Sawfish and Glyphis A. species is provided in **Appendix 8C**.

Recreational fishing activity as a result of the Project is expected to be no higher than in recent years as the population in Weipa is not expected to increase significantly (refer to **Table 16.3** for projected changes in population). Therefore it would be unlikely that recreational fishing impacts on sawfish and Glyphis species would increase as a result of the Project. Recreational fishing is regulated by Queensland agencies. A permit to enter the South of Embley area must be obtained from the Aurukun Shire Council (refer to **Section 16.3.2**).

Freshwater Sawfish (*Pristis microdon*): Vulnerable

The DSEWPaC SPRAT database indicates that the Freshwater Sawfish may potentially occur in all large rivers of northern Australia from the Fitzroy River, Western Australia, to the western side of Cape York Peninsula (DSEWPaC 2010). It is mainly confined to the main channels of large rivers. Anecdotal evidence suggests that the Freshwater Sawfish may also be found in closed systems and that they enter and leave the closed system during the wet season (Thorburn *et al*. 2003). Small specimens of this species have been caught in remote ponds that have been isolated for a number of years, which suggests that they can survive if their habitat is not connected for a period of time (DSEWPaC 2010). The distribution of the Freshwater Sawfish outside of Australia is uncertain, but it is known to occur in several major river basins of Indonesia and Papua New Guinea. The total population of the Freshwater Sawfish is unknown.

The Freshwater Sawfish is highly vulnerable to gillnet fishing. Other known threats have been identified as Indigenous harvest, habitat modification and recreational 'trophy' fishing.

Speartooth Shark (*Glyphis* sp. A): Critically Endangered

The DSEWPaC SPRAT database indicates that the Speartooth Shark has been recorded in tidal rivers and estuaries within the Northern Territory and Queensland. Within the Northern Territory the Speartooth Shark has been recorded in the Adelaide River, South, East and West Alligator Rivers, Murganella Creek and Marrakai Creek (DSEWPaC 2010). In Queensland the Speartooth Shark has been found in the Wenlock and Ducie Rivers, Port Musgrave (the mouth of these two rivers) and the Bizant River. The Speartooth Shark has also been recorded close to Port Romilly and the Fly River in New Guinea.

The population size of the Speartooth Shark remains unknown, but is thought to be small based on current knowledge and the apparent rarity of the species. There is insufficient data regarding the Speartooth Shark to suggest a decline in population size and information in the SPRAT database indicates that the species may be naturally rare.

The main threats to the Speartooth Shark have been identified by DSEWPaC (2010) as being recreational line fishing, gillnetting, and habitat degradation or modification.

The potential impacts on this species from associated Project related disturbance associated with Dam C on a freshwater tributary of Norman Creek and the ferry/barge terminals in the Hey and Embley Rivers is considered minimal for the following reasons.

- The potential area of occupancy of the Speartooth Shark is restricted from the mouth of a river to the point where the river ceases to be perennial (Stevens *et al.* 2005). The proposed Dam C on a freshwater tributary of Norman Creek will be located in an ephemeral reach of one branch of Norman Creek. Therefore, it is unlikely that if present in Norman Creek, this species would require passage past the proposed site of the dam. This species prefers highly turbid, weakly saline, tidal or estuarine environments (DSEWPaC 2010).
- The Speartooth Shark prefers a highly turbid, environment (DSEWPaC 2010). Norman Creek is not a highly turbid environment and therefore although the species may occur in Norman Creek, there are more suitable habitats in the area that this species is more likely to inhabit.
- Although there was an unverified report of the presence of this species in the Embley River in 1985, ongoing fish surveys over 20 years in the Embley River have not recorded the Speartooth Shark (Stevens *et al.* 2005). It is therefore suggested that this species is restricted the Wenlock and Ducie Rivers in this region (Stevens *et al.* 2005).

The EPBC Act significance assessment summarised below is based on the potential impacts to the Freshwater Sawfish and the Speartooth Shark associated with Project related disturbance to aquatic ecosystems. Project related disturbance to aquatic ecosystems is limited to the construction and operation of Dam C in a freshwater tributary of Norman Creek and activities (including dredging and the clearing of 400m^2 of Mangrove habitat) associated with the construction and maintenance of the ferry/barge terminals on the Hey and Embley Rivers. Descriptions of these activities and infrastructure are in **Section 2.7.2** and **Section 2.7.3**. A detailed description of the location and size of Dam C on a freshwater tributary of Norman Creek is summarised in **Section 5.2.3**.

Will the proposed works...	**Freshwater Sawfish *(Pristis microdon)***
....lead to a long-term decrease in the size of an important population of a species?	A long term decrease in any population of the species present is unlikely to occur.
....reduce the area of occupancy of an important population?	Sufficient habitat would remain to support this species, if present within the proposed disturbance areas, and the area of occupancy of any population of the species present would not be reduced.
....fragment an existing important population into two or more	Any population present would not be fragmented. Evidence suggests the species would not travel upstream of the proposed Dam C footprint on a freshwater tributary of

Will the proposed works...	**Freshwater Sawfish *(Pristis microdon)***
populations?	Norman Creek (refer to **Table 8.14**).
....adversely affect habitat critical to the survival of a species?	The Project area, or areas that would be disturbed within the Project area, does not include any critical habitat areas for this species. As summarised in **Table 8.14**, the species is unlikely to travel upstream of the proposed Dam C location due to low conductivity and lack of suitable habitat. Therefore the freshwater environment in the freshwater tributary upstream of Dam C would not be considered critical breeding habitat for the species.
....disrupt the breeding cycle of an important population?	The breeding cycle of the species (if present within proposed disturbance areas) would not be disrupted. As summarised in **Table 8.14**, the species is unlikely to travel upstream of the proposed Dam C location. Therefore the freshwater environment in the freshwater tributary upstream of Dam C would not be considered critical breeding habitat for the species.
....modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?	The species is unlikely to decline as a result of the Project related disturbance. Evidence suggests the species would not travel upstream of the proposed Dam C location (refer to **Table 8.14**). The impacts on potential habitat associated with dredging activities and clearing of 400m^2 of mangroves associated with the ferry/barge terminals on the Hey and Embley Rivers are considered minor and would not to be to the extent that would cause a decline of the species, if present. The number of bulk carriers proposed to enter the Embley River as a result of the Project would actually decrease, which would result in a positive impact. There is no evidence to suggest that large vessels pose a threat to sawfish species or that large vessels would cause a decline in the species.
....result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?	The Project is unlikely to lead to the introduction of any invasive fauna that could affect this species. RTA would conduct routine monitoring of the port for marine pests, similar to that currently undertaken for Port of Weipa high-risk areas.
.....introduce disease that may cause the species to decline?	Disease is not known as a threat to this species. It is not anticipated that the Project would represent a threat with respect to the introduction of disease.
....interfere with the recovery of the species?	The Project is not expected to interfere with the recovery of this species.

Will the proposed works...	**Speartooth Shark (Glyphis sp. A)**
....lead to a long-term decrease in the size of a population?	A long term decrease in any population of the species present is unlikely to occur.
....reduce the area of occupancy of the species?	Sufficient habitat would remain to support the species, if present within the proposed disturbance areas, and the area of occupancy of any population of the species present would not be reduced.
....fragment an existing population into two or more populations?	Any population present would not be fragmented. Evidence suggests the species would not travel upstream of the proposed Dam C footprint on a freshwater tributary of Norman Creek (refer to **Table 8.14**).
....adversely affect habitat critical to the survival of a species?	The Project area, or areas that would be disturbed within the Project area, does not include any critical habitat areas for the species. As summarised in **Table 8.14**, the species is unlikely to travel upstream of the proposed Dam C location due to low conductivity and lack of suitable habitat. Therefore the freshwater environment in the freshwater tributary upstream of Dam C would not be considered critical breeding habitat for the species.
....disrupt the breeding cycle of a population?	The breeding cycle of the species (if present within proposed disturbance areas) would not be disrupted. As summarised in **Table 8.14**, the species is unlikely to travel upstream of the proposed Dam C location. Therefore the freshwater environment in the freshwater tributary upstream of Dam C would not be considered critical breeding habitat for either species.
....modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?	The species is unlikely to decline as a result of the Project related disturbance. Evidence suggests the species would not travel upstream of the proposed Dam C location (refer to **Table 8.14**). The impacts on potential habitat associated with dredging activities and clearing of 400m^2 of mangroves associated with the ferry/barge terminals on the Hey and Embley

Will the proposed works...	**Speartooth Shark (Glyphis sp. A)**
	Rivers are considered minor and would not to be to the extent that would cause a decline of the species, if present. The number of bulk carriers proposed to enter the Embley River as a result of the Project would actually decrease, which would result in a positive impact. There is no evidence to suggest that large vessels pose a threat to the Speartooth Shark species or that large vessels would cause a decline in the species.
....result in invasive species that are harmful to an endangered species becoming established in the endangered species' habitat?	The Project is unlikely to lead to the introduction of any invasive fauna that could affect thespecies. RTA would conduct routine monitoring of the port for marine pests, similar to that currently undertaken for Port of Weipa high-risk areas.
.....introduce disease that may cause the species to decline?	Disease is not known as a threat to the species. It is not anticipated that the Project would represent a threat with respect to the introduction of disease.
....interfere with the recovery of the species?	The Project is not expected to interfere with the recovery of the species.

No specific mitigation measures are required for threatened sharks and sawfish, as the Project related disturbance on aquatic habitat is predicted to pose a low risk to the four sawfish and shark species. Nevertheless, the mitigation measures that have been proposed to minimise potential impacts on all aquatic ecology associated with the construction and operation of Dam C, would also directly relate to threatened sharks and sawfish in the unlikely event that habitat upstream of the dam is utilised by these species. In particular, the proposed low gradient rock ramp fishway would be effective.

Mitigation measures for impacts to catchment hydrology, elevated sediment and contaminant loads, and loss of aquatic habitat connectivity which may also relate to either the Freshwater Sawfish or the Speartooth Shark are provided in **Section 8.14.2**, **Section 8.15.2**, and **Section 8.16.2**, respectively. Mitigation of dredging impacts are discussed in **Section 6.9.2.8** and monitoring in **Section 6.9.3.1**.

8.18 Potential Impacts and Mitigation Measures – Aquatic Habitat Summary

Detailed descriptions of freshwater and estuarine aquatic habitats occurring within the Project area are provided in **Section 8.6**. The key environmental values of the aquatic habitats are shown in **Table 8-20**, along with proposed mitigation and monitoring measures associated with areas to be disturbed by Project related activities.

Table 8-20 Aquatic Habitat Key Values, Potential Impacts, Mitigation and Monitoring Measures

Aquatic Habitat Type	Key Values	Potential Impacts	Mitigations and Monitoring Measures
Perennial Streams	○ Aquatic refugia ○ Recreational / Indigenous Fisheries ○ Fishery nursery ○ Primary productivity driver / exports ○ Threatened species habitat ○ Aquatic vertebrate habitat (frogs, snakes)	Alteration of surface runoff flow volumes and duration with potential for channel geomorphology impacts. Alterations of contributing groundwater flow volumes or duration with potential for alteration of perennial stream reach extent or location. Elevated suspended and bed sediment loads with potential for pool infilling and alteration of water quality. Clearing and/or altered fire regime impacts on riparian vegetation In-stream structures and/or flow regime impacts on reach connectivity.	1. Environmental flows would be released from water supply dam to match the timing of dam inflows. Flow rates would be monitored upstream and downstream of each dam. Spillway overflows would provide large flows during the wet season. 2. Post-mining drainage paths would be configured as far as practicable to match pre-mine surface drainage pattern. Hydrological monitoring would be undertaken in representative sub-catchments affected by mining. 3. Vegetation buffers would be established which provide "setback" distances of mining areas from riparian, wetland and estuarine vegetation in order to minimise sediment transport into streams and to protect sensitive vegetation types (refer **Section 7.9.2**). Mining pits would be internally draining in most instances in order to retain surface runoff. Retention ponds would be installed in cases where mine pits are not internally draining or for haul road crossings of sensitive riparian vegetation. Mine development work would be completed prior to the wet season where possible. Turbidity monitoring would be undertaken in representative sub-catchments upstream and downstream of representative mining areas. 4. Fishway structures would be incorporated into water supply dam spillway to provide aquatic habitat connectivity. Fish species composition would be surveyed above and below the dam after one year of operation and then included into the periodic aquatic fauna program thereafter (see below). 5. Periodic (3-5yr) monitoring of freshwater aquatic fauna would be undertaken in reaches upstream and downstream of the water supply dam. 6. Mapping of representative vegetation ecotonal boundaries (e.g. sclerophyll, riparian/wetland/ estuarine) from aerial photography to detect any long-term (decadal) shift. 7. Fire and Feral Management programs as described in **Section 7.10.2**.
Perennial Coastal Lagoons /Lakes	○ Aquatic refugia ○ Threatened species habitat incl. crocodile breeding ○ Waterbird habitat ○ Aquatic vertebrate habitat (frogs, turtles, snakes)	Alteration of surface runoff flow volume or duration with potential for altered inundation level impacts e.g. riparian tree death and associated ecotonal boundary shifts. Alteration of contributing groundwater flow volumes or durations with potential for truncation of inter/base flows and greater recession of dry season water levels and further intrusion of tidal influence. Elevated suspended and bed sediment loads with potential for pool infilling and alteration of water quality. Clearing and/or altered fire regime impacts to riparian vegetation.	1, 2, 3, 6 and 7 (refer above).
Perennial Pools / Channel Hosted Lagoons	○ Aquatic refugia ○ Aquatic vertebrate habitat (frogs, turtles, snakes) ○ Recreational / Indigenous Fisheries ○ Threatened species habitat ○ Aquatic vertebrate habitat (frogs, turtles, snakes)	Alteration of surface runoff flow volumes and duration with potential for channel geomorphology impacts. Alterations of contributing groundwater flow volumes or duration with potential for alteration of perennial stream reach extent or location. Elevated suspended and bed sediment loads with potential for pool infilling and alteration of water quality. Clearing and/or altered fire regime impacts to riparian vegetation. In-stream structures and/or flow regime impacts to reach connectivity.	1, 2. 3, 4, 5, 6 and 7 (refer above)

Aquatic Habitat Type	Key Values	Potential Impacts	Mitigations and Monitoring Measures
Coastal Swale Swamps	○ Aquatic refugia ○ Potential fishery nursery ○ Threatened species habitat ○ Aquatic vertebrate habitat (frogs, turtles, snakes, crocodiles)	Alteration of contributing groundwater flow volumes and duration including by disturbance of shallow beach ridge aquifers with potential for truncation of inter/base flows and greater intrusion of tidal influence. Elevated suspended sediment loads. Clearing and/or altered fire regime impacts to riparian vegetation.	2, 3, 6 and 7 (refer above)
Tree Swamps	○ Aquatic refugia ○ Threatened species habitat ○ Waterbird habitat ○ Aquatic vertebrate habitat (frogs, turtles, snakes)	Alteration of surface runoff flow volumes and duration with potential for altered inundation level impacts e.g. localised riparian tree death and associated ecotonal boundary shifts. Alteration of contributing groundwater flow volumes and duration with potential for truncation of inter/base flows and altered water level recession rates and associated ecotonal boundary shifts. Elevated suspended sediment loads. Clearing and/or altered fire regime impacts to riparian vegetation.	1, 2, 3, 6 and 7 (refer above)
Seasonal Stream Channels	○ Seasonal aquatic habitat and in-stream productivity ○ Connectivity / dispersion conduits ○ Restricted undescribed species	Alteration of surface runoff flow peaks with potential for channel geomorphology impacts. Alteration of contributing groundwater flow volumes or duration with potential for truncation of inter/base flows and reduced persistence duration of seasonal aquatic habitats. Elevated suspended and bed sediment loads. Clearing and/or altered fire regime impacts to riparian vegetation. In-stream structures and/or flow regime impacts to reach connectivity.	1, 2, 3, 4, 5, 6 and 7 (refer above)
Seasonal Coastal Lakes	○ Seasonal productivity hot spots ○ Primary productivity driver / exports ○ Waterbird habitat ○ Fishery nursery ○ Threatened species habitat ○ Seasonal aquatic vertebrate habitat (frogs, turtles, snakes)	Alterations of catchment runoff volumes or timing with consequent impacts on lake filling frequency or timing. Alteration of contributing groundwater flow volumes or duration with potential for impacts to seasonal water level recession rates and tidal ingress buffering capacity and associated movement of brackish mixing zone.	1 and 2 (refer above)

Aquatic Habitat Type	Key Values	Potential Impacts	Mitigations and Monitoring Measures
Bulkuru Spike Rush swamps	○ Seasonal productivity hot spots ○ Primary productivity driver / exports ○ Waterbird breeding and dry season feeding habitat ○ Threatened species habitat incl. crocodile breeding ○ Seasonal aquatic vertebrate habitat (frogs, turtles, snakes)	Alterations of catchment runoff volumes or timing with consequent impacts on swamp filling frequency or timing. Alteration of contributing groundwater flow volumes or duration with potential for impacts to seasonal water level recession rates and tidal ingress buffering capacity and associated movement of brackish mixing zone.	1 and 2 (refer above)
Groundwater Seepage Zones and Springs	○ Aquatic refugia ○ Coastal salinity regime modifier ○ Freshwater invertebrate habitat	Alteration of contributing groundwater flow volumes or duration with potential for impacts to aquatic habitat persistence, fire refugial functions and associated vegetation ecotonal zonation patterns.	2 and 6 (refer above)
Drainage Depressions / Flood Runners	○ Seasonal aquatic habitat and food resources ○ Seasonal aquatic vertebrate habitat (frogs, turtles, snakes) ○ Connectivity / dispersion conduits	Alteration of surface runoff flow peaks with potential for geomorphology impacts i.e. loss of scour pools. Alteration of contributing groundwater flow volumes or duration with potential for truncation of interflows derived from the bauxite profile and reduced duration of seasonal aquatic habitats. Elevated suspended and bed sediment loads with potential for impacts to invertebrate community and drainage depression infilling. Clearing and/or altered fire regime impacts to riparian vegetation In-stream structures and/or flow regime impacts to reach connectivity.	1, 2, 3, 4, 5, 6 and 7 (refer above)
Estuaries	○ Recreational / Indigenous Fisheries ○ Fishery nursery ○ Primary productivity driver / exports ○ Threatened species habitat ○ Cultural/ spiritual	Alteration of surface runoff flow peaks and duration with potential for changes in sediment transport capacity and associated geomorphology impacts to estuary form and function. Alteration of contributing groundwater flow volumes or durations with potential impacts being realised in terms of altered salinity regimes within the estuary and associated changes to primary productivity, fisheries recruitment and ecotonal vegetation boundary shifts at the fresh–brackish interface.	1, 2, and 6 (refer above)

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Environmental Impact Statement

for South of Embley Project

Section 9
Air Quality

9 AIR QUALITY

An assessment of air quality impacts, including particulates, sulphur dioxide (SO_2) and oxides of nitrogen (NO_x), based on current Queensland guidelines, has been made for the Project. Greenhouse gas emissions have also been assessed (refer **Section 9.6**).

The Project is situated in a remote part of Cape York where there are no other significant sources of anthropogenic emissions within the air-shed. Bushfires are common and result in particulate and greenhouse gas emissions. There is unlikely to be other sources within the air-shed in the future with the exception of the proposed Aurukun Bauxite Project. Since the area is not urban and unlikely to become so in the future, it is not considered necessary to undertake an airshed assessment.

The mining and beneficiation of bauxite does not involve the use of chemical reagents and does not give rise to odours. Odour is therefore not considered relevant to this study. Ozone depleting substances would not be used on the site.

9.1 Ambient Air Quality

The Project area is situated in a mostly undeveloped and remote part of Cape York. To the north of the Project area are the townships of Weipa and Napranum, which are approximately 4km from the closest mining areas and 40km from the Boyd infrastructure area and proposed port (refer **Figure 9-1**). To the south of the Project area is the township of Aurukun, which is 15km from the nearest mining areas and 35km from the Norman Creek infrastructure area. There are several homesteads on the remote cattle stations more than 50km to the east of the Project area. The site itself is vegetated and does not currently contain significant dust sources. Potential sources of particulate emissions from the environment surrounding the proposed mine primarily comprise:

- unsealed roads;
- smoke from bushfires;
- existing RTA mines and processing plants at East Weipa and Andoom; and
- cattle station activities.

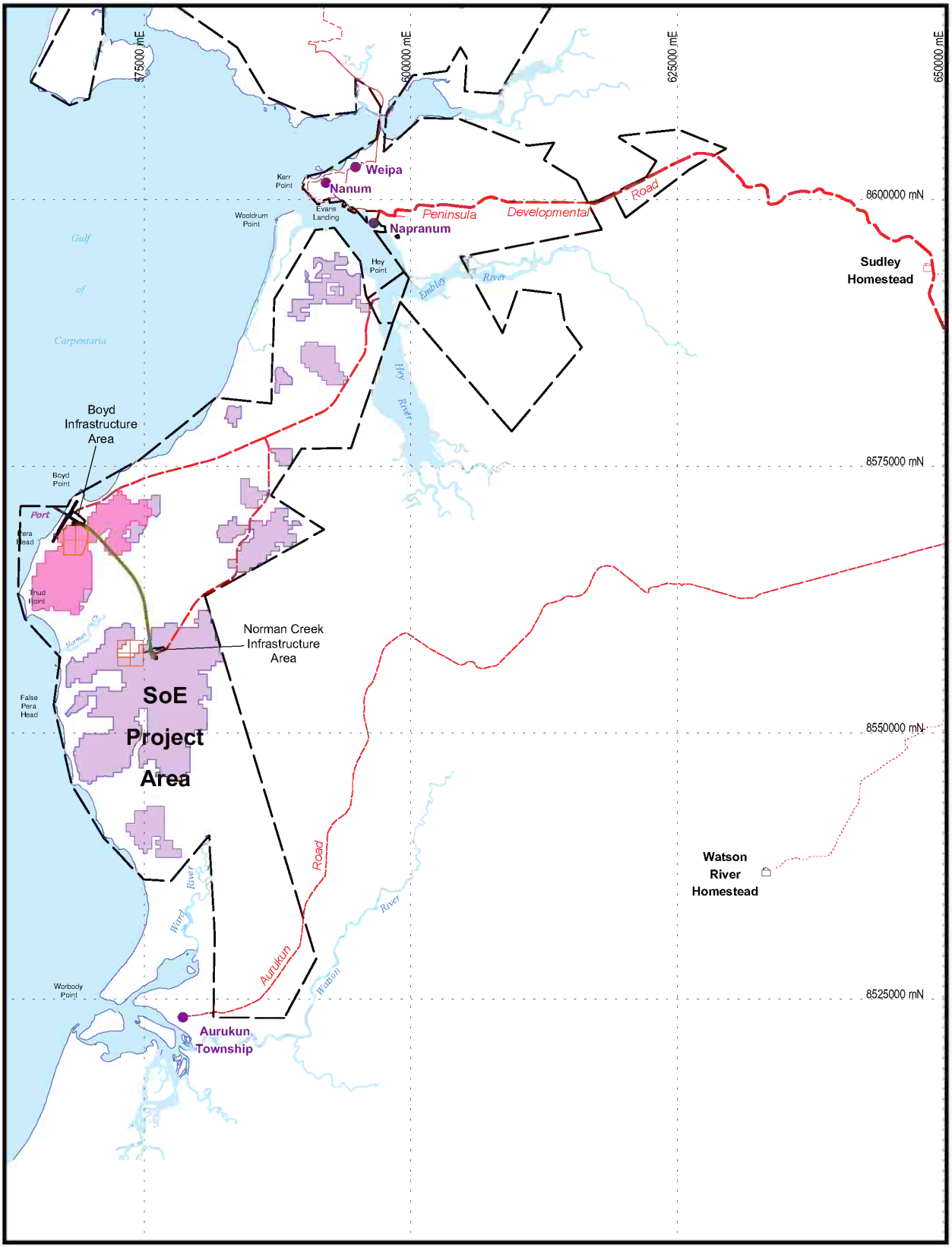
Since particulate exposure is highest close to the source of the particulates it is expected that vehicle movement on unsealed roads would be the most significant source of dust in the remote areas, although the actual dust exposure would be low. Closer to Weipa and Napranum the existing RTA mines and associated infrastructure would contribute to the dust exposure levels. Particulates in smoke from bushfires are occasionally elevated in the dry season.

Typically, airborne dust is referred to as "particulate matter" and is characterised by its size. The usual particle size ranges referred to are total suspended particulate (TSP), particulate matter with an aerodynamic diameter of less than 10 microns (PM_{10}), and particulate matter less than 2.5 microns in diameter ($PM_{2.5}$). By definition, TSP includes both the PM_{10} and $PM_{2.5}$ fractions, and PM_{10} includes the $PM_{2.5}$ fraction. Concentrations of suspended particulate matter are measured in micrograms per cubic metre of air ($\mu g/m^3$).

Normally, dust particles with an aerodynamic diameter of more than PM_{10} will typically fall out and be deposited onto the ground within several minutes of becoming airborne. This is referred to as "dust deposition" and is measured in milligrams per square metre per day ($mg/m^2/day$).

Dust exposure in Weipa has been monitored previously (PAE 2004) and the following results were found:

- the annual average PM_{10} concentration measured was $23.3\mu g/m^3$;
- the highest PM_{10} (24-hour) concentration measured was $116.2\mu g/m^3$ at the Scherger RAAF base;
- typical maximum PM_{10} (24-hour) concentration was measured in the range 25 to $70\mu g/m^3$ at various sites, including the RAAF base and North Napranum;



P:\RTA\Plans\SoE\2009\EIS Report Figures\Chapter9\Fig 9-01 Receptor Locations.wor

RTA Mining Lease boundary
Township (Sensitive Receptor)
Homestead (Sensitive Receptor)
Road/track
Tailings dam
Mining Years 1 -13
Mining Years 14 - 40

South of Embley Project

Fig 9-1: Sensitive Receptor Locations

N

5 0 5 10km

Datum/Projection: GDA94/MGA Zone 54 Date: 14/07/2010

- for 99% of the time, the 24-hour average PM_{10} concentration was below 60μg/m³; and
- for 50% of the time, the 24-hour average PM_{10} concentration was below 22μg/m³.

The monitoring was undertaken at various sites near the now decommissioned calcination plant. The calcination plant was, at the time of the monitoring, perceived as a significant dust source.

It is considered that these dust measurements would be representative of the highest dust exposure in occupied areas such as Weipa, Napranum or Aurukun. It is proposed to adopt these measurements as the background exposure level at all sensitive sites.

Further monitoring and assessments were carried out over a short period in 2008 during the construction of the East Weipa tailings storage facility, which is close to the suburb of Nanum in Weipa. The construction involved significant disturbance of an old tailings storage facility with high fraction of very fine material. This is unrepresentative of the Project operations and, as a consequence, it is not appropriate to use this monitoring data.

The ambient dust levels for $PM_{2.5}$ and PM_{10} that have been adopted are based on PAE (2004) data for PM_{10} and are summarised in **Table 9-1**.

The levels for $PM_{2.5}$ have been derived based on the *Queensland 2007 air monitoring report* (EPA 2008b), which shows that the ratio of $PM_{2.5}$ to PM_{10} in ambient air is approximately 1:2.4 for urban areas where motor vehicles are a large source of $PM_{2.5}$ emissions. For rural areas a ratio of 1:3 has been adopted.

The ambient air quality values for TSP and deposited dust are conservative estimates, based upon the consultant's knowledge of monitoring in north Queensland, and are also shown in **Table 9-1**.

Table 9-1 Ambient Air Quality

Indicator	Ambient Air Quality	Averaging Period
$PM_{2.5}$	7 μg/m³	24 hours
PM_{10}	22 μg/m³	24 hours
TSP	23 μg/m³	Annual average
Deposited dust	50 mg/m²/day	30 days ± 2 days

The ambient levels for Napranum and Aurukun are likely to be lower than Weipa due to the increased distance from existing dust sources. However, as air quality criteria are based on health protection criteria rather than ambient levels, the higher the ambient level assumed for the modelling, the more conservative the approach. Therefore, the ambient levels are assumed to be the same across Weipa, Napranum and Aurukun.

There have not been any measurements of existing levels of NO_2 or SO_2 in Weipa. The existing power station and vehicle fleet in the region will be the main contributors. The *Queensland 2007 air monitoring report* (EPA 2008b) states the annual mean for NO_2 is between 4 parts per billion (ppb) and 8ppb for various industrial locations in Queensland. For SO_2 the annual mean is reported to be between 1 and 2ppb. The maximum 1-hour NO_2 level is typically 40ppb. The SO_2 level is typically 5ppb for the maximum 1-hour and 3ppb for the maximum 24-hour average. These values have been adopted as ambient concentrations for the Project area. Given they mostly relate to industrial areas (Townsville, Gladstone, etc) they are likely to be elevated compared to existing levels in Weipa. As for particulates, this is a conservative approach to the modelling given that air quality criteria are based on health protection criteria rather than ambient levels.

9.2 Guidelines, Policies and Legislation

9.2.1 Environmental Protection (Air) Policy

The *Environmental Protection (Air) Policy 2008* (Qld) (EPP (Air)) commenced on 1 January 2009 and sets out a framework for:

- identifying environmental values for the air environment;
- setting air quality objectives for sensitive receptors; and
- avoiding, minimising or managing air emissions.

The relevant environmental values to be enhanced or protected under this policy are:

(a) the qualities of the air environment that are conducive to protecting the health and biodiversity of ecosystems; and

(b) the qualities of the air environment that are conducive to human health and wellbeing.

Schedule 1 of the EPP (Air) nominates air quality indicators and objectives and incorporates the goals recommended in the *National Environment Protection (Ambient Air Quality) Measure* for $PM_{2.5}$. Relevant indicators and objectives for the Project are as shown in **Table 9-2**.

9.2.2 DERM Guidelines

The Department of Environment and Resource Management (DERM) Guideline *Preparing an environmental management overview strategy (EMOS) for non-standard mining projects* requires that the release of dust or particulate matter or both resulting from the mining activity must not cause an environmental nuisance at any sensitive or commercial place. The maximum dust levels, measured downwind of the operation at a sensitive or commercial place suggested in the Guideline are shown in **Table 9-2**.

9.2.3 Project Air Quality Criteria

The applicable air quality criteria for the Project are therefore summarised in **Table 9-2**.

Table 9-2 Proposed Project Air Quality Criteria

Indicator	Receptor	Air Quality Objective	Units	Averaging Period	Comment	Source
$PM_{2.5}$	Residences	8	$\mu g/m^3$	1 year		EPP (Air)
	Residences	25	$\mu g/m^3$	24 hours		EPP (Air)
PM_{10}	Residences	50	$\mu g/m^3$	24 hours	Not to be exceeded on more than 5 days/yr	EPP (Air)
PM_{10}	Residences	150	$\mu g/m^3$	24 hours		DERM Guideline
TSP	Residences	90	$\mu g/m^3$	1 year		EPP (Air)
Dust deposition	Residences	120	mg/m^2/ day	1 month		DERM Guideline
NO_2	Residences	120	ppb	1 hour	Not to be exceeded on more than 1 day/yr	EPP (Air)
	Residences	30	ppb	1 year		EPP (Air)
	Natural ecosystems	16	ppb	1 year		EPP (Air)
SO_2	Residences	200	ppb	1 hour	Not to be exceeded on more than 1 day/yr	EPP (Air)
	Residences	80	ppb	1 day	Not to be exceeded on more than 1 day/yr	EPP (Air)
	Residences	20	ppb	1 year		EPP (Air)
	Agriculture	11	ppb	1 year		EPP (Air)
	Ecosystems	7.5	ppb	1 year		EPP (Air)

9.3 Emission Sources

The main operations associated with the Project comprise:

Construction

Preparation of the site for construction of infrastructure involves clearing and burning the vegetation. The dust emissions from these activities have not been included as they are localised and relatively short in duration. The predicted annual rate of vegetation clearing during construction is less than the predicted annual rate of clearing at the 30Mdptpa and 50Mdptpa production rate scenarios. In addition, fewer heavy vehicles would be in use during construction. Therefore, the air quality impacts during construction are likely to be appreciably less than the predicted operational levels.

Operations

Vegetation would be cleared by bulldozers following the wet season when the ground is sufficiently moist to allow tree roots to pull clear of the ground rather than breaking. The cleared vegetation would be left on the ground for approximately 12 months before being burnt. The particulate dust (and smoke) emissions from these operations have not been included as it is of a relatively short duration.

Following vegetation clearing, front-end loaders and rear-dump trucks are used to strip soil, which would be returned directly to mined-out areas undergoing rehabilitation, where possible, or stockpiled for later respreading. This activity would be one of the main dust sources from the Project.

Mining comprises extraction of bauxite ore by front-end loaders and loading into dump trucks. The dump truck takes the bauxite to a dump station on unsealed roads. Where haul distances are long, this can be a significant source of dust. The dump stations near the beneficiation plants are also significant dust sources.

The bauxite ore is conveyed a short distance from the dump station to the beneficiation plant. The conveyor is a minor source of dust.

The beneficiation plant area includes run-of-mine (ROM) stockpiles, the beneficiation plant, conveyors, stackers and reclaimers, product stockpiles, and tailings storage facilities. The dust emissions from the beneficiation plant are comparatively low since the bauxite is washed to remove the fines. However, the exposed areas surrounding the plant are potential sources of dust due to vehicle movement and wind-blown dust. Product stockpiles are not a main source of dust, as after beneficiation the product is free of fine particulates. Tailings storage facilities have the potential to be a source of dust if the surface is dry.

Ship loading involves reclaimers, conveyors and ship loaders. The bauxite has high moisture content during these processes. As a result, ship loading is only a minor source of dust.

Rehabilitation would involve replacing the topsoil and revegetation. Replacing topsoil generates a similar amount of dust to stripping topsoil.

The diesel-fired power station (and mobile equipment) are sources of SO_2 and NO_2. RTA currently uses low sulphur diesel in the existing power station; however, high sulphur diesel has been used in the Project model to provide a conservative estimate. The fuel consumption is assumed to be at a steady rate throughout the year.

9.4 Air Dispersion Modelling

The types of dust particles are described in **Section 9.1**. Aerodynamic diameters account for the density of the dust involved. The PM_{10} fraction does not have a significant settling velocity component and will tend to behave in a gaseous fashion – that is, the fall out time is significantly longer than a few minutes.

The air quality modelling comprised:

(a) development of an emissions database using both *AP-42* (US-EPA 1995) and the *Emission Estimation Technique Manual for Mining Version 2.3* (NPI 2001); and

(b) modelling of the likely downwind ground level concentrations using The Air Pollution Model (TAPM).

TAPM draws on Bureau of Meteorology (BoM) Limited Area Prediction System (LAPS) analyses to solve the equations of motion to predict the meteorology and dispersion of pollutants hour by hour without needing any local meteorological data. Terrain and land use information are employed in the simulations and are in-built into the model.

TAPM predicts meteorology and concentrations for a range of contaminants important for air quality applications. The model consists of coupled prognostic meteorological and air pollutant concentration components, eliminating the need to have site-specific meteorological observations. Instead, the model predicts the flows important to local-scale air quality, such as sea breezes and terrain induced flows, against a background of larger-scale meteorology provided by synoptic analyses.

Some limitations of TAPM include the following:

- It is not suitable for horizontal domain sizes above approximately 1,000km by 1,000km.
- It cannot be used to accurately represent deep atmospheric circulations or extreme weather events (cyclones).
- It cannot be used for very steep terrain because of the use of a terrain following coordinate system in the model. Thus the model cannot represent discontinuities in terrain height (for example, cliffs or bluffs).
- It assumes that cloud processes are resolved by the typical inner grid spacings used in the model (i.e. 3km or less). Therefore no large-scale cloud convection parameterisation is included.

These limitations are of minor significance to the modelling of air quality for the Project. The area of interest is much smaller than the maximum horizontal domain size. Extreme weather events (such as cyclones) are not of interest from an air quality perspective. The terrain does not have significant cliffs or bluff bodies within the region and it is expected that the inclusion of large-scale cloud convection would only slightly change the radiation and moisture balances.

TAPM is well regarded by DERM and a verification study carried out by the CSIRO (the developers of TAPM) found:

> TAPM performs well in a variety of regions throughout Australia (e.g., coastal, inland and generally complex terrain for sub-tropical to mid-latitude conditions). The pollution results show that TAPM performs well for a range of important phenomena (e.g. concentration variance and fluctuation intensity; building wakes; nocturnal inversion break-up fumigation; stable, neutral, and convective dispersion; shoreline fumigation; and general dispersion in complex rural and urban conditions). In particular, TAPM performs very well for the prediction of extreme pollution statistics, important for environmental impact assessments, for both non-reactive (tracer) and reactive (nitrogen dioxide, ozone and particulate) pollutants for a variety of sources (e.g. industrial stacks and/or general surface or urban emissions) (Hurley et al. 2005).

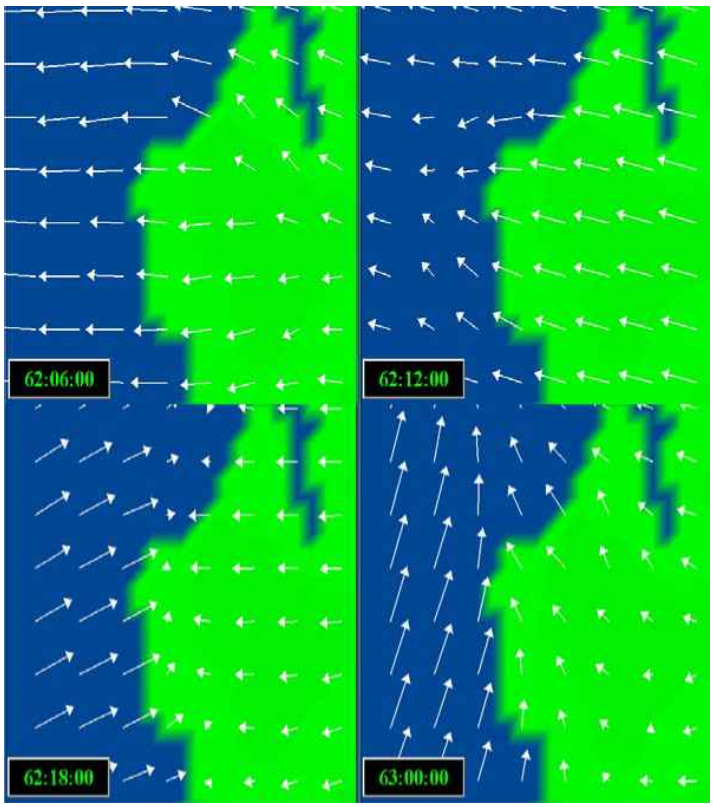
TAPM was used to determine the downwind ground level concentrations for all pollutants and dusts (including photochemistry). The gas-phase photochemistry included in TAPM is based on the semi-empirical mechanism called the Generic Reaction Set. The gas-phase photochemistry is associated with the NO-to-NO_2-to-NO cycle in sunlight. The cumulative effects of the existing industry, power station and other emission sources in the region have been included the predictions.

9.4.1 Meteorology Conditions

TAPM was used to calculate the meteorology over the entire site. TAPM includes in its database six-hourly observations based on interpretation of the results from all relevant weather stations in Australia. Although not strictly required, the accuracy of TAPM can be improved by incorporating meteorological data from weather stations within the study zone.

The meteorology for Weipa has been observed by BoM since 1959; however, rainfall records from the Weipa area are available from 1914. Since 1992 BoM has maintained an automatic weather station at Weipa Aerodrome to continuously record observations every 30 minutes. A subset of these observations was obtained for this study, specifically, to improve the accuracy of the generation of meteorological data over the entire site by TAPM. The data obtained from BoM comprised hourly wind speed and direction as required by TAPM.

TAPM calculates a wind field over the study area for every hour of the simulation period. An example which shows the variability of the winds is contained in **Figure 9-2**. The figure shows that the winds can vary significantly in terms of both speed and direction.



Notes: Arrows represents wind speed (arrow length) and direction over the study area over one day, with six-hourly time steps.
Green indicates land; blue indicates sea or water.
Weipa is located towards the top of the figure; Aurukun is located towards the bottom.

Figure 9-2 Example of TAPM Wind Calculations over Project Area

The general features of winds that will affect plume dispersion are illustrated in the wind rose diagrams for the years 2004 and 2005 for a location approximately in the middle of the Project area (adjacent to Dam C on Norman Creek). The years 2004 and 2005 were selected as cyclone activity was below average with only two relatively mild cyclones in 2004 and one in 2005 affecting Cape York. The wind roses show the frequency of occurrence of winds by direction and strength. The bars correspond to the 16 compass points – N, NNE, NE, ENE, E etc. The length of the bar represents the frequency of occurrence of winds from that direction, and the

colour of the bar sections correspond to wind speed categories. The wind roses in **Figure 9-3** and **Figure 9-4** summarise the wind statistics at 10m above ground on-site, as calculated by TAPM and adjusted (nudged) by Weipa Aerodrome statistics. It is noted that the predominant wind direction during the year is from the east to the south-east. The meteorological modelling indicates that the inland areas do not experience the full effect of coastal sea breeze influences.

Wet Season

The wet season (November to April) wind roses (**Figure 9-3**) show that from midnight to 6am prevailing winds were generally light and from the east-south-east to east-north-east, approximately 80% of the time. Morning winds (6am to 12pm) showed easterlies increasing in strength. During the afternoons (12pm to 6pm) wind frequency and velocity from the westerly directions increased, representing both the sea breeze and monsoonal influences. During the evenings (6pm to midnight) wind strength generally decreased, with the most common direction from east-south-east.

Wind rarely blows from the south over the Embley River towards Weipa. This implies that dust and contaminants released in the Project area are unlikely to combine with dust or contaminants from existing mining operations in the Weipa area.

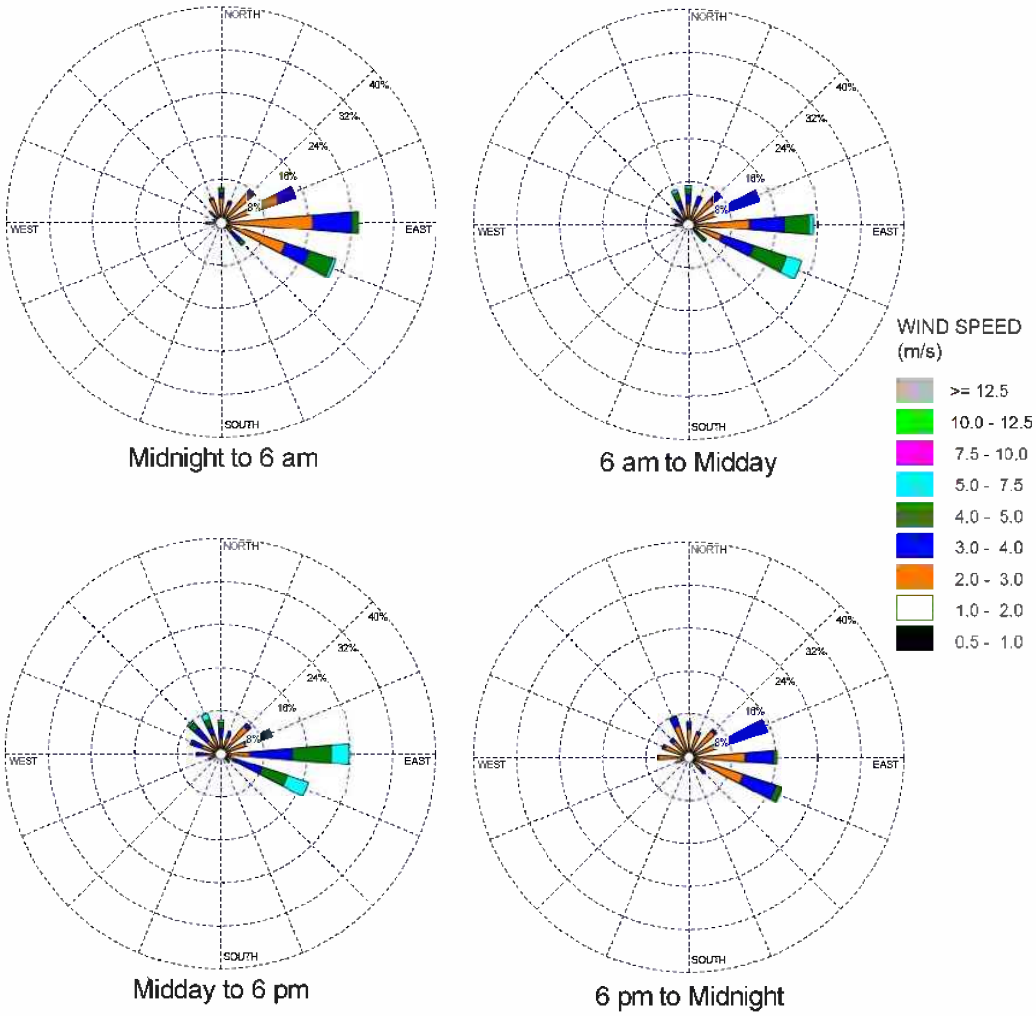


Figure 9-3 Wet Season Wind Roses for Norman Creek Area

Dry Season

The dry season (May to October) wind roses (**Figure 9-4**) show that the winds are almost exclusively from the east. From midnight to 6am, prevailing winds were generally light. Easterlies increased in strength during the morning (6am to 12pm) while during the afternoons (12pm to 6pm) the easterlies marginally increased in strength. During the evenings (6pm to midnight) a general decrease in strength of winds is observed with the most common direction from the east.

The wind rarely blows towards Weipa, Napranum or Aurukun from the Project area.

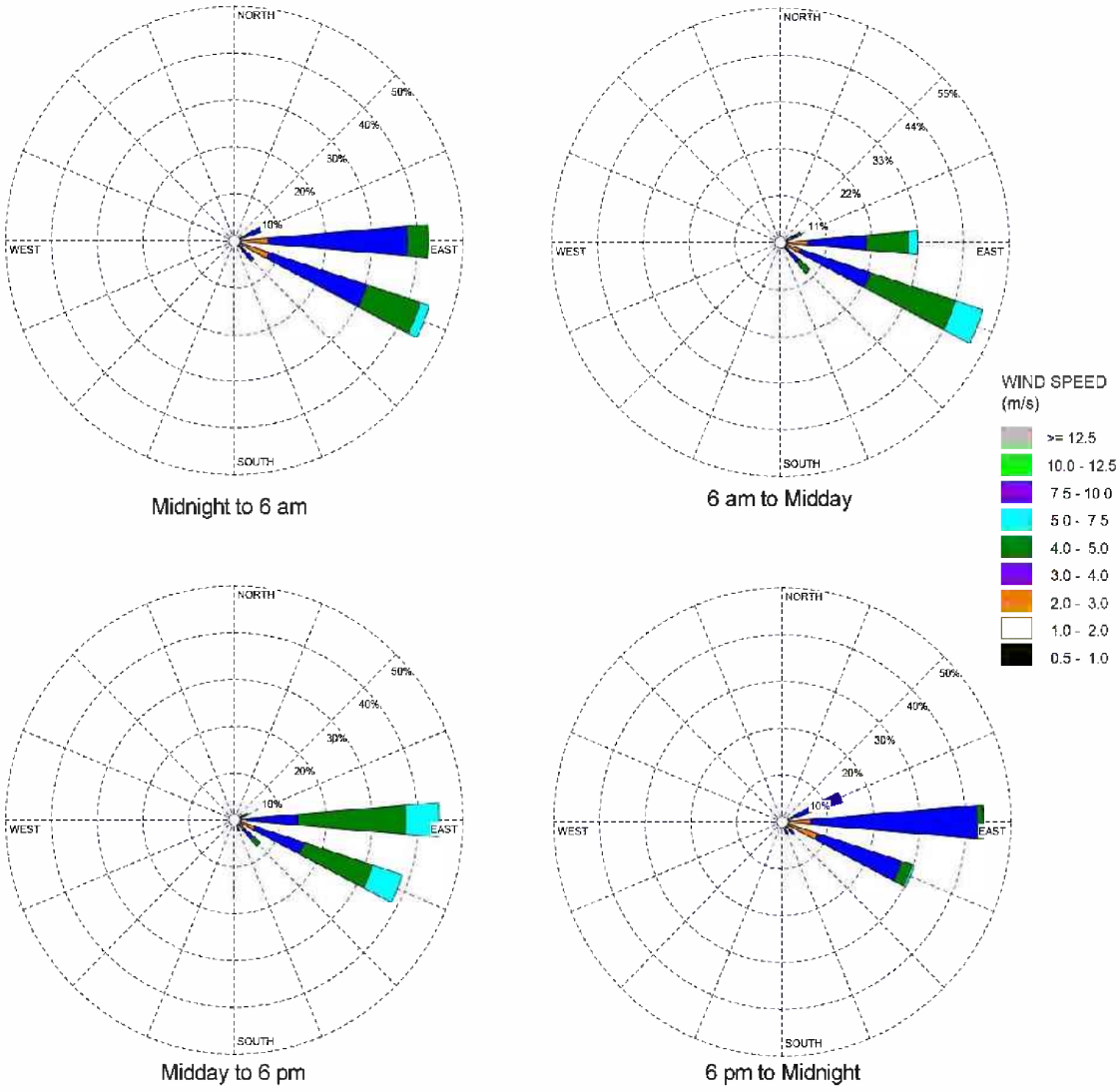


Figure 9-4 Dry Season Wind Roses for Norman Creek Area

9.4.2 Emissions Data

Projected emissions from the Project were modelled using TAPM. This assessment is based on the long-term maximum projected output for the Project of 50Mdptpa.

The emissions data is based on observed current RTA mining, process and shipping operations at Weipa. The operations are described in terms of:

- clearing for mining;
- soil stripping and overburden removal (mine development);
- mining (extraction of the bauxite);
- truck and conveyor haulage;
- process plant (beneficiation);
- stockpiling;
- power generation;
- ship loading; and
- mine rehabilitation.

It is likely the development (stripping soil and overburden prior to mining) areas would be located close to previously mined areas. This is a good operational practice since it limits the total travel distances and cycle time for dump trucks and minimises dust generation on the roads.

In generating the emissions data it is important to recognise that dust emissions are highly dependent on the moisture content of the surface material, be it overburden, roads or bauxite. Dust emissions are lowest during the wet season as the surface material moisture content is very high. However, during the dry season, there is a higher potential for dust emissions to be released.

Rather than adopt a constant emission rate for all hours, the model uses a methodology that determines an emission rate from every operation, for each hour of the year, which includes the effects of dust emission controls due to rainfall and the operation of water trucks. In addition, the emissions from wind-generated dusts have also been included.

The methodology adopted to generate the emissions data is discussed below.

- Initially, each dust source was identified. For each of these dust sources an emission/erosion potential for dry exposed surfaces was calculated based on either the NPI (2001) *Emission Estimation Technique Manual for Mining Version 2.3* or US-EPA AP-42 (1995) 5th Update 2003.
- The dry emission rate (for each source and for every hour of the modelling simulation) was modified to account for the actual moisture content of the overburden, road surface, bauxite stockpiles and tailings storage facilities from both rainfall and water truck usage.

The moisture content of overburden and unmined bauxite due to rain was established through the following methodology:

- The TAPM model was initially run in meteorology mode only and an hourly meteorological file for the entire year extracted. This TAPM calculated and generated file contains inter alia, wind speed and rainfall for each hour.
- If any rain occurred during that hour then the moisture content of the ground was assumed to be 10%.
- If there was at least 1mm of rain during the preceding three hours the moisture content of the ground was assumed to be 10%.
- Otherwise the assumed moisture content for the ground or overburden was assumed to be 4% during the wet season and 2% during the dry season.

The moisture content of roads and haulage routes due to rain and water truck operations was established through the following methodology:

- If any rain occurred during that hour then the moisture content of the road was assumed to be 5%.
- If there was at least 1mm of rain during the preceding three hours the moisture content of the road was assumed to be 5%.
- For all other hours the moisture content of the road was assumed to vary randomly between 0% and 1.66%. Thus the maximum control efficiency of watering by water trucks was 50% (1.66% moisture content).

9.4.3 Construction

The construction phase has not been modelled because the modelled operational phase has a higher impact than construction (refer **Section 9.3**).

9.4.4 Operations

For the purposes of impact assessment, three production scenarios have been considered over the life of the mine:

- 15Mdptpa;
- 30Mdptpa; and
- 50Mdptpa.

The 15Mdptpa production scenario covers the early years of the Project when the mining areas would be located close to the Boyd infrastructure area and furthest from sensitive receptors. Under the 30Mdptpa production scenario the mining areas would be more remote from the Boyd infrastructure area and also occur near the Norman Creek infrastructure area and extend further away over time. Under the 50Mdptpa production scenario the mine would extend from the north to the south of the lease area over a distance of approximately 60km. The equipment and plant utilisations expected for each production scenario are shown in **Table 9-3**. The air quality model incorporates plant and equipment operating at 50Mdptpa production rate with a spatial distribution representative of operations likely to cause the highest dust levels at all sensitive locations. The distribution of the dust sources comprise:

- a mining and development area approximately 5km west of the Hey River barge/ferry terminal and 6.4km south-west of Napranum (Hey River A);
- a mining area 23km south-south-west of Napranum (Hey River B);
- a mining and development area 17km north of Aurukun (Norman Creek A);
- a mining area 35km north of Aurukun (Norman Creek B); and
- haul roads, conveyors, beneficiation plants, power station and shiploaders.

For modelling purposes, mobile equipment fleet have been located in mining areas, on haul roads, and at dump stations, as would occur in a realistic mining situation.

For wind generated dust, the default emission rate applies for all hours where the wind speed exceeds 1m/s, except when raining, or hours when there has been more than 1mm of rain in the past three hours. The dust emissions from an exposed area depend on the surface area and the number of disturbances per year. An exposed surface has a thin layer of particulates that are light enough to be liberated by the wind. Once these surfaces have emitted dust there are no more particulates available until the surface is disturbed, usually by the action of vehicles, bringing fine particulates to the surface. After rain or watering of exposed surfaces, the fine particulates tend to bind together and to the heavier particulates to form a crust. This model assumes that an actively disturbed area is available to emit dust for every hour wind speeds are high enough to liberate dust from a surface.

Table 9-3 Summary of Equipment

Production Rate	**15Mdptpa**	**30Mdptpa**		**50Mdptpa**	
Work Area	**Boyd**	**Boyd**	**Norman Creek**	**Boyd**	**Norman Creek**
Plant	Beneficiation plant 4.7km of conveyors 16 conveyor drives Power station (12MW) Stacker and reclaimer 1 bulldozer	Beneficiation plant 6.4km of conveyors 19 conveyor drives Power station (26 MW) Stacker and reclaimer 1 bulldozer	Beneficiation plant 0.5km of conveyors 2 conveyor drives Stacker and reclaimer	Beneficiation plant 8.9km of conveyors 29 conveyor drives Power station (46 MW) Stacker and reclaimer 1 bulldozer	Beneficiation plant 1km of conveyors 4 conveyor drives Stacker and reclaimer
Shiploader	1.2km of conveyors 3 conveyor drives Ship housing noise	1.2km of conveyors 3 conveyor drives Ship housing noise		2.4km of conveyors 6 conveyor drives Ship housing noise	
Number of Mining Areas	2	1 north of Boyd Point	1 south of Boyd Point	2 north of Boyd Point	2 south of Boyd Point
Number of Development Areas	2	1 north of Boyd Point	1 south of Boyd Point	1 north of Boyd Point	1 south of Boyd Point
Mining/Production (total fleet numbers)	8 trucks 3 excavators 1 loaders 1 water truck 1 grader 1 field service truck 1 field fuel truck 1 low loader	18 trucks 6 excavators 2 loaders 2 water trucks 2 graders 2 field service trucks 2 field fuel trucks		33 trucks 8 excavators 2 loaders 4 water trucks 3 graders 2 field service trucks 2 field fuel trucks	
Development (total fleet numbers)	1 loaders 3 trucks 1 grader 1 water truck 1 bulldozer 1 field service truck 1 field fuel truck	1 loader 3 trucks 1 grader 1 water truck 1 bulldozer 1 field service truck 1 field fuel truck		2 loaders 6 trucks 2 graders 2 water trucks 2 bulldozers 1 field service truck 1 field fuel truck	
Overland Conveyor	-		15km of conveyor 4 conveyor drives		15km of conveyor 4 conveyor drives

The actively disturbed area comprises:

- 30ha for each development area (60ha in total);
- 20ha for each mining area (80ha in total);
- 5ha for the area surrounding each of the beneficiation plants;
- 435ha for each of the tailings storage facilities (three out of four cells assumed to be dry); and
- 25ha for the product stockpiles.

It should be noted that the exposed areas would be significantly larger.

Annual dust emissions from each activity in each active area are shown in **Table 9-4**. The most significant source of all the dust fractions is vehicles on haul roads. A summary of the total annual emissions is contained in **Table 9-5**. It should be noted that there is only limited measured data available for $PM_{2.5}$ emissions. Based on review of the literature, the quantity of $PM_{2.5}$ released is taken to be 12% of the quantity of PM_{10}. TSP is expressed as PM_{30} in TAPM.

Table 9-4 Dust Emissions by Area and Source at 50Mdptpa

Location	Activity	Annual dust emissions (tonnes per annum)		
		$PM_{2.5}$	PM_{10}	TSP
Mining and development (Hey River A)	Excavator on overburden	2	18	38
	Excavator on bauxite	1	9	19
	OB haul truck move	7	60	294
	OB haul truck dump	18	152	423
	Dozer	13	105	447
	Grader	12	98	391
	Wind erosion	8	68	136
Mining (Hey River B)	Excavator on bauxite	1	9	19
	Wind erosion	3	27	54
Mining and development (Norman Creek A)	Excavator on overburden	2	18	38
	Excavator on bauxite	1	9	19
	OB haul truck move	7	60	294
	OB haul truck dump	18	152	423
	Dozer	13	105	447
	Wind erosion	8	68	136
Mining (Norman Creek B)	Excavator on bauxite	1	9	19
	Wind erosion	3	27	54
Boyd beneficiation and tailings storage facility	Dumping	18	148	353
	Dozer	4	35	149
	Handling	0.01	0.1	0.2
	Wind erosion	142	1182	2365
Norman Creek beneficiation and tailings storage facility	Dumping	18	148	353
	Dozer	4	35	149
	Handling	0.01	0.1	0.2
	Wind erosion	142	1182	2365
Roads	All roads combined	231	1925	9385

Table 9-5 Annual Dust Emissions at 50Mdptpa

Source	Annual dust emissions (tonnes) from operations for particle diameters		
	$PM_{2.5}$	PM_{10}	TSP
Dust from haul roads	231	1,925	9,385
Dust from mining areas (development, mining operation, and rehabilitation)	119	993	3,249
Dust from two beneficiation plants, conveyors, stockpiles, tailings storage facilities and shiploaders	185	1,153	3,363
Annual Total [tonnes]	**535**	**4,071**	**15,997**

Both the power station and the mobile equipment are diesel powered. The main emissions from these sources are presented in **Table 9-6**. The emissions are based on annual diesel consumption of 101,000kL. The percentage sulphur assumed is 1,000 parts per million (ppm) or 0.1%. By comparison, retail fuel has a sulphur content of 10ppm.

Although the EPP (Air) provides air quality objectives for nitrogen dioxide (NO_2), the amount of NO_2 released by combustion of diesel is very low. However, NO_2 is formed from nitric oxide (NO) through photochemical reactions in the atmosphere. Therefore, NO emissions have been calculated as a conservative estimate of NO_2 emissions using the *Emission Estimation Technique Manual for Mining* (NPI 2001).

Table 9-6 Annual NO_x and SO_2 Emissions at 50Mdptpa

Contaminant	Annual Emissions [tonnes] from Diesel Operations	
	Power Station	Mobile Equipment
NO_X (taken to be all NO)	2100	1125
SO_2	111	54

9.4.5 Air Quality Modelling Outputs

The predicted particulate, SO_2 and NO_2 concentrations at the sensitive places close to the Project are shown in **Table 9-7** and **Table 9-8**. The ground level concentrations at the sensitive places include the ambient background concentrations. The modelling was carried out using TAPM for both the meteorology and pollution aspects of the Project. Since the simulation includes two years of meteorology, the model incorporates all likely and expected meteorological conditions, including adverse meteorological conditions (such as inversions) and various likely mixing heights. The model is a thorough and realistic simulation of the expected meteorological and operational conditions for the Project.

The NO_2 concentrations levels shown in **Table 9-8** include the effect of photochemistry and are therefore a conservative estimate.

Table 9-7 Predicted Particulates at Sensitive Residential Receptors at 50Mdptpa

Receptor	Predicted Particulate Levels For Sensitive Receptors (including ambient levels)				
	Maximum PM_{10} (24 hour) – Fifth highest in a year [$\mu g/m^3$]	Maximum $PM_{2.5}$ (24 hour) [$\mu g/m^3$]	$PM_{2.5}$ (annual average) [$\mu g/m^3$]	TSP (annual average) [$\mu g/m^3$]	Dust deposition (highest month) [$mg/m^2/day$]
Proposed Criteria	**50**	**25**	**8**	**90**	**120**
Existing Ambient	**22**	**8**	**2**	**23**	**50**
Weipa	27	10	2	23	51
Napranum	27	9	2	23	51
Aurukun	27	10	2	23	52

Table 9-8 Predicted NO_2 and SO_2 at Sensitive Residential Receptors at 50Mdptpa

Receptor	Predicted Concentrations For Sensitive Receptors				
	Maximum NO_2 (1 hour) [ppb]	Annual Average NO_2 [ppb]	Maximum SO_2 (1 hour) [ppb]	Maximum SO_2 (1 day) [ppb]	Annual Average SO_2 [ppb]
Proposed Criteria	**120**	**30**	**200**	**80**	**20**
Existing Ambient	**40**	**6**	**5**	**3**	**1.5**
Weipa	52	6	6	3	1.5
Napranum	51	6	6	3	1.5
Aurukun	51	6	5	3	1.5

The calculated ground level dust deposition, particulate, SO_2 and NO_2 concentration contours for the 50Mdptpa production scenario are shown in:

Figure 9-5 – Maximum PM_{10} (24-hour) (fifth highest) with concentration contours expressed in terms of $\mu g/m^3$;

Figure 9-6 – The ultra-fine particulates maximum $PM_{2.5}$ (24-hour) with concentration contours expressed in terms of $\mu g/m^3$;

Figure 9-7 – The ultra-fine particulates $PM_{2.5}$ (annual average) with concentration contours expressed in terms of $\mu g/m^3$;

Figure 9-8 – TSP (annual average) with concentration contours expressed in terms of $\mu g/m^3$;

Figure 9-9 – Dust deposition (annual maximum month) with deposition contours expressed in terms of $mg/m^2/day$;

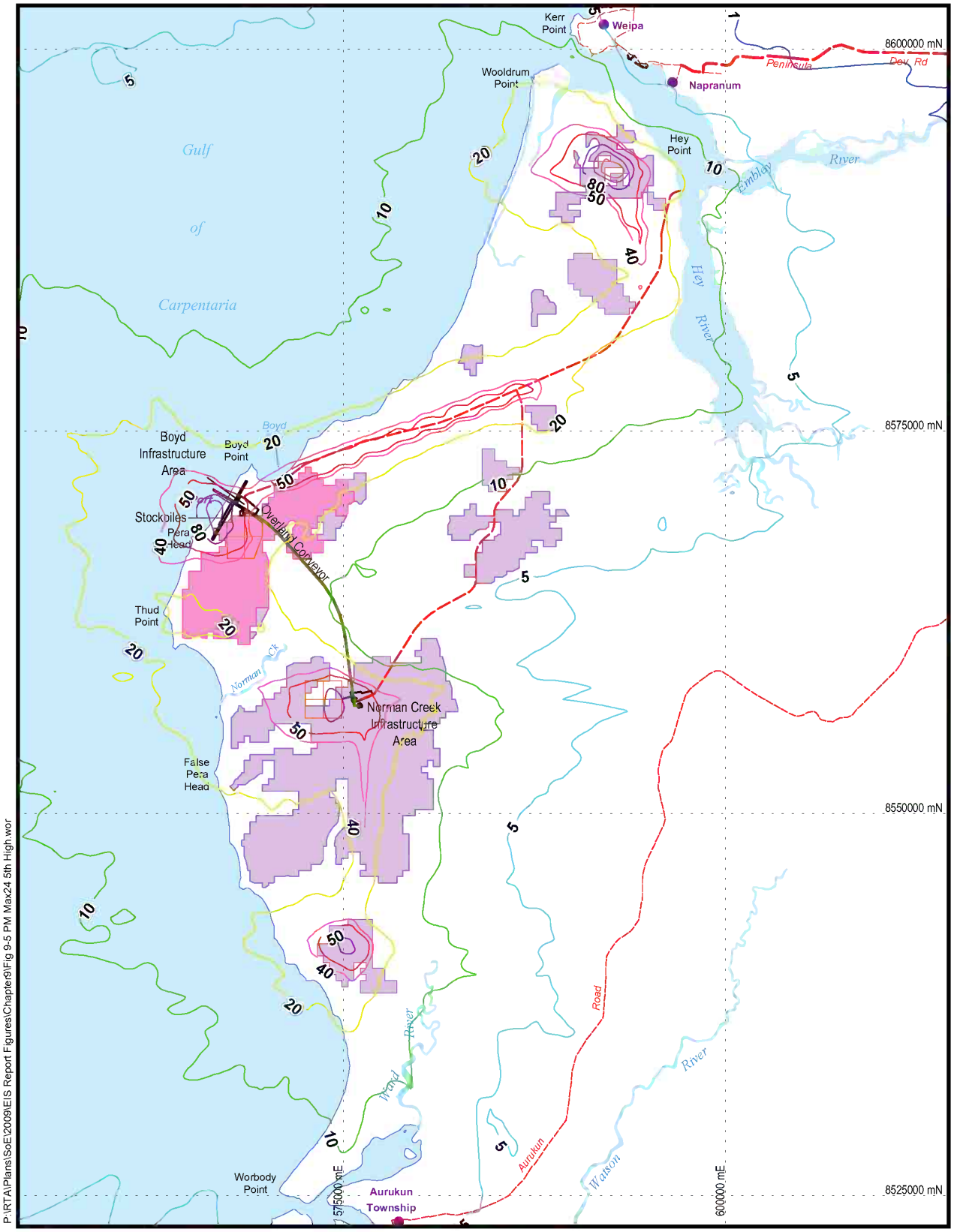
Figure 9-10 – NO_2 maximum hourly concentration with contours expressed in terms of ppb;

Figure 9-11 – NO_2 annual average concentration with contours expressed in terms of ppb;

Figure 9-12 – SO_2 maximum hourly concentration with contours expressed in terms of ppb;

Figure 9-13 – SO_2 maximum 1-day concentration with contours expressed in terms of ppb; and

Figure 9-14 – SO_2 annual average concentration with contours expressed in terms of ppb.



P:\RTA\Plans\SoE\2009\EIS Report Figures\Chapter9\Fig 9-5 PM Max24 5th High.wor

Township
Road/track
Tailings dam
Mining Years 1 -13
Mining Years 14 - 40

Objective for residences: 50 µg/m³

Rio Tinto Alcan

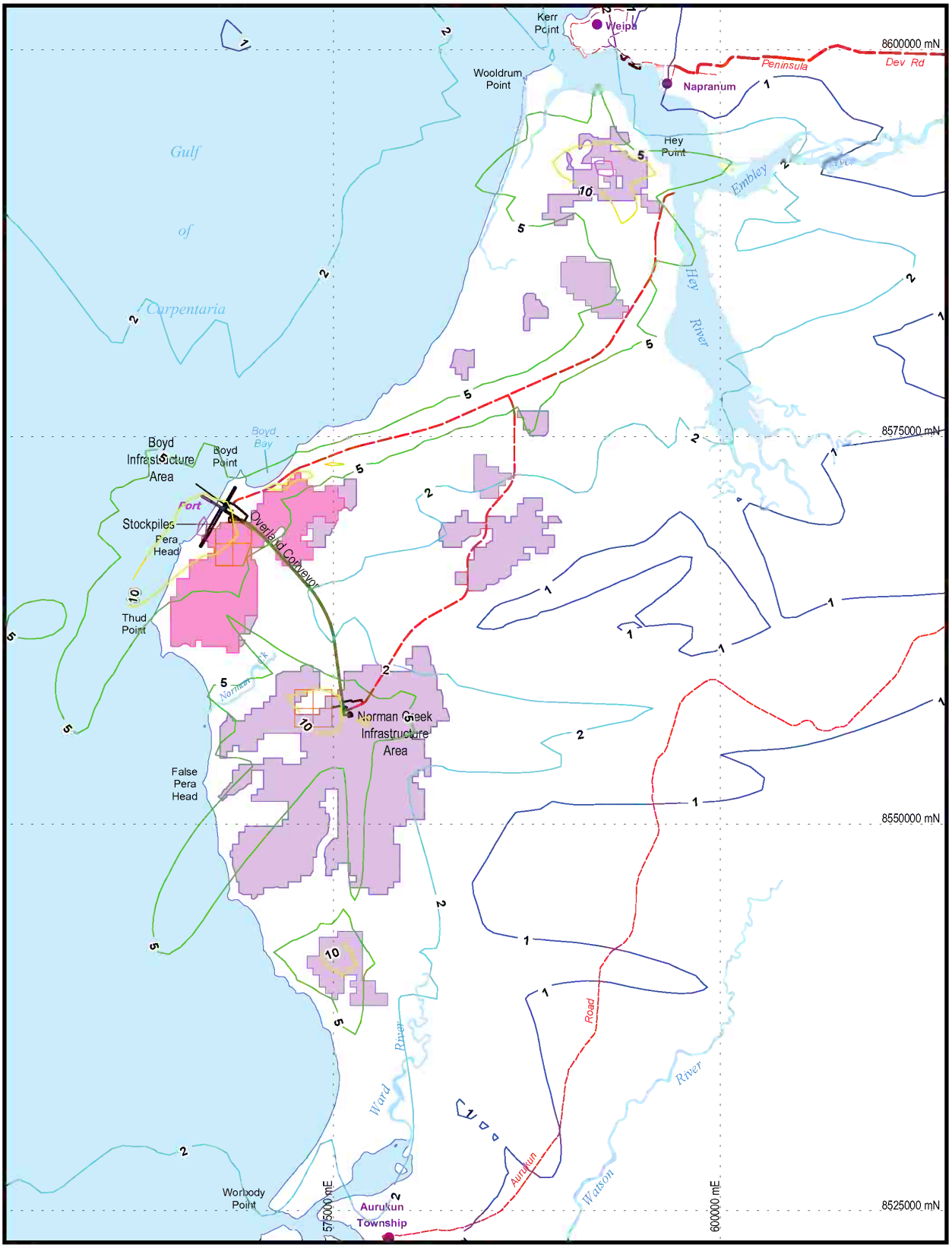
South of Embley Project

Fig. 9-5: Modelled PM_{10} fifth highest 24-hr (µg/m³)

N

5 0 5km

Datum/Projection: GDA94/MGA Zone 54 Date: 14/07/2010



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Township
Road/track
Tailings dam
Mining Years 1 -13
Mining Years 14 - 40

Objective for residences: 25 µg/m³

Rio Tinto Alcan

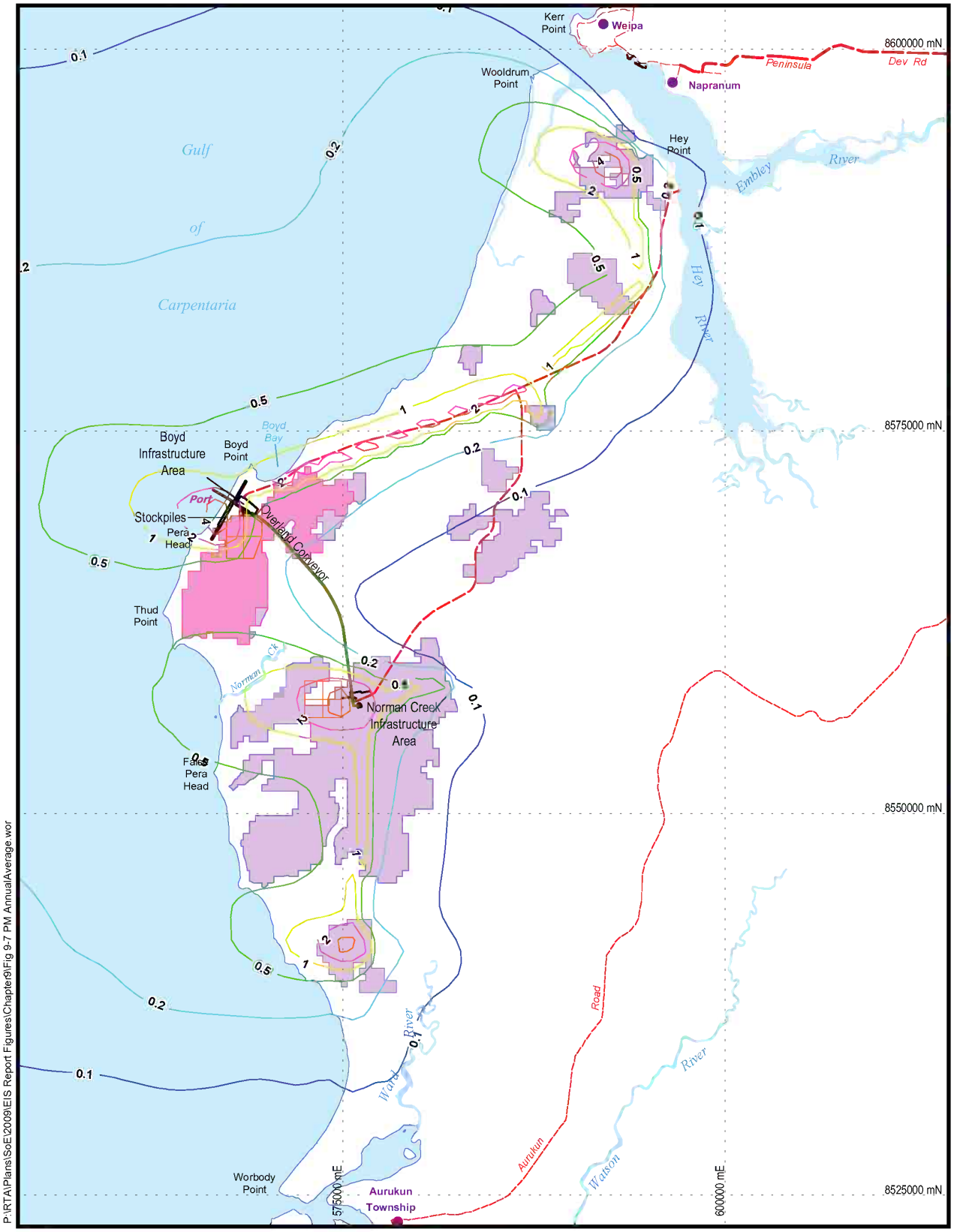
South of Embley Project

Fig. 9-6: Modelled $PM_{2.5}$ max 24-hr (µg/m³)

N

5 0 5km

Datum/Projection: GDA94/MGA Zone 54 Date: 14/07/2010



P:\RTA\Plans\SoE\2009\EIS Report Figures\Chapter9\Fig 9-7 PM Annual Average.wor

Township
Road/track
Tailings dam
Mining Years 1 -13
Mining Years 14 - 40

Objective for residences: 8 µg/m³

Rio Tinto Alcan

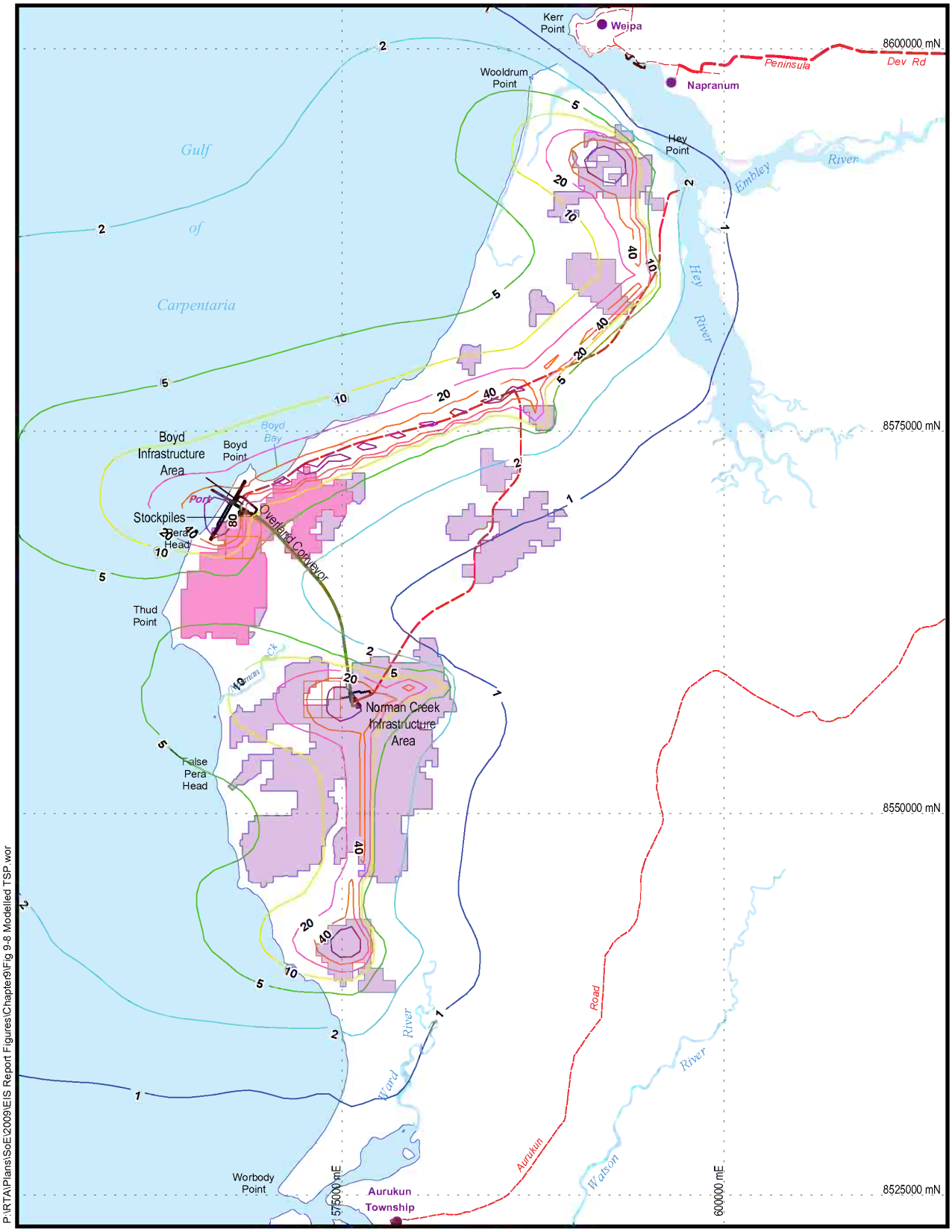
South of Embley Project

Fig. 9-7: Modelled $PM_{2.5}$ annual ave (µg/m³)

N

5 0 5km

Datum/Projection: GDA94/MGA Zone 54 Date: 14/07/2010



P:\RTA\Plans\SoE\2009\EIS Report Figures\Chapter9\Fig 9-8 Modelled TSP.wor

Township
Road/track
Tailings dam
Mining Years 1 -13
Mining Years 14 - 40
Objective for residences: 90 µg/m°

Rio Tinto Alcan

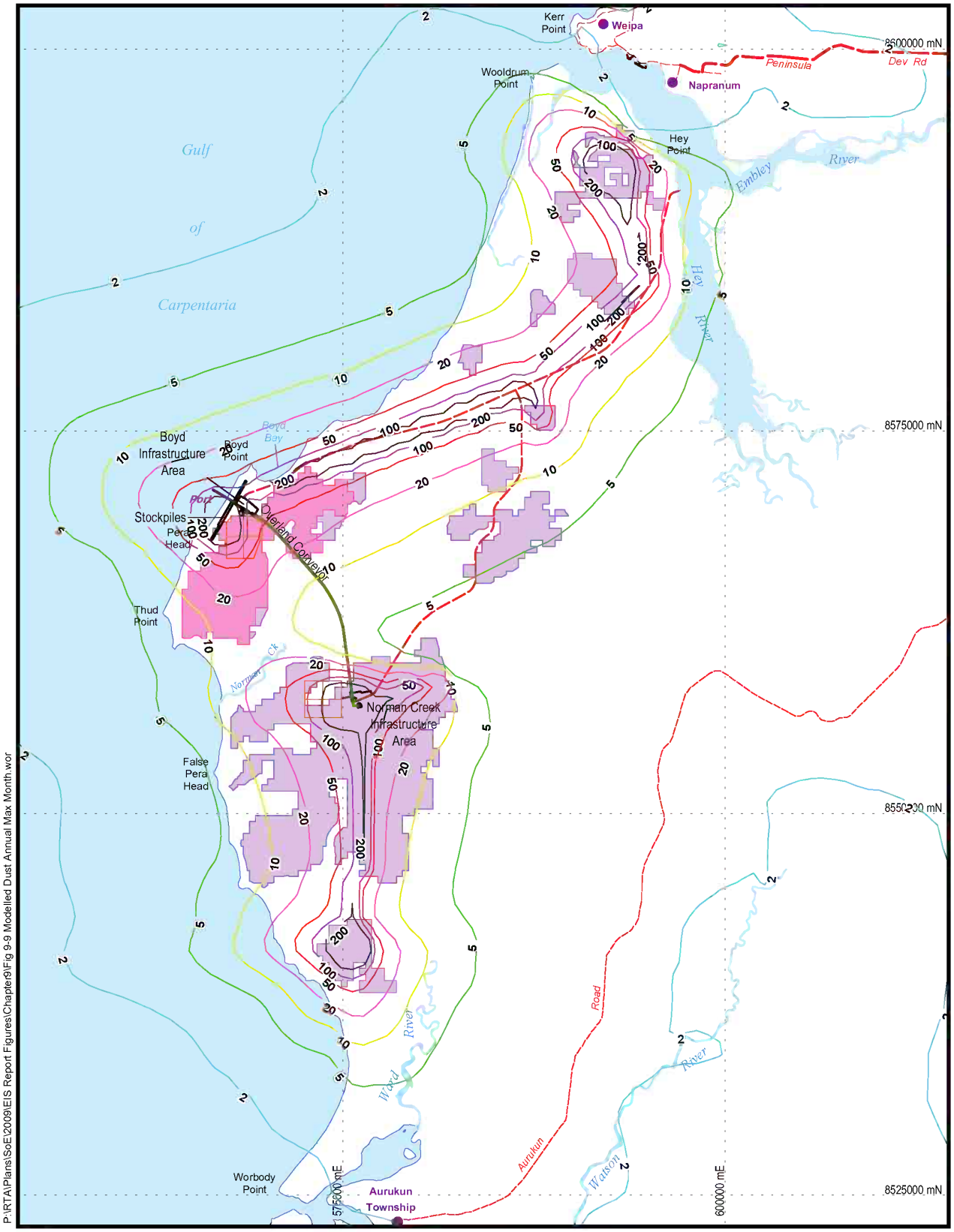
South of Embley Project

Fig. 9-8: Modelled TSP Annual Average (µg/m³)

N

5 0 5km

Datum/Projection: GDA94/MGA Zone 54 Date: 14/07/2010



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Township

Road/track

Tailings dam

Mining Years 1 -13

Mining Years 14 - 40

Objective for residences: 120 mg/m²/day

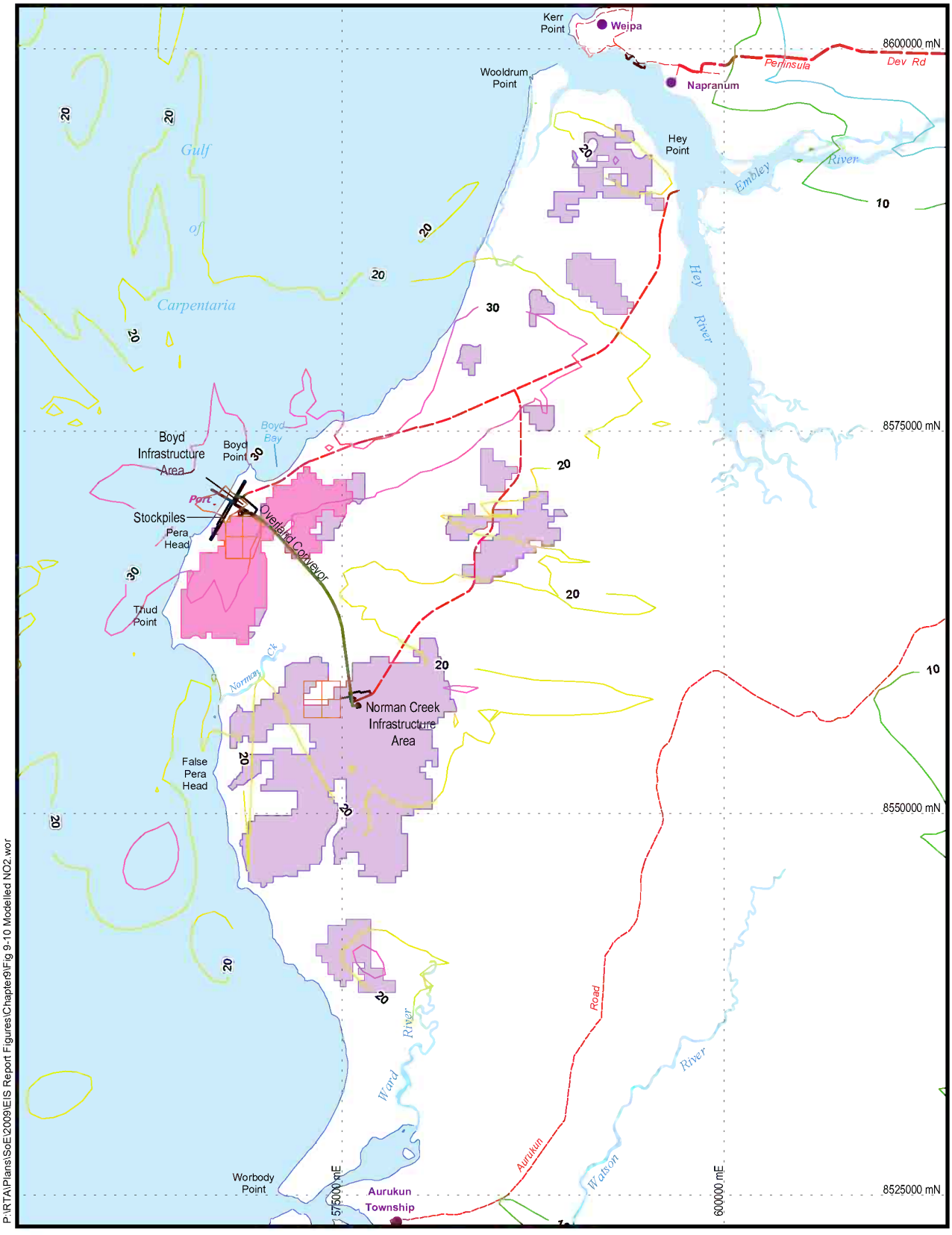
South of Embley Project

Fig. 9-9: Modelled Deposited Dust Annual Maximum Month (mg/m²/day)

N

5 0 5km

Datum/Projection: GDA94/MGA Zone 54 Date: 14/07/2010



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Township
Road/track
Tailings dam
Mining Years 1 -13
Mining Years 14 - 40

Objective for residences: 120ppb

Rio Tinto Alcan

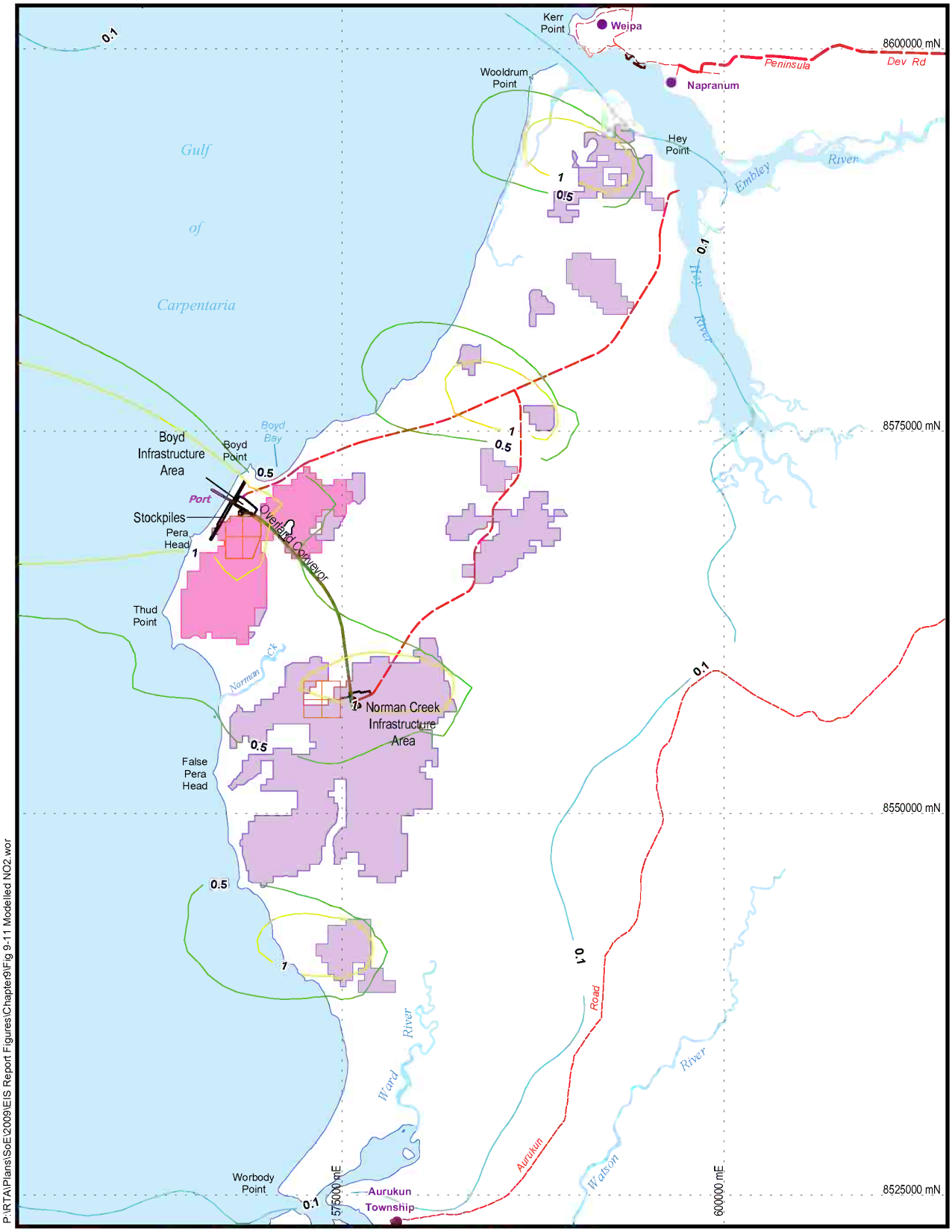
South of Embley Project

Fig. 9-10: Modelled NO_2 Maximum Hourly (ppb)

N

5 0 5km

Datum/Projection: GDA94/MGA Zone 54 Date: 14/07/2010



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Township
Road/track
Tailings dam
Mining Years 1 -13
Mining Years 14 - 40

Objective for residences: 30ppb
Objective for natural ecosystems: 16ppb

Rio Tinto Alcan

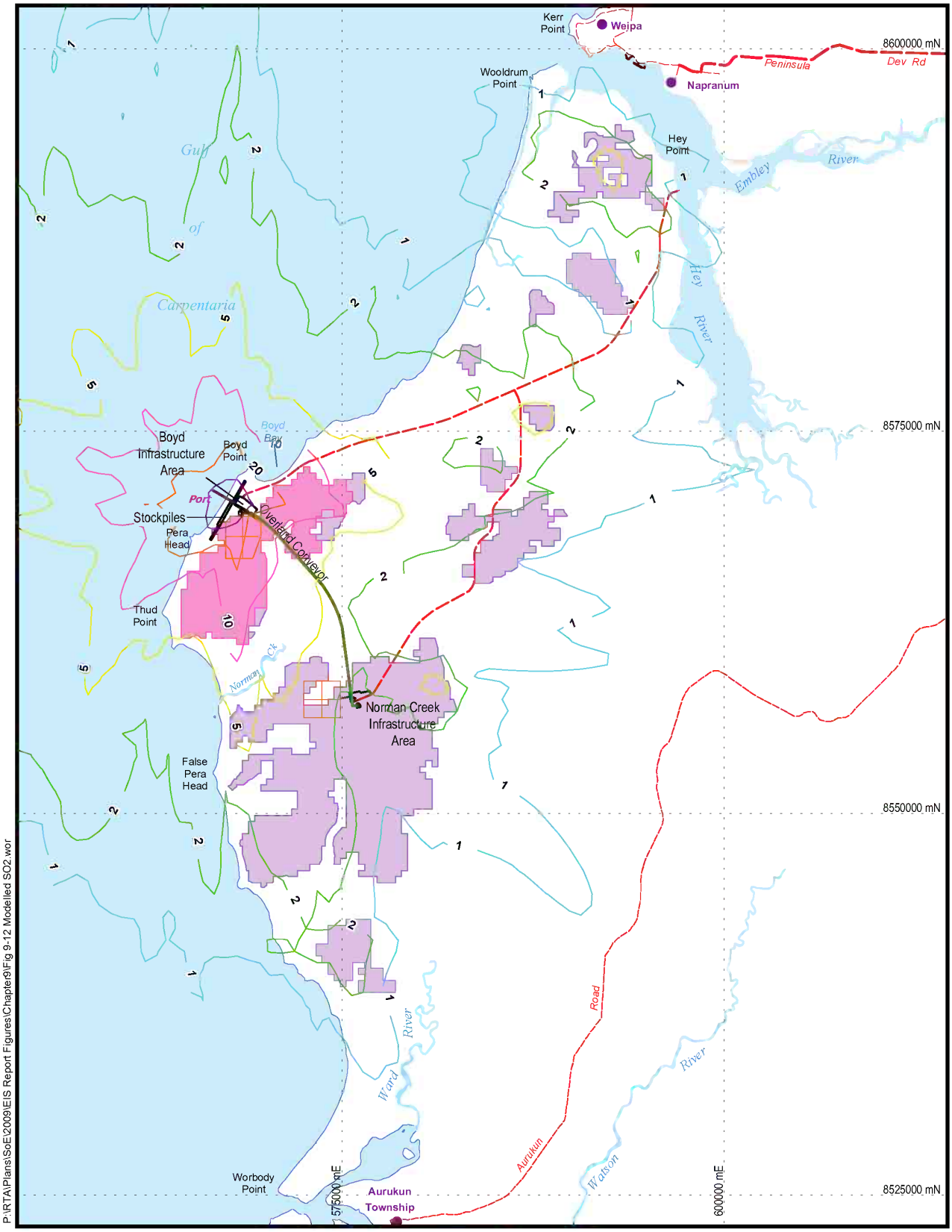
South of Embley Project

Fig. 9-11: Modelled NO_2 Annual Average (ppb)

N

5 0 5km

Datum/Projection: GDA94/MGA Zone 54 Date: 14/07/2010



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Township
Road/track
Tailings dam
Mining Years 1 -13
Mining Years 14 - 40
Objective for residences: 200ppb

Rio Tinto Alcan

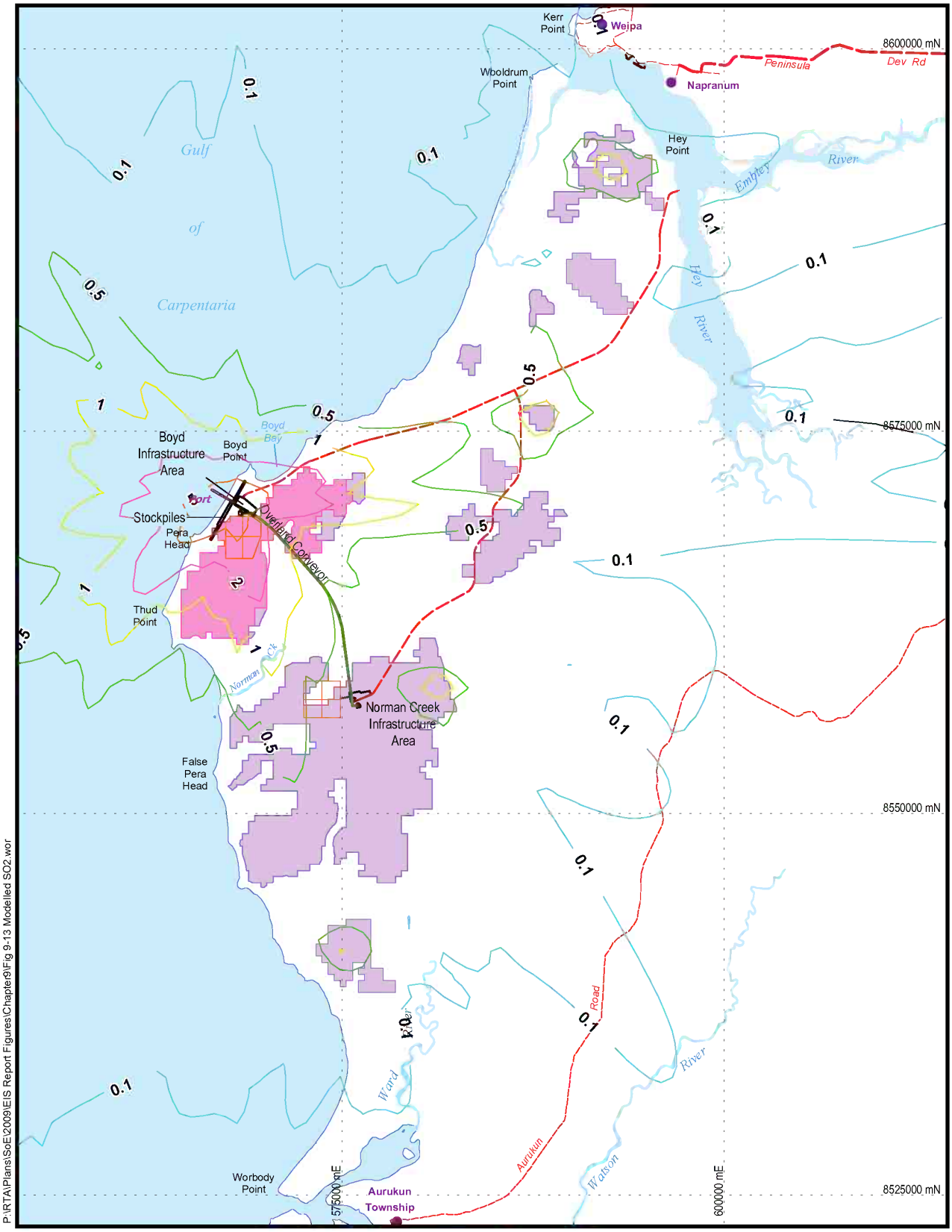
South of Embley Project

Fig. 9-12: Modelled SO_2 Maximum Hourly (ppb)

N

5 0 5km

Datum/Projection: GDA94/MGA Zone 54 Date: 14/07/2010



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Township
Road/track
Tailings dam
Mining Years 1 -13
Mining Years 14 - 40

Objective for residences: 80ppb

Rio Tinto Alcan

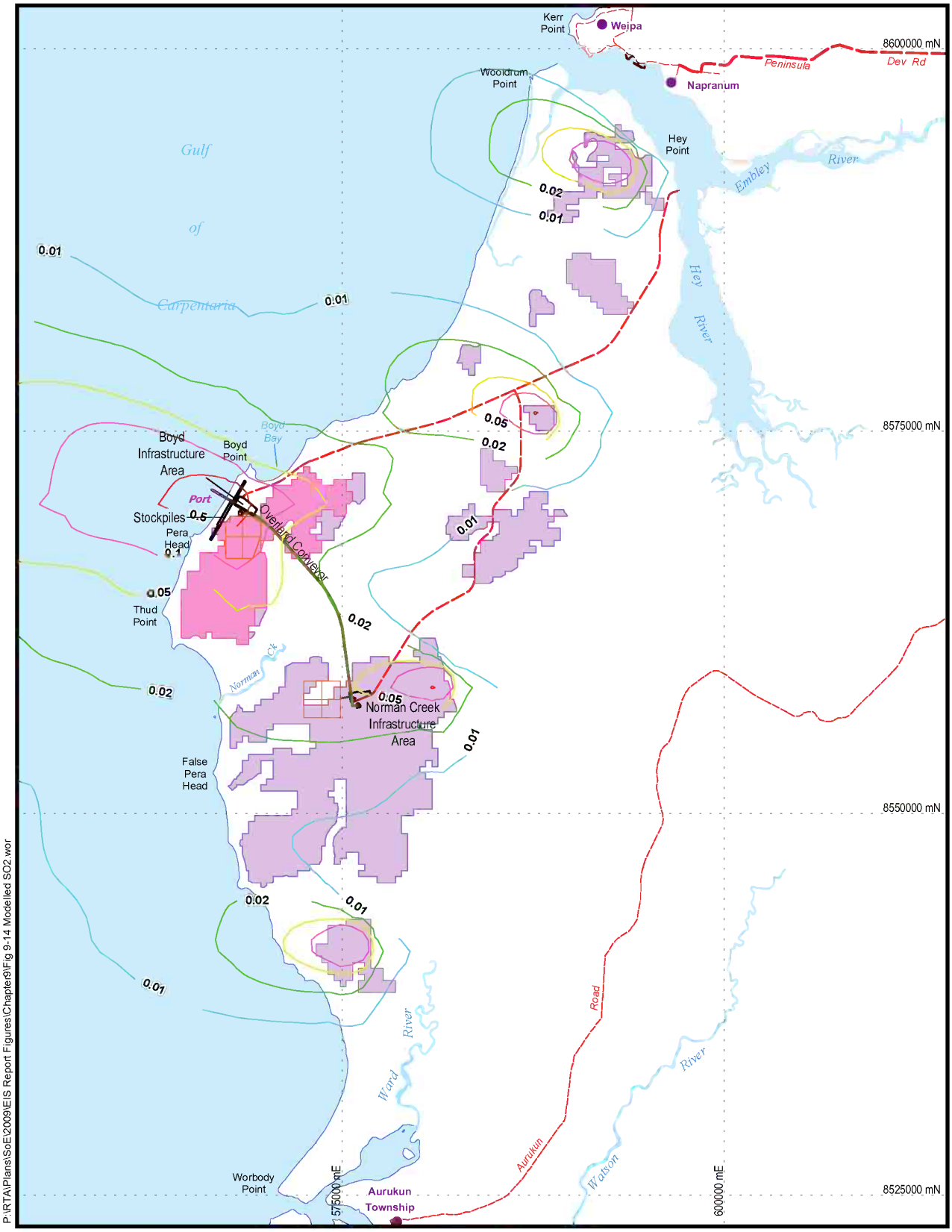
South of Embley Project

Fig. 9-13: Modelled SO_2 Maximum 1 Day (ppb)

N

5 0 5km

Datum/Projection: GDA94/MGA Zone 54 Date: 14/07/2010



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Township
Road/track
Tailings dam
Mining Years 1 -13
Mining Years 14 - 40
Objective for residences: 30ppb
Objective for agriculture: 11ppb
Objective for ecosystems: 7.5ppb

Rio Tinto Alcan

South of Embley Project

Fig. 9-14: Modelled SO_2 Annual Average (ppb)

N

5 0 5km

Datum/Projection: GDA94/MGA Zone 54 Date: 14/07/2010

9.5 Predicted Impacts and Mitigation Measures

The particulate emissions from the Project readily comply with all particulate air quality objectives at the nearest sensitive receptors.

The NO_2 and SO_2 concentrations from the Project comply with all air quality objectives at the nearest sensitive places.

9.5.1 Local Impacts

The impacts associated with the Project are entirely local. The modelling generally shows that the greatest impacts occur to the north-west of the operations. The dust concentration levels at sensitive receptors in Weipa, Napranum and Aurukun are expected to readily comply with all DERM guidelines.

The predicted NO_2 and SO_2 concentrations at all sensitive receptors (Weipa, Napranum and Aurukun) are much lower than the objectives to protect health and wellbeing. The predicted incremental increase to annual average NO_2 and SO_2 concentrations is zero at Weipa, Napranum or Aurukun as a result of the Project. In addition, the predicted annual increase does not exceed the EPP (Air) quality objectives for the protection of agriculture and natural ecosystems.

It is noted that the highest concentrations, as expected, occur close to the operations and within the mining lease.

The PM_{10} model indicates that the prevailing wind in the vicinity of the Embley River is easterly (parallel to the Embley River) and southerly winds rarely occur. However, at the southern end of the study area there are sufficient northerly winds to slightly increase the maximum PM_{10} concentrations at Aurukun above Weipa concentrations (refer **Figure 9-5**); however, the resulting concentrations are still well below the proposed criteria.

Levels of $PM_{2.5}$ are sensitive to winds that sustain direction and strength for an extended period of time (e.g. 24 hours). This is indicated as "lobes" in the contour lines shown on **Figure 9-6**, which are most noticeable in the 1 $\mu g/m^3$ contour. The lobes represent unusual winds and may only occur once or twice per year. For instance, in the north there are noticeable lobes to the north, north-east, and east, while in the south there are lobes to the east and south. These lobes represent unusual winds rather than high dust levels, since the total maximum 24-hour $PM_{2.5}$ concentrations are still less than 40% of the proposed criteria.

Modelled dust deposition levels in Weipa, Aurukun and Napranum from the Project are minor and likely to be no more than 1mg/m^2/day averaged over one month (51mg/m^2/day including ambient) for the highest month in a 12-month period (refer **Figure 9-9**). This readily complies with the dust deposition guideline.

Apart from the conventional haul road watering and water sprays on chutes where trucks dump crude ore at the beneficiation plant, which were incorporated into the modelling, no further mitigation measures are required. Water sprays would also be used to clean the ship-loading conveyor belt, which would reduce build-up of fine material.

9.5.2 Regional Impacts

The Project is situated in a remote region. Dust mostly falls out of the air within a few hundred metres of the source. The very fine dust fraction ($PM_{2.5}$) remains aloft for the longest period, yet even this dust quickly becomes less significant than the estimated regional ambient concentration. Therefore the northern Cape York regional air quality is not expected to deteriorate as a result of the Project.

The levels throughout the Project area and surrounding region are also lower than the EPP (Air) objectives to protect agriculture and health and biodiversity of ecosystems.

9.6 Greenhouse Gas Emissions and Abatement

This subsection provides an inventory of projected greenhouse gas (GHG) emissions for the Project and proposed abatement measures.

9.6.1 Projected Emissions

Methodology

The Department of Climate Change and Energy Efficiency delivers the majority of programs under the Australian Government's climate change strategy. The methods and emission factors contained within the *National Greenhouse Accounts (NGA) Factors* (DCCEE 2010a) workbook were used to calculate GHG emissions from the Project. The NGA factors are designed to estimate greenhouse gas emissions for reporting under various government programs, including the *National Greenhouse and Energy Reporting* (NGER) scheme.

The greenhouse gases covered by this assessment include: carbon dioxide (CO_2); methane (CH_4); nitrous oxide (N_2O); perfluorocarbons (PFC); hydrofluorocarbons (HFC); and sulphur hexafluoride (SF_6). The global warming potential is an index for each greenhouse gas which is used to convert emissions to carbon dioxide equivalents (CO_2-e). This allows the atmospheric warming effect of the different greenhouse gases to be compared.

The methodology for estimating the GHG inventory used the NGA Factors listed below.

- Scope 1 emissions – or direct emissions at point of release for diesel electricity generation – were calculated using the factors of 38.6 gigajoule per kilolitre (GJ/kL) and 69.2 kilograms of carbon dioxide equivalents per gigajoule (kg CO_2-e/GJ).
- Scope 1 emissions – or direct emissions at point of release for diesel for transport – were calculated using the 2.7 tonnes CO_2-e/kL factor.

The biomass carbon for the Weipa eucalypt tall open forest to be cleared ahead of mining was estimated as 44.5 tonnes/ha cleared using Full Carbon Accounting Model, a tool within the National Carbon Accounting Toolbox (AGO 2005).

An average growth rate of 1.07t carbon/ha/year was assumed for Weipa eucalypt tall open forest revegetation in the Project area, which has been derived for the area based on productivity rates in the Weipa region using default values from the National Carbon Accounting Toolbox (AGO 2005).

Note that while vegetation clearing and revegetation has been included in the greenhouse gas assessment for completeness, land management is not included under NGER and therefore would not be the subject of annual reporting under the NGER scheme.

Inputs

This GHG assessment accounts for direct Scope 1 emissions for the three production scenarios of 15Mdptpa, 30Mdptpa and 50Mdptpa.

Primary sources of GHG emissions included in this assessment are:

- the on-site generation of electricity (diesel-fired power station) which is used to power the beneficiation plants, conveyors, stackers, reclaimers and shiploader, as well as support facilities such as the water treatment plant, pumps, workshops, and offices;
- heavy vehicle transport (diesel) including mobile equipment for mining bauxite and haulage; and
- vegetation clearing prior to mining.

Secondary sources of GHG emissions include:

- light vehicles and buses (diesel);
- barge and ferry movements (diesel); and

- a proportion of the fuel used in the existing Lorim Point power station to power Project support facilities located in Weipa. Half of the emissions attributable to electricity use in warehouses, offices, residences and commercial premises in Weipa have been included in Project emissions at 15Mdptpa increasing to 100% at 30 and 50Mdptpa.

The CO_2 absorbed by vegetation in rehabilitation areas has been subtracted from the calculated emissions.

To minimise on-site generation of electricity, the following energy efficiency measures have been adopted to increase energy efficiency:

- generating power at the load source to avoid transmission line losses;
- reducing height in the beneficiation plants minimising the energy needed to lift ore;
- fit for purpose design (lower excess capacity margins to reduce unused electric motor capacity) resulting in higher electrical efficiency (power factor); and
- High-density polyethylene (HDPE) tailings line to reduce pumping energy due to lower friction losses.

Emissions

A summary of the projected GHG emissions is shown in **Table 9-9**. The estimate of emissions from all Project components at 50Mdptpa production is 508kt CO_2-e per annum. By comparison, GHG emissions in Australia were estimated to be 537,000kt CO_2-e in 2009 (DCCEE 2010b) and 181,000kt CO_2-e from Queensland in 2007 (DERM 2009d).

Greenhouse gas emissions vary considerably from year to year at the current Weipa operations, depending on production rate and activities carried out (e.g. the amount of land clearing). The amount of land cleared per tonne of ore is higher at Andoom and East Weipa operations than it would be for the Project due to thinner bauxite layers.

Table 9-9 Projected Annual Energy Use and Greenhouse Gas Emissions

	Source	Units	Production rate		
			15Mdptpa	30Mdptpa	50Mdptpa
Input Data	Diesel used for power generation*	kL	26,100	46,100	70,100
	Diesel used for transport	kL	11,700	23,100	38,400
	Cleared land	ha	500	850	1,360
	Rehabilitated land	ha	290	850	1,360
Greenhouse Gas Emissions	Power generation	t CO_2-e	69,740	121,100	187,400
	Transport	t CO_2-e	31,600	62,300	103,500
	Vegetation cleared	t CO_2-e	81,700	138,800	222,100
	Less vegetation sink (rehabilitation)	t CO_2-e	1,100	3,300	5,300
	Annual Total	t CO_2-e	181,840	318,900	507,700
	Intensity	t CO_2-e / t bauxite	0.0121	0.0106	0.0102

* Includes electricity supply for Weipa, which would be supplied from the existing East Weipa power station.

Note: Conversion factors and methodology described in DCCEE (2010a)

Environmental Impact Statement

for South of Embley Project

Section 10

Noise and Vibration

10 NOISE AND VIBRATION

This section provides an assessment of noise impacts based on current Queensland guidelines. This assessment considers the construction phase as well as ongoing mining, processing and ship-loading operations. This assessment is based on three mine production rates, namely:

- 15 million dry product tonnes per annum (Mdptpa);
- 30Mdptpa; and
- 50Mdptpa.

There are no significant vibration sources associated with the operations. The operations do not require that blasting be carried out. Nor are there any vibration sensitive receptors within or close to the lease area. As a result, vibration issues will not be addressed further.

10.1 Existing Noise Environment

10.1.1 The Land Environment

An environmental noise survey was conducted in Evans Landing, adjacent to the Department of Primary Industries Fisheries building. This site was considered to be representative of the residential areas along the Embley River, namely Napranum and the accommodation areas in Evans Landing, which would be the nearest sensitive receptors to the Project area (refer **Figure 9-1**). The measured noise levels are shown in **Table 10-1**. The noise levels recorded at Evans Landing included noise from recreational boating and activities in the boat ramp car park. During the night, noise from the Lorim Point ship loader was noted. No rain fell during the monitoring period, which was hot and dry. There were light winds, mostly from the east, during the day and the nights were still.

The noise level survey was carried out using a calibrated Rion NL-22 sound level meter in accordance with AS1055.1 and AS1055.2. The equipment was configured to record the fast "A" weighted noise levels over a period of one week. The noise levels in **Table 10-1** are expressed in terms of the $L_{A90\ (1\ hour)}$, $L_{Aeq\ (1\ hour)}$ and the $L_{Aeq\ (24\ hour)}$. The L_{Aeq} is the average noise energy during a measurement period. The L_{A90} is the noise level that is exceeded 90% of the time and is commonly referred to as the background noise level.

By way of comparison, the results of an earlier survey commissioned by RTA at Nanum are presented in **Table 10-2** (Moore and Associates 2007). Nanum is approximately 3km north of Evans Landing and closer to Weipa.

The results of the noise monitoring for both Nanum and Evans Landing are similar. The background noise levels are almost identical, while the $L_{Aeq\ (1\ hour)}$ shows that Evans Landing is exposed to slightly higher overall noise levels.

Table 10-1 Environmental Noise Survey at Evans Landing

Date	$L_{A90\ (1\ hour)}$ Background Noise Level [dB(A)]			$L_{Aeq\ (24\ hour)}$ [dB(A)]	$L_{Aeq\ (1\ hour)}$ Noise Level [dB(A)]		
	Day	Evening	Night		Day	Evening	Night
17 September 2008	—	37	37	—	—	52	47
18 September 2008	41	37	35	51	54	48	45
19 September 2008	40	38	36	48	50	46	48
20 September 2008	40	38	37	50	53	46	45
21 September 2008	43	41	42	53	54	56	49
22 September 2008	41	38	38	53	55	50	47
23 September 2008	42	34	39	51	53	45	48
24 September 2008	39	—	—	49	52	—	—
Median Level	41	38	38	51	53	48	47

— No data

Table 10-2 Environmental Noise Survey at Nanum

Date	$L_{A90\ (1\ hour)}$ Background Noise Level [dB(A)]			$L_{Aeq\ (24\ hour)}$ [dB(A)]*	$L_{Aeq\ (1\ hour)}$ Noise Level [dB(A)]		
	Day	Evening	Night		Day	Evening	Night
19 July 2007	42	39	36	47	48	50	42
20 July 2007	38	38	35	45	46	46	41
21 July 2007	38	38	38	47	48	45	42
22 July 2007	37	40	37	44	42	53	42
23 July 2007	41	40	36	49	48	50	42
24 July 2007	40	38	37	46	47	45	43
25 July 2007	40	38	38	48	49	45	43
Median Level	40	38	37	47	48	46	42

* $L_{Aeq(24\ hour)}$ not provided in data provided by RTA but estimated from results

10.1.2 The Underwater Environment

The noisy background environment must be considered when evaluating the various noise sources and their impacts on the marine environment (SVT, 2009). Ambient underwater noise levels are frequency dependent, as follows (SVT, 2009):

- seismic activity is in the first 10 Hz;
- shipping and meteorological effects, including rain and wind, dominate the spectrum from 10 to 100 Hz;
- wave action, rain and wind dominate the spectrum up to almost 100 kHz; and
- molecular thermal effects dominate above 100 kHz.

10.2 Guidelines, Policies and Legislation

10.2.1 Environmental Protection (Noise) Policy 2008

The *Environmental Protection (Noise) Policy 2008* (Qld) (EPP (Noise)) came into effect on 1 January 2009 and sets out a framework for:

- identifying environmental values for the acoustic environment;
- setting acoustic quality objectives for sensitive receptors;
- avoiding, minimising or managing noise; and
- controlling background creep.

Schedule 1 of the EPP (Noise) contains acoustic quality objectives for sensitive receptors, including dwellings, hospitals, schools and parks.

For dwellings, the acoustic quality objectives are expressed as indoor noise level goals at Night (10pm to 7am) and indoor and outdoor noise level goals during the Day (7am to 6pm) and Evening (6pm to 10pm). The EPP (Noise) also includes acoustic quality objectives for critical habitats (as defined in a conservation plan under the *Nature Conservation Act 1992* (Qld) and marine parks under the *Marine Parks Act 2004* (Qld)). These objectives are shown in **Table 10-3**.

When setting limits it is not intended that the acoustic environment be permitted to deteriorate and this is achieved by controlling background creep. To the extent that it is reasonable to do so, noise from an activity must not be:

- for noise that is continuous noise measured by $L_{A90,T}$ – more than nil dB(A) greater than the existing acoustic environment measured by $L_{A90,T}$; or
- for noise that varies over time measured by $L_{Aeq,adj,T}$ – more than 5dB(A) greater than the existing acoustic environment measured by $L_{A90,T}$.

Table 10-3 EPP (Noise) Acoustic Quality Objectives

Location	Time of Day	Acoustic Quality Objectives (measured at the receptors) dB(A)			Environmental Value
		$L_{Aeq, adj, 1 hr}$*	$L_{A10, adj, 1 hr}$*	$L_{A1, adj, 1 hr}$*	
Dwelling outdoors	Day & Evening	50	55	65	Health and wellbeing – for outside areas
Dwelling indoors	Day & Evening	35	40	45	Health and wellbeing – for indoor areas
Dwelling indoors	Night	30	35	40	Health and wellbeing in relation to the ability to sleep
Protected area, or an area identified under a conservation plan under the *Nature Conservation Act 1992* as a critical habitat or an area of major interest	Anytime	The level of noise that preserves the amenity of the existing area or place			Health and biodiversity of ecosystems
Marine park under the *Marine Parks Act 2004*	Anytime	The level of noise that preserves the amenity of the existing area or place			Health and biodiversity of ecosystems

* $L_{Aeq,adj,1hr}$ is the A-weighted sound pressure level of a continuous steady sound, adjusted for tonal character, that within a 1-hour period has the same mean square sound pressure of a sound that varies with time.

L_{A10} and L_{A1} is the A-weighted sound pressure level, adjusted for tonal character or impulsiveness, which is exceeded for 10% and 1% respectively of the 1-hour measurement period.

10.2.2 DERM Ecoaccess Guideline - Low Frequency Noise

DERM's Ecoaccess Guideline *Assessment of Low Frequency Noise* categorises items such as boilers, pumps, transformers, cooling fans, compressors, oil and gas burners, foundries, wind farms, electrical installations, diesel engines, ventilation and air-conditioning equipment, wind turbulence and large chimney resonance as noise sources that have a proportionally high level of frequency content less than 200Hz.

These sources exhibit a spectrum that characteristically shows a general increase in sound pressure level with decrease in frequency. Annoyance can be caused by low frequency noise even though the total noise level measured is relatively low. Typically, annoyance is experienced in the otherwise quiet environs of residences adjacent to, or near, low frequency noise sources. Generally, low frequency noises become annoying when the masking effect of higher frequencies is absent.

This loss of high frequency components may occur as a result of transmission through the fabric of a building or in propagation over long distances. Where a noise emission exhibiting unbalanced frequency spectra occurs, the overall sound pressure level inside residences should not exceed 50dB (Linear) to avoid complaints of low frequency noise annoyance.

10.2.3 enHealth Guideline – Health Effects of Environmental Noise

The enHealth Council (2004) Guideline *The Health Effects of Environmental Noise – Other than Hearing Loss* provides a review of the health effects (other than hearing loss) of environmental noise and reviews measures aimed at the management of environmental noise. The document addresses annoyance and quality of life, sleep disturbance, low frequency noise, performance

and learning with school children, cardiovascular disease, mental health and neuro-physiological stress. The goals adopted in this report address all relevant aspects of this document

10.2.4 Proposed Noise Level Criteria for Human Receptors

The proposed noise level criteria for the Project have been derived taking into consideration the acoustic quality objectives for health and wellbeing as well as the control of background creep. The criteria are expressed as outdoor noise levels, measured 4m from dwellings.

The EPP (Noise) indoor noise quality objectives for health and wellbeing at dwellings have been adjusted so they can all be expressed as outdoor noise levels and are presented in **Table 10-4**. The equivalent external noise levels measured at least 4m from the residence would be 5dB higher, and therefore the indoor criteria for health and wellbeing has been adjusted by 5dB to allow comparison for measurements to be undertaken outdoors.

It is not uncommon for bedrooms in tropical areas to be air-conditioned. For air-conditioning to be effective it is necessary to keep the windows closed. Having the windows closed further reduces outside noises and the reduction of external noise from outside to inside can be as high as 20dB; i.e. the equivalent external noise levels measured at least 4m from the residence would be 20dB higher than the acoustic quality objectives noted in **Table 10-3**. However, for the purposes of this assessment, it is conservatively assumed that the residences have open windows.

Table 10-4 Adjusted Acoustic Quality Objectives for Dwellings

Location	Time Period	Acoustic Quality Objectives [dB(A)]		
		$L_{Aeq,\ 1\ hour}$	$L_{A10,\ 1\ hour}$	$L_{A1,\ 1\ hour}$
4m from Residential Receptors	Day and Evening	50	55	65
	Day and Evening*	40	45	50
	Night*	35	40	45

* indoors criteria adjusted for outdoors by adding 5dB

It is difficult to model the L_{A10} and the L_{A1} since there is no accurate calculation method available. Since the noise sources are not of very short duration but occur throughout the monitoring period it is expected that if the L_{Aeq} goals are met then the L_{A10} and L_{A1} would be met as well. As a consequence it is not proposed to model or report either the L_{A10} or L_{A1}.

The noise level criteria to avoid background creep is based on the median background level measured at Evans Landing and are shown in **Table 10.5.** The noise from most plant and equipment at the Project varies over a short time period. Furthermore, the noise propagation characteristics over large distances always results in fluctuating noise levels. Since all the noise sensitive locations are located at large distances from the operations it was considered reasonable to apply the limits for time variable noise. The noise level criteria to avoid background creep have been calculated using the method specified in the EPP (Noise) and is equal to $L_{Aeq,T} = L_{A90,T} + 5$ dB(A). The $L_{A90,T}$ is the median background noise level calculated in **Table 10.1**.

Table 10-5 Calculated Noise Levels to Avoid Background Creep in Residential Areas

Location	Noise Level to Avoid Background Creep $L_{Aeq,\ 1\ hour}$ [dB(A)]		
	Day	Evening	Night
4m from Residential Receptors	46	43	43

It is noted that the noise level criteria to avoid background creep are higher than the indoor acoustic quality objectives for health and well-being (adjusted for outdoors) (refer **Table 10-4**). This is due to the existing noise levels being considerably higher than the acoustic quality objectives.

The "acoustic quality objectives" seek to protect the amenity of an acoustic environment. The indoor night-time objectives effectively address sleep disturbance and sleep awakenings, while during the day the objectives protect conversation. The acoustic quality objectives are not individual point source emission standards but are total levels of noise in the surrounding environment. Currently the existing ambient levels are much higher than the acoustic quality objectives.

The controlling background creep objective seeks to avoid intrusiveness. When setting limits it is not intended that the acoustic environment be permitted to deteriorate and this is achieved by controlling background creep.

Thus the noise level criteria proposed for the project are designed to avoid background creep and are shown in **Table 10-6**.

Table 10-6 Proposed Noise Level Criteria for Residential Areas

	Noise Level Criteria to Avoid Background Creep [$L_{Aeq,\ 1\ hour}$ dB(A)]			Low Frequency Noise [$L_{eq,\ adj,\ 1\ hr}$ dB(Linear)]
Time Period	**Daytime**	**Evening**	**Night**	**Night**
Measured 4m from Residential Receptors	46	43	43	50

10.2.5 Sensitivity of Fauna to Noise

There are no designated Marine Parks or Protected Areas in the vicinity of the Project area, and therefore the objectives provided by the EPP (Noise) are not relevant to the Project.

There are no other regulatory criteria relating to noise impacts on terrestrial or marine animals. Sensitivities to noise vary among species and potential effects also depend on a number of factors including the type of noise, whether or not the noise source is stationary or moving, or if it is constant or sporadic.

Underwater noise is likely to occur as a result of construction of the proposed port, tug berths and barge/ferry terminals (predominantly due to pile driving activities), and later in operation of these facilities. The marine animals expected to occur in the vicinity of the Project area are described in **Section 6.6**. Marine turtles and mammals, such as whales, dolphins and dugongs, are known to be sensitive to underwater noises that are louder (greater intensity) than normal background levels. It should be noted that underwater noise is converted to the decibel ratio using a reference pressure of one micro-Pascal (µPa). In air the reference pressure is 20µPa. Thus sound pressure underwater would appear to be 26dB greater than the equivalent pressure in air due to the difference in the reference pressures.

No study to date has shown injury in marine mammals from pile driving (Erbe 2009). However, physical damage to the auditory system of dolphins and whales, which is understood to be the onset of permanent threshold shift, may occur at noise levels of greater than 230dB re 1µPa (Gausland 2000, Erbe 2009, SVT 2009).

Temporary threshold shift in mid-frequency cetaceans was observed at 224dB re 1 µPa at a sound exposure level (SEL) of 183dB re 1µPa^{2}s (Erbe 2009). These same levels were recommended by Southall *et al.* (2007) as criteria for temporary threshold shift in dolphins. Avoidance behaviour begins to occur at around 110–130dB re 1µPa (McCauley 1994).

There is lack of data to determine injury thresholds (including temporary threshold shift) for low frequency sensitive mammals (e.g. brydes whale). However it is recommended that injury and avoidance threshold levels for mid-frequency sensitive mammals (e.g. dolphins) be accepted for low-frequency mammals (SVT 2009, Southall *et al.* 2007). SVT (2009) proposed that the

criteria for seismic survey activities be accepted for piling activities due to the lack of known avoidance thresholds for piling. The relevant criteria proposed were:

- possible physical injury may occur at peak pressure levels greater than 230dB re 1 μPa at a sound exposure level (SEL) of 198dB re 1μPa^{2}s; and
- avoidance behaviour was estimated to occur at peak pressure levels greater than 224dB re 1 μPa at a SEL of 160dB re 1μPa^{2}s;

SVT (2009) conducted underwater noise modelling and assessment for pile driving activities proposed for the Cape Lambert Port B Development in Western Australia. The following conclusions were made regarding marine turtles:

- physical injury would be likely to occur at peak pressure levels greater than 222dB re 1μPa at a sound exposure level (SEL) of 198dB re 1μPa^{2}s;
- hearing damage may occur at peak pressure levels greater than 222dB re 1μPa;
- avoidance behaviour was estimated to occur at peak pressure levels greater than 120dB re 1μPa based on the auditory bandwidth of turtles; and
- there is no supporting literature to establish acceptable levels of continuous noise to prevent threshold shift in marine turtles.

Underwater noise criteria have not currently been developed specifically for Dugong to manage potential temporary threshold shift. However previous anatomical studies of dugong suggest that their overall hearing sensitivity would likely to be less than that of dolphins. Therefore adopting the same underwater noise criteria for Dugongs as for dolphins, would provide a conservative management basis for Dugongs.

As there is no critical breeding or feeding habitat for these species close to the construction areas, an avoidance response is unlikely to have a significant impact.

10.3 Noise Sources

The main activities associated with the Project comprise:

- Construction of mine facilities, beneficiation plant and supporting infrastructure
- Clearing for mining
- Soil stripping and overburden removal (mine development)
- Mining
- Truck and conveyor haulage
- Process plant and stockpiling
- Power generation
- Ship loading
- Barge and ferry transport
- Mine rehabilitation.

Construction of the mine facilities and beneficiation plants consist of earthworks, erection of buildings and structures, and installation of plant and equipment. The construction of the proposed port would involve dredging and driving more than two hundred 800–1200mm raked steel piles for the wharf into the sea floor in a manner similar to that which has been previously carried out at the Port of Weipa. The construction of the ferry/barge terminals are comparatively minor building works (including limited piling of 600mm piles). Once the terminals are constructed, the operation of the ferry and barge would be a potential noise source.

Land clearing involves the pushing over of trees and other vegetation with a bulldozer during the dry season. Land clearing, like mine rehabilitation, is considered a minor noise source.

Following removal of the vegetation, topsoil is stripped using front-end loaders or scrapers. Overburden is then loaded into haul trucks, with front-end loaders. Typically these development activities take place close to the active mining areas.

Mining comprises the extraction of bauxite by front-end loader and loading haul trucks. The trucks travel to the dump station situated close to the beneficiation plant. In each development area there is a fleet of loaders and trucks stripping and placing overburden. In each mining area there are likely to be several loaders and a fleet of haul trucks.

The mine industrial area comprises the beneficiation plant (including crushers), conveyors, power station and stacker/reclaimers. Ships are loaded via a dedicated ship loader fed by a conveyor from the stockpile.

10.3.1 Plant and Equipment Sound Power Survey

The sound power levels for the plant and equipment proposed for the operational aspects of the Project was obtained by measuring similar equipment at the current RTA operations. These measurements were obtained during September 2008 using a calibrated Norsonic NOR118 real-time 1/3 Octave band analyser in accordance with AS 1055.1, 1997 Acoustic – Description and Measurement of Environmental Noise Part 1: General Procedures and Part 2: Application to Specific Situations. A summary of the measured noise levels is presented in **Table 10-7**.

Rear dump trucks operate between the development area and the recently mined areas. This is a relatively short journey as the development operations are normally closely followed by mining. For mining areas, haul trucks are expected to operate between the mining areas and the dump station. However, for the more remote mining areas, prime movers with multiple trailers or side dump trucks are likely to be employed.

10.3.2 Underwater Noise from Pile Driving

Noise emitted from a pile during pile driving operations is a function of its material type, its size, the force applied to it and the characteristics of the substrate into which it is being driven. The action of driving the pile into the sea floor would create a mixture of compression and transverse waves within the pile. The transverse waves would propagate into the ocean while the compression waves would propagate into the sea floor (SVT 2009).

Most of the energy from pile driving activities would normally transfer into the sea floor. Once in the sea floor, the energy would then move outwards. The waveform normally generated from pile driving activities produces a substantial peak Sound Pressure Level (SPL). However, the pulse duration and pulse rise time during pile driving activities is longer than that of an explosion. As a result, the effect of a pile driving activities on marine fauna would not be as damaging as a pulse from an explosion of equal peak SPL (SVT 2009).

The piles that would be used for the construction of the port would range from 329mm to 1050mm in diameter. Approximately 300 piles would be used. A hydraulic piling hammer would be used for pile driving. The hammer would be sized according to seabed geotechnical conditions. Preliminary investigations indicate that a hammer between 30 tonnes and 45 tonnes would be required. Drilling may also be used to install some piles, which would reduce the noise impact.

The piles used for the ferry and barge terminals would be 600mm in diameter. There would be 14, 10, and 20 piles for Humbug, Hornibrook and Hey River Terminals respectively. The hammer size would be smaller than that required for the Port. Approximately 28 piles (610mm - 1050mm) would also be required for navigational aids.

Pile driving activities would closely follow the completion of dredging activities and may occur at any time of the year.

Table 10-7 Summary of Sound Power Levels for Operational Noise Sources

Source	Configuration when measured	Octave Sound Power Level [dB] in Octave Band Centre Frequency (Hz)								Overall Sound Power Level [dB(A)]	Sound pressure level at 100m [dB(A)]
		63	125	250	500	1000	2000	4000	8000		
Rear dump truck	20km/h laden	109	109	113	119	118	118	120	126	128	80
	40km/h laden (estimate)	112	112	116	122	121	121	123	129	131	83
Prime mover (with multiple trailers)	40km/h laden	121	120	118	112	110	105	100	97	115	67
	40km/h unladen	132	119	116	110	108	106	105	110	116	68
Loader	Development area (low work rate)	118	118	111	105	107	104	97	88	111	63
	Development area (normal work rate)	121	123	120	117	110	106	100	93	118	70
	Mining area	111	107	100	98	104	98	92	88	106	58
Grader	20km/h	114	109	107	106	108	104	101	100	112	64
Water truck (note 1)	20km/h	105	112	108	109	109	107	101	93	113	65
Bulldozer	Mine rehabilitation area	123	122	120	115	115	112	108	100	120	72
	Stockpile (bauxite)	128	123	119	118	118	115	109	104	122	74
Conveyor	(per 100m overland)	111	112	106	110	106	103	97	90	111	66
	(per 100m on wharf)	114	112	111	115	110	104	100	92	115	70
Conveyor Drives	Land based	105	105	108	111	105	99	96	90	110	62
	Wharf based	99	100	107	116	102	96	90	87	113	65
Beneficiation plant	Overall	124	122	116	115	111	109	106	101	117	69
Power station (22MW)	Overall	122	119	107	101	95	99	96	88	108	60
Ship	Housing noise from boiler	117	109	112	116	109	108	111	106	118	70
Barge/Ferry*	Diesel engine 1200kW with mufflers	117	119	115	109	107	102	93	85	112	64

* Noise levels obtained from previous studies or calculated from first principles

10.4 Noise Modelling

Noise Model

A digital terrain noise model of the site and surroundings has been developed using PEN3D. The PEN3D General Prediction Model (GPM) is based on the method by Bies and Hansen (1988).

The PEN3D software was originally developed in 1993 and has been in constant development and review. The basic equation adopted by the GPM is:

$$Lp = Lw - 20\log_{10}(r) - 10\log_{10}(4\pi) + AE$$

Where:

- Lp is the sound pressure level at an observer
- Lw is the sound power level of the source
- $20\log_{10}(r) + 10\log_{10}(4\pi)$ is the distance attenuation (spherical)
- AE is the excess attenuation factor

The excess attenuation factors (AE) comprise:

$$AE = Aa + Ag + Am + Ab + Af$$

Where:

- Aa = excess attenuation due to air absorption
- Ag = excess attenuation due to ground reflection
- Am = excess attenuation due to meteorological effects
- Ab = excess attenuation due to barriers
- Af = excess attenuation due to forests.

The noise model developed for this Project incorporates three-dimensional terrain data. Since there is considerable coverage of natural vegetation, the noise model also incorporates the noise attenuation effects from tree zones. The effects of the tree zones are minimal within approximately 500m of the haul roads and conveyors and within approximately 1,250m of the bauxite processing, mining and development areas. It should be noted that the noise attenuation effect from tree zones is typically minor at night or down-wind since the noise adopts a downward curved path, well above the height of the trees. However, under neutral conditions, or upwind, the attenuation effects can be substantial.

Meteorology

The meteorology for Weipa was reviewed (refer **Section 9.4.1**) and four representative modelling cases were developed where meteorological conditions may be expected to lead to elevated noise levels in Weipa and Napranum. The modelling cases are summarised in **Table 10-8**. Each of these modelling cases occurs at least 10% of the time over the duration of a year.

Table 10-8 Noise Modelling Cases

Modelling Case Name	Wind Speed [m/s]	Wind Direction [degrees]	Vertical temperature gradient [°C/100m]	Temperature [°C]	Humidity [%]	Stability Class
Day	3.0	125	–1	27	75	C
Evening	2.3	129	1	24	75	E
Night	0	0	2	22	75	F
Night with Wind	2.6	113	2	22	75	E

10.4.1 Construction

During the construction phase of the Project the most significant sources would be the construction of the proposed port and the ferry and barge terminals. Construction sounds that have the potential to affect both human receptors and marine animals include pile-driving and jack hammers.

The proposed port is approximately 38km from Weipa. The Hornibrook ferry terminal is more than 1km from Napranum and the Humbug barge terminal is more than 1km from Evans Landing. It is therefore unlikely there would be significant impact to sensitive human receptors as a result of construction of these facilities and these impacts have not been modelled.

Underwater noise generated by piling has the potential to impact individual marine animals, however the potential impact of Project pile driving activities on threatened and migratory species is considered low. Although the areas where pile driving activities would be conducted may be traversed by some species, or utilised by some species for foraging, there is no critical breeding or feeding habitat for these species (refer **Table 6.34**) close to these construction areas. Specific quantitative analysis has not been conducted on the potential underwater impacts on threatened marine fauna associated with pile driving activities. However a number of recent studies have been conducted on this subject, the results of which are summarised below.

Measurements taken at the Port of Melbourne during piling in 13m of water with cylindrical steel piles found that the mean sound pressure level underwater was 179dB re 1µPa at 30m and 170dB 1µPa at 206m (McCauley 2008). Measurements taken by Erbe (2009) during pile driving activities (750mm and 1500mm diameter piles) in Moreton Bay found:

- 750mm piles at a distance of 14m produced a sound pressure level peak of 207+/-2dB re 1µPa. At a distance of 320m the peak sound pressure level produced by these piles was measured at 181+/-1dB re 1µPa. At a distance of 1290m the peak sound pressure level produced by these piles was measured at 126+/-1dB re 1µPa;
- 1500mm piles at a distance of 14m produced a sound pressure level peak of 205+/-2dB re 1µPa. At a distance of 360m the peak sound pressure level produced by these piles was measured at 180+/-1dB re 1µPa. At a distance of 1330m the peak sound pressure level produced by these piles was measured at 133+/-1dB re 1µPa.

The measurements from Moreton Bay also show that at a distance of 14m, underwater noise from both 750mm and 1500mm pile driving activities are below the peak pressure levels considered to cause hearing loss in both marine turtles and cetaceans. The measured levels for both sized piles were greater than the avoidance and behavioural thresholds (refer **Section 10.2.5**) for both marine turtles and cetaceans. An exclusion zone of 200m was implemented during the piling (Erbe 2009).

Underwater noise modelling (SVT 2009) of the driving of 1600mm piles undertaken for the Cape Lambert Port B Development in Western Australia found:

- physical injury could occur to marine turtles within 20m (piling close to shore) and 30m (piling in deeper water); and
- avoidance behaviour by marine turtles could occur within 300m (piling close to shore) and 400m (piling in deeper water).

In addition to the above studies, the recent approval relating the Cape Lambert Port B Development (EPBC Approval 2008/4032) imposed the requirement to develop and implement both marine turtle (Biota 2010) and cetacean (SKM 2010) management plans that are approved by DSEWPaC, which were to include mitigation measures for underwater noise impacts on marine fauna associated with pile driving activities. The management plans committed to a 500m exclusion zone for marine turtles during pile driving activities, however remained silent on exclusion zones for dolphins. However it is assumed that the 500m exclusion zone would also apply to dolphins as the turtle management plan states that observers would look for marine turtles and other marine fauna within 500m of piling operations (Biota 2010).

The construction of the ferry/barge terminals are minor building works compared to the construction of the port (including limited piling of 600mm piles) of short duration. Pile driving activities for the ferry/barge terminals is anticipated to take approximately 15 days. The impacts would be limited to the day-time period and localised to the immediate area. The works are not of sufficient size to be addressed further other than by a Construction Management Plan of sufficient detail as is usual for works of this nature.

The operation of the ferry and barge would be a potential noise source once the terminals are commissioned, which would be at least six months into the construction period. This has been modelled in the operations phase of the project.

10.4.2 Operations

For the purposes of impact assessment, three production scenarios have been considered over the life of the mine:

- 15Mdptpa;
- 30Mdptpa; and
- 50Mdptpa.

The 15Mdptpa production scenario covers the early years of the Project when the mining areas would be located close to the Boyd infrastructure area and furthest from sensitive receptors. Under the 30Mdptpa production scenario would be more remote from the Boyd infrastructure area and also occur near the Norman Creek infrastructure area and extend further away over time. Under the 50Mdptpa production scenario the mine would extend from the north to the south of the lease area over a distance of approximately 60km. The equipment and plant utilisations for each production level are shown in **Table 10-9**. The noise model incorporates plant and equipment operating at 50Mdptpa production rate with a spatial distribution representative of operations likely to cause the highest noise levels in all noise sensitive locations as follows:

- a mining and development area approximately 5km west of the Hey River barge/ferry terminal and 6.4km south west of Napranum;
- a mining area 23km south-south-west of Napranum;
- a mining area 35km north of Aurukun;
- a mining and development area 17km north of Aurukun; and
- haul roads, conveyors, beneficiation plant, power station, and ship loaders.

For modelling purposes, mobile equipment fleet have been located in mining areas, on haul roads, and at dump stations, as would occur in a realistic mining situation.

A barge would be used to transport equipment, cargo and fuel from the Humbug Terminal to the Hey River Terminal (refer **Section 14.4** for full description of barge and ferry operations). At maximum production approximately six trips would occur each day, with each trip taking approximately 30 minutes.

A ferry would transport the workforce from the Hornibrook Terminal to the Hey River Terminal. At maximum production, it is estimated that four to six crossings per day would be required, each taking approximately 12 minutes.

The route for the barge and ferry is approximately mid-channel and at least 1km from the banks of the Embley River at Napranum. For the purposes of modelling it is conservatively assumed there would be two barge/ferry passages in the hour. The noise level would be representative of a barge or passenger ferry with standard mufflers.

Table 10-9 Summary of Equipment for Production Scenarios

Production Rate	**15Mdptpa**	**30Mdptpa**		**50Mdptpa**	
Work Area	**Boyd**	**Boyd**	**Norman Creek**	**Boyd**	**Norman Creek**
Plant	Beneficiation Plant 4.7km of conveyors 16 conveyor drives Power station (12MW) Stacker and reclaimer 1 bulldozer	Beneficiation Plant 6.4km of conveyors 19 conveyor drives Power station (26 MW) Stacker and reclaimer 1 bulldozer	Beneficiation Plant 0.5km of conveyors 2 conveyor drives Stacker and reclaimer	Beneficiation Plant 8.9km of conveyors 29 conveyor drives Power station (46 MW) Stacker and reclaimer 1 bulldozer	Beneficiation Plant 1km of conveyors 4 conveyor drives Stacker and reclaimer
Ship loader	1.2km of conveyors 3 conveyor drives Ship housing noise	1.2km of conveyors 3 conveyor drives Ship housing noise		2.4km of conveyors 6 conveyor drives Ship housing noise	
Number of Mining areas	2	1 north of Boyd Point	1 south of Boyd Point	2 north of Boyd Point	2 south of Boyd Point
Number of Development areas	2	1 north of Boyd Point	1 south of Boyd Point	1 north of Boyd Point	1 south of Boyd Point
Mining/Production (total fleet numbers)	8 trucks 3 excavators 1 loaders 1 water truck 1 grader 1 field service truck 1 field fuel truck 1 low loader	18 trucks 6 excavators 2 loaders 2 water trucks 2 graders 2 field service trucks 2 field fuel trucks		33 trucks 8 excavators 2 loaders 4 water trucks 3 graders 2 field service trucks 2 field fuel trucks	
Development (total fleet numbers)	1 loaders 3 trucks 1 grader 1 water truck 1 bulldozer 1 field service truck 1 field fuel truck	1 loader 3 trucks 1 grader 1 water truck 1 bulldozer 1 field service truck 1 field fuel truck		2 loaders 6 trucks 2 graders 2 water trucks 2 bulldozers 1 field service truck 1 field fuel truck	
Overland Conveyor	-		15km of conveyor 4 conveyor drives		15km of conveyor 4 conveyor drives

The calculated noise levels (including the low frequency noise levels) for Weipa, Napranum and Aurukun for the four meteorological cases are shown in **Table 10-10, Table 10-11** and **Table 10-12** respectively. Since the 50Mdptpa production scenario is likely to produce the highest noise levels, only this case is modelled. Refer to **Figure 10-1, Figure 10-2, Figure 10-3,** and **Figure 10-4** for the $L_{Aeq,\ adj,\ 1\ hr}$ noise levels during the day, evening, night and night with wind respectively for the 50Mdptpa production scenario.

Table 10-10 Noise Levels from Mining and Barge/Ferry Operations in Weipa

Operations	Operational Noise Levels [$L_{Aeq,\ adj,\ 1\ hr}$ dB(A)]				Low Frequency Noise [$L_{eq,\ adj,\ 1\ hr}$ dB(Linear)]	
	Day	Evening	Night	Night With Wind	Night	Night With Wind
Noise Objectives	***40***	***40***	***35***	***35***	***50***	***50***
Proposed Noise Criteria	***46***	***43***	***43***	***43***	***50***	***50***
Barge/Ferry only	23	23	17	22	33	39
Mining only	27	27	28	26	46	45
Barge/Ferry and mining combined	29	28	28	28	46	46

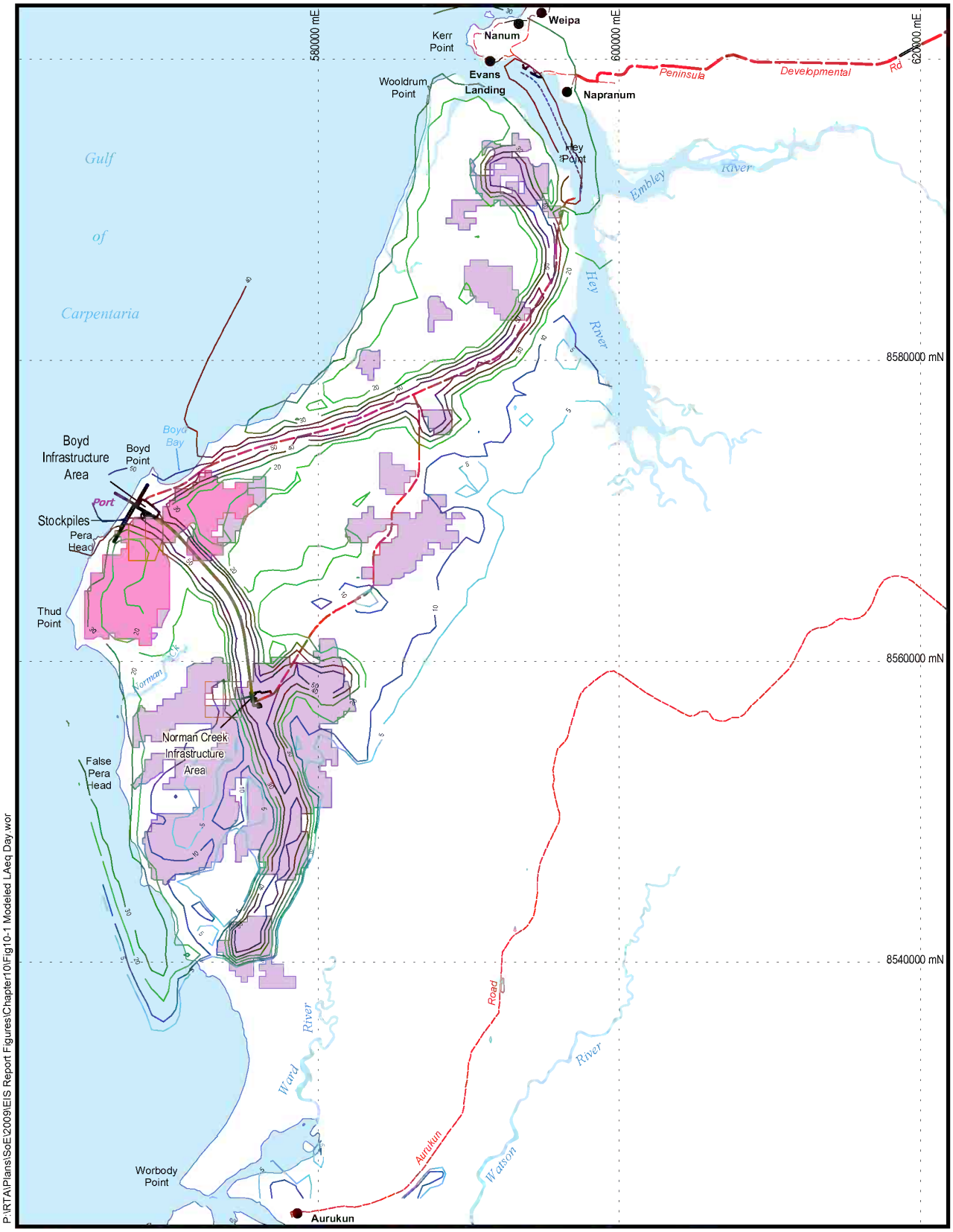
Table 10-11 Noise Levels from Mining and Barge/Ferry Operations in Napranum

Operations	Operational Noise Levels [$L_{Aeq,\ adj,\ 1\ hr}$ dB(A)]				Low Frequency Noise [$L_{eq,\ adj,\ 1\ hr}$ dB(Linear)]	
	Day	Evening	Night	Night With Wind	Night	Night With Wind
Noise Objectives	***40***	***40***	***35***	***35***	***50***	***50***
Proposed Noise Criteria	***46***	***43***	***43***	***43***	***50***	***50***
Barge/Ferry only	28	29	31	30	44	44
Mining only	28	31	34	30	49	48
Barge/Ferry and mining combined	32	33	35	33	50	50

Table 10-12 Noise Levels from Mining and Barge/Ferry Operations in Aurukun

Operations	Operational Noise Levels [$L_{Aeq,\ adj,\ 1\ hr}$ dB(A)]				Low Frequency Noise [$L_{eq,\ adj,\ 1\ hr}$ dB(Linear)]	
	Day	Evening	Night	Night With Wind	Night	Night With Wind
Noise Objectives	***40***	***40***	***35***	***35***	***50***	***50***
Proposed Noise Criteria	***46***	***43***	***43***	***43***	***50***	***50***
Barge/Ferry only	<thh	<thh	<thh	<thh	4	<thh
Mining only	8	8	19	<thh	40	<thh
Barge/Ferry and mining combined	8	8	19	<thh	40	<thh

Note: <thh are very low noise levels below the threshold of human hearing



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Township (Sensitive Receptor)
Road/track
Overland conveyor
Barge / Ferry route
Tailings storage facility
Mining Years 1 -13
Mining Years 14 - 40

Rio Tinto Alcan

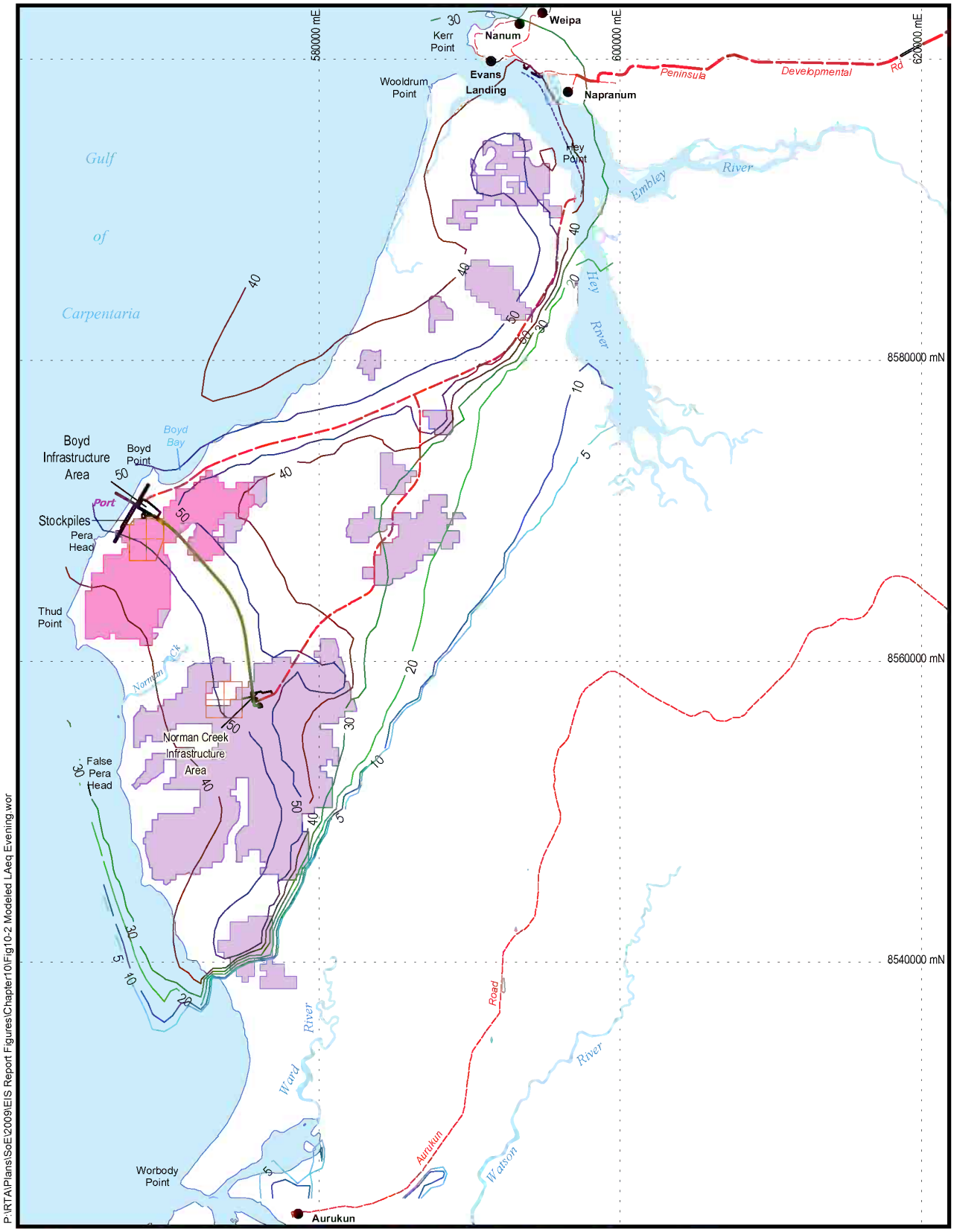
South of Embley Project

Fig 10-1: Modelled L_{Aeq} (1 Hour) for 50 Mdptpa Day Period

N

5 0 5km

Datum/Projection: GDA94/MGA Zone 54 Date: 05/11/2010



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- Township (Sensitive Receptor)
- Road/track
- Overland conveyor
- Barge / Ferry route
- Tailings storage facility
- Mining Years 1 -13
- Mining Years 14 - 40

Rio Tinto Alcan

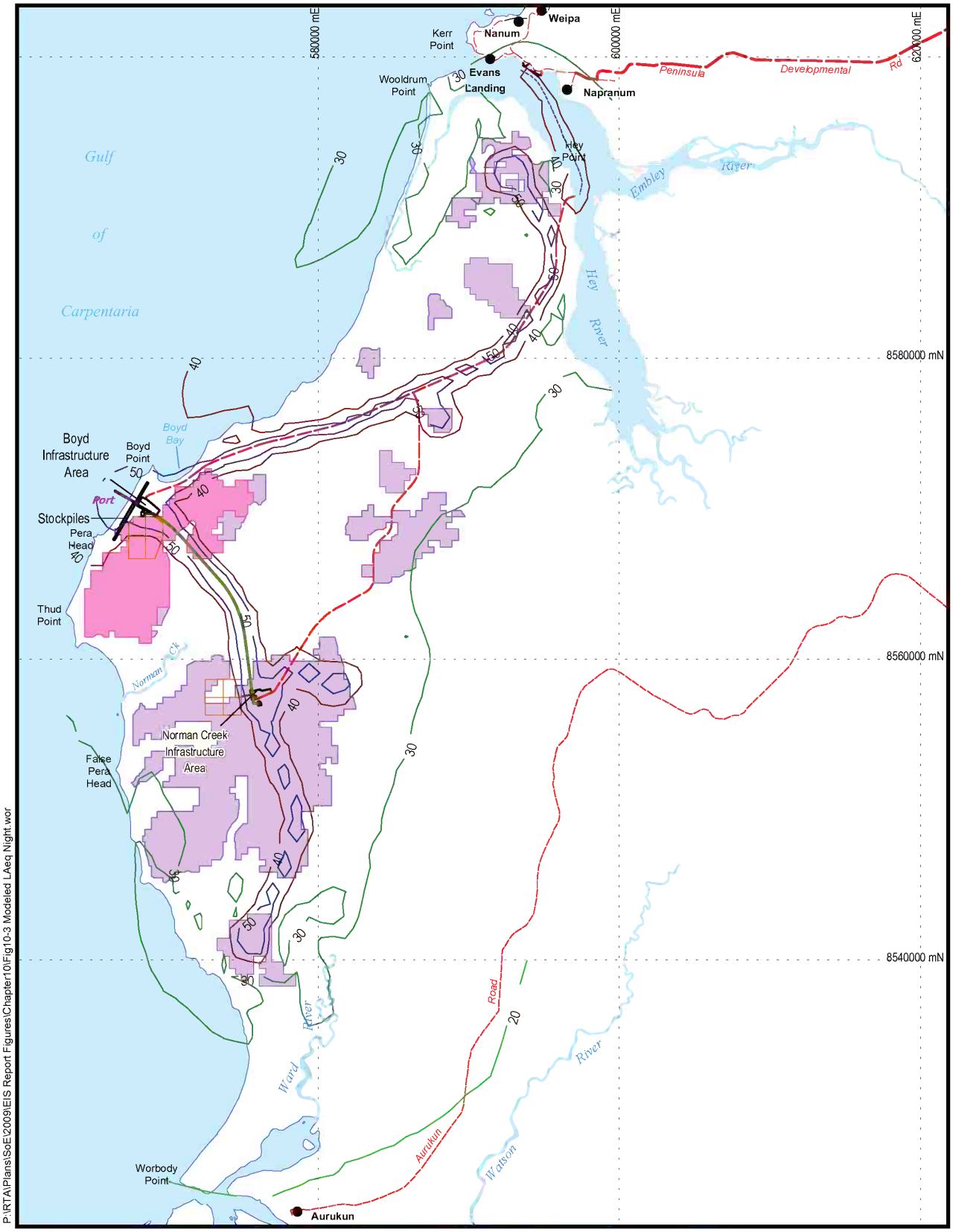
South of Embley Project

Fig 10-2: Modelled L_{Aeq} (1 Hour) for 50 Mdptpa Evening Period

N

5 0 5km

Datum/Projection: GDA94/MGA Zone 54 Date: 05/11/2010



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Township (Sensitive Receptor)
Road/track
Overland conveyor
Barge / Ferry route
Tailings storage facility
Mining Years 1 -13
Mining Years 14 - 40

Rio Tinto Alcan

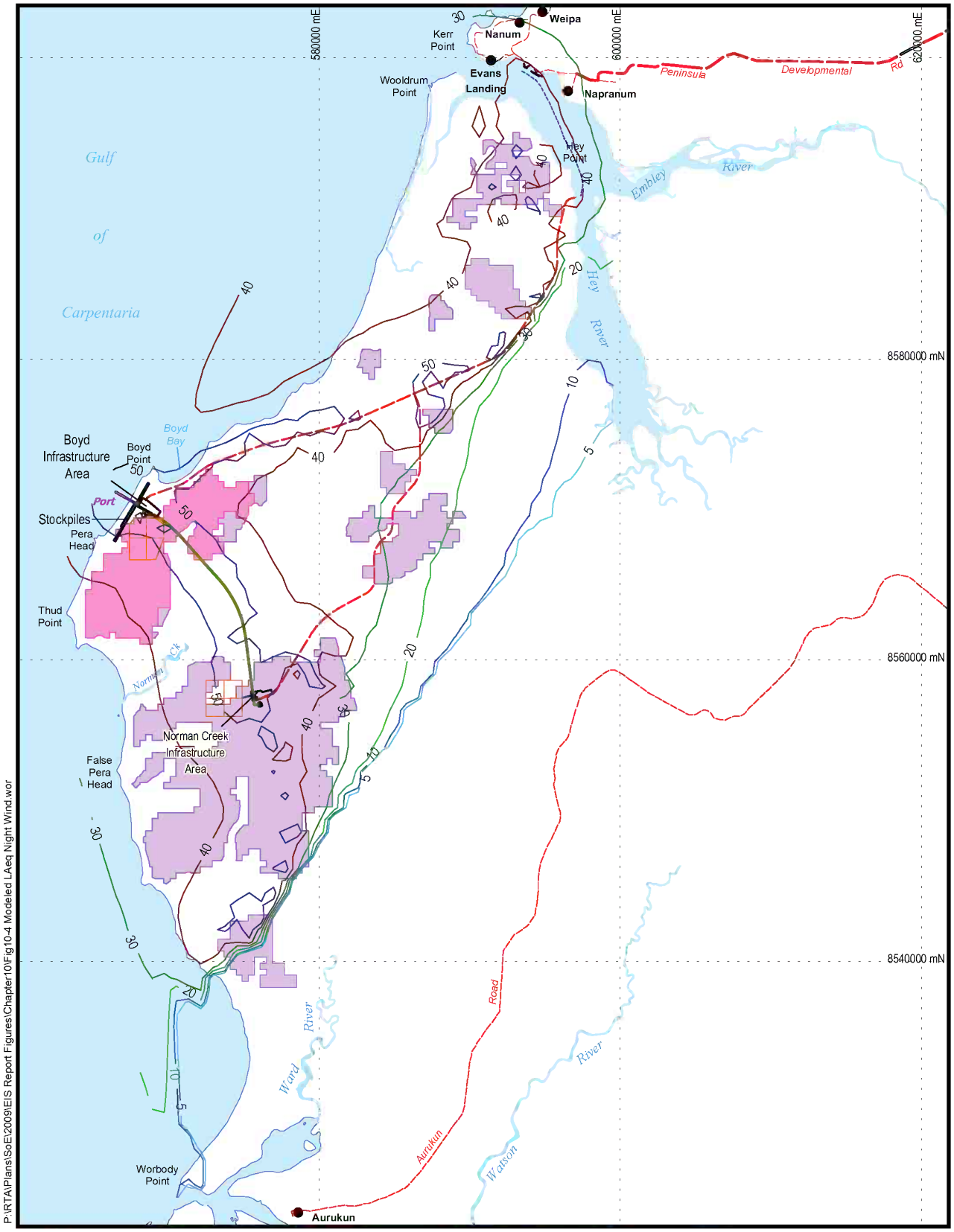
South of Embley Project

Fig 10-3: Modelled L_{Aeq} (1 Hour) for 50 Mdptpa Night Period

N

5 0 5km

Datum/Projection: GDA94/MGA Zone 54 Date: 05/11/2010



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Township (Sensitive Receptor)
Road/track
Overland conveyor
Barge / Ferry route
Tailings storage facility
Mining Years 1 -13
Mining Years 14 - 40

Rio Tinto Alcan

South of Embley Project

Fig 10-4: Modelled L_{Aeq} (1 Hour) for 50 Mdptpa Night with Wind Period

N

5 0 5km

Datum/Projection: GDA94/MGA Zone 54 Date: 05/11/2010

The existing $L_{A90,\ 1hour}$ noise levels are 41dB(A), 38dB(A), and 38dB(A) respectively for the day, evening and night periods. These existing background noise levels are well above the calculated noise levels from the Project. The existing $L_{Aeq,\ 1\ hour}$ are even higher. Adding the calculated Project noise levels to the existing levels would not change the noise levels in the sensitive areas. Furthermore, the noise levels comply with the noise level objectives; therefore, health and amenity are unlikely to be adversely affected if there are periods of the year with very low ambient levels.

There are homesteads on the cattle stations to the east of the mining areas (refer **Figure 9-1**). The separation distances between the project and the homesteads are at least 50km. The noise levels at these homesteads from the Project are expected to be inaudible under all circumstances.

10.5 Potential Impacts and Mitigation Measures

Construction Phase

Most construction operations take place at large distances away from noise sensitive locations. Napranum is the closest noise sensitive area to the Project.

The main construction noise sources affecting Napranum would be the construction of the Hornibrook ferry terminal and subsequent operation of the ferry and barge. Baseline noise monitoring would be carried out at Napranum prior to the commencement of construction.

Piling activities for the ferry terminal would be temporary activities that would be carried out during the day. Therefore this activity is unlikely to cause nuisance at these sensitive receptors.

The construction of the wharf at the proposed port between Boyd Point and Pera Head would involve pile driving. The underwater noise that is generated by the hammer hitting the top of the pile is of short-term duration and therefore can be described as impulsive noise. Noise generated from driving a pile is broadband and does not have any tonal characteristics. The time taken to drive each pile would depend on the hardness of the seabed in each location.

Based on the noise measurements conducted for similar sized pile driving operations by McCauley (2008), Erbe (2009) and SVT (2009), marine turtles and cetaceans in the vicinity of the pile driving activities may experience changes in behavioural patterns.

It is anticipated that the construction activity would deter most turtles and marine mammals from the immediate area. However, for precautionary purposes, it is proposed that a "soft start" approach would be used to disperse animals in the vicinity prior to normal pile driving. The "soft start" involves commencing pile driving with a partial capacity strike, or giving a warning with an underwater airgun prior to normal pile driving. It is proposed that an exclusion zone be established and monitored by an observer around pile driving activities and that a soft start approach be undertaken prior to normal pile driving. Normal pile driving would not be conducted while threatened marine fauna species are indentified within the nominated exclusion zone. The extent of the exclusion zone would be defined based on further literature review and quantitative analysis of the potential underwater noise impacts from pile driving relating to threatened marine fauna. The final extent of the exclusion zone would be defined in consultation with DSEWPaC.

With the implementation of the proposed mitigation measures, the impact of noise and vibration on sensitive receptors during the construction phase of the Project is considered to be low.

Operational Phase

The modelling has demonstrated that the noise levels from mining are expected to comply with all noise level objectives and criteria in Weipa, Napranum and Aurukun during the day, evening and night, as shown in **Table 10-10**, **Table 10-11** and **Table 10-12**. The expected $L_{Aeq,adj,1hr}$ noise level from the ferry and barge is calculated to be less than 31dB(A) in Napranum during the day, evening, night and "night with wind" modelling cases.

Furthermore, the low frequency noise level limit of 50dB(Linear) is likely to be met at all locations during the night. It should be noted that noise from the ferry is likely to be the main source of low frequency noise from the Project at both Napranum and Weipa. The noise from the ferry has been modelled at 50dB(Linear) at Napranum at night with wind; however, this is based on a conservatively high noise emission from the ferry and barge. Smaller passenger ferries would be significantly quieter.

The vessels using the proposed port would also produce underwater noise. In Australia, dolphin species co-exist with coastal development, including extensive port facilities, and therefore noise from operation of the port is not expected to have a significant impact. Further discussion on impacts to marine fauna is provided in **Section 6.9.4**.

The manufacturer's sound power level specifications for major equipment items would be used as guidance when purchasing equipment. A noise monitoring campaign, including attended monitoring at Napranum, would be conducted after operation commences to validate the noise model. Where it is determined that actual noise levels exceed applicable noise limits, action would be taken to reduce noise levels.

The impact of noise from the operation on the natural terrestrial animals and avifauna is best assessed by the noise from operations compared with the existing noise levels. The existing background noise levels (close to the Embley River) are 41dB(A) during the day and 38dB(A) during the evening and night. Coastal areas are often noisy environments due to the action of birds and wildlife, wind and waves. The areas around Boyd Point are likely to be noisier than that measured near Hornibrook ferry terminal as it is more exposed to the Gulf. The noise modelling shows that these existing noise levels are typically met between 1km and 1.5km from roads, mining and the processing plant. Close to Boyd Point, these levels are typically met at a much larger distance, typically 5km along the shoreline and out to sea.

Blasting is not proposed, and therefore there would be no impact from blasting noise, ground vibration, or flyrock. Off-site impacts from increased road or other transportation are addressed in **Section 14**.

The impact of noise and vibration on sensitive receptors during the operational phases of the Project is therefore considered to be low.

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Environmental Impact Statement for South of Embley Project

Section 11
Cultural Heritage

11 CULTURAL HERITAGE

11.1 Indigenous Cultural Heritage

11.1.1 Legislation and Indigenous Land Use Agreement

In 2000 the Federal Court made a litigated determination recognising the existence of Native Title over the entire claim area of the Wik and Wik Way people, whose land extends over much of the southern part of RTA's ML 7024 and over ML 6024. This means the Indigenous claimants of the Wik area have rights and interests in their traditional lands and waters that are recognised under the *Native Title Act 1993* (Cwlth). Following this determination, RTA undertook a series of negotiations with all Indigenous groups whose land falls on any part of any RTA mining lease on Cape York Peninsula. As a result of these negotiations an Indigenous Land Use Agreement (ILUA) was formulated and agreed to by all Traditional Owner groups, RTA and the State of Queensland. This agreement, known at the Western Cape Communities Coexistence Agreement (WCCCA) provides the context for Indigenous cultural heritage management on ML 7024 and ML 6024. The ILUA is registered with the National Native Title Tribunal (QAI2001/002) as an agreement that recognises and incorporates Indigenous interests in land with development and business activities. The ILUA is recognition of Native Title that is negotiated separately to any Native Title claims on the Cape that have been determined, or are in the application process. The benefit of the ILUA is that it is flexible, negotiable, and is tailored to address specifically the impacts of bauxite mining on the landscape. All parties are bound to the provisions of the agreement.

All Indigenous cultural heritage in Queensland is protected under the *Aboriginal Cultural Heritage Act 2003* (Qld). To comply with the duty of care provision under section 23 of the Act, proponents are required to have a recognised cultural heritage management plan or other agreement that provides for the management of Indigenous cultural heritage. The *Aboriginal Cultural Heritage Act 2003* recognises Indigenous Land Use Agreements as a mechanism for managing cultural heritage as long as cultural heritage is included in the ILUA (as it is in the WCCCA). The WCCCA provides for a system of cultural heritage management over the Project area. In accordance with section 86 of the Act, this agreed process for identifying, assessing and managing places of cultural heritage significance satisfies the requirements of the Act and meets Queensland legislative requirements for any new permits or approvals required for Project development works. The WCCCA requires RTA and Traditional Owners to establish mutually agreed plans for each commercial activity that may have an impact upon Indigenous cultural heritage. Under the WCCCA, the definition of a commercial activity includes extractive mining, vegetation clearing, the establishment of drill lines and the establishment of infrastructure and other facilities.

11.1.2 Cultural Heritage Context

The antiquity of human occupation on Cape York has been established through the excavation of rock shelter deposits near Laura, approximately 500km south of the Project area. Radiocarbon determinations from these deposits indicate that Indigenous people have occupied the Cape York region for over 35,000 years (David and Lourandos 1997). Radiocarbon determinations from shell mounds and the smaller middens around Albatross Bay at Weipa date back to approximately 2,500 years before present (Stone 1992). Archaeological evidence for occupation of the Weipa area prior to this may have been destroyed by the formation of the current coastline with stabilisation of sea levels approximately 6,000 years ago. The Weipa shell mounds are very important to Traditional Owners and are of national archaeological value established through a number of research projects undertaken since the 1960s (Bailey 1977, 1993, 1999; Morrison 2003). Major concentrations of shell mounds have been recorded along the Pine and Mission Rivers north of Weipa and the Hey and Embley Rivers to the south. The Weipa shell mounds were placed on the Register of the National Estate in 1980 (Place ID 9103). Shell mounds have also been identified in areas outside of the National Estate Boundaries. Recent cultural heritage surveys around Weipa have documented a diverse record of late Holocene archaeology consisting of scarred trees, shell middens, earthen mounds and stone artefact scatters (Shiner and Morrison 2009).

A search of the cultural features code of the Town Planning Scheme for the Shire of Cook revealed no cultural heritage sites identified on either ML 7024 or ML 6024. The Department of Environment and Resource Management's Indigenous Sites Database contains two site records situated within the Project area. Both sites are in the Hey River area and both are shell middens. One is located on ML 6024 and the other on M L7024. Both sites have been inspected during heritage surveys conducted for the Project and neither would be disturbed by the Project.

11.1.3 Cultural Heritage Surveys

The WCCCA sets out the process for consultation between RTA and Traditional Owners and this enables the Traditional Owners who can speak for country to participate in heritage surveys. This process has been followed to complete six cultural heritage surveys in the Project area. Cochrane (2006a) surveyed a sample of proposed exploration drilling lines and conservation areas of riparian vegetation during 2005. This was followed by further exploration drill line surveys by Cochrane (2006b) and Woolfe (2007). RTA staff archaeologists conducted an additional survey of proposed drill lines in 2008 and 2009 (RTA 2009b and 2009c). Woolfe (2009a and 2009b) surveyed the possible locations of infrastructure on ML 7024 related to Chalco's proposed Aurukun Bauxite Project development. The surveys to date have documented archaeological sites totalling 525 scarred trees, 23 surface stone artefact scatters (with a total of 43 artefacts), and 111 shell middens. Previous anthropological fieldwork has identified 15 places of cultural significance to Traditional Owners (Sommer and Sommer 1994). These include story places which have oral histories detailing information about creation, magic, taboo, hunting, and ritual. These stories are culturally sensitive and some of their locations cannot be disclosed to the public without the consent of the Traditional Owners. Other sites are traditional hunting and gathering areas and places of contemporary use for camping, fishing and hunting.

Cochrane (2006a) undertook the first systematic archaeological survey of the Project area in 2005. This involved the survey of 45 separate transects, each approximately 1km in length across the Boyd Bay, Norman Creek, Ward River and Waterfall (Ina Creek) areas. The main objective of the survey was to obtain information on the types of archaeological sites that occurred in the area. All major ecosystems and landforms represented in the area were investigated. The survey team consisted of the consultant archaeologist, a Rio Tinto archaeologist and up to four Traditional Owners. Members of the survey team were spread 5 to 10m apart and walked in straight lines until the entire survey area was completed.

The survey was completed over 17 days and located 115 different archaeological sites. These consist of 58 shell middens, 53 scarred trees and four stone artefact scatters. The shell middens are all concentrated along a linear strip of one kilometre on the southern side of the Norman Creek estuary. Unlike the Weipa shell middens that are composed of the debris of *Anadara granosa* (cockle shell), the Norman Creek shell middens are dominated by the debris of *Marcia hiantina* (clam). This indicates a significant regional difference in the composition of shell middens. Scarred trees are more broadly distributed across the plateau and consist of mainly sugarbag scars from the extraction of native bee honey with a smaller number of woomera scars from the removal of wood for the manufacture of spear throwers. The stone artefact scatters ranged in size from 1 to 11 artefacts for a combined total of 22 artefacts. The two largest artefact scatters were located in the upper reaches of creeks, while one artefact was found on a sand dune near the coast and another on a midden adjacent to Norman Creek.

Cochrane returned to the area in 2006 to undertake an additional survey of proposed exploration drill lines (Cochrane 2007). The survey took place over 36 days and located 28 previously unidentified scarred trees. A total of 66 transects was surveyed over the bauxite plateau for a total length of 158km. Cochrane estimated that the total area surveyed was approximately 474ha. The majority of transects was located south of Norman Creek, with a smaller number situated in the Boyd Bay area. All of the scarred trees identified were Cooktown ironwoods found within *Eucalyptus tetrodonta* woodland settings usually near the coast or inland streams. The scarred trees are broadly distributed and do not occur as dense concentrations. Cochrane concluded that the combined results of the two surveys indicate it is

unlikely that substantial shell midden or stone artefact sites would be found on the bauxite plateau.

Woolfe (2007) also undertook a survey of proposed drill lines over 35 days during 2006. A total of 58 transects was surveyed over the bauxite plateau for a total length of 238.4km. The survey located another 69 scarred trees, five shell middens and three ethnographic sites. The majority of the scarred trees were recorded as sugarbag scars with smaller numbers of woomera and marker scars. Woolfe also noted that cultural scars were only found on Cooktown ironwoods and suggested that this may reflect differential preservation as the ironwood is a long-lived species compared to the other trees within the *Eucalyptus tetrodonta* woodland. It was also noted that higher densities of scarred trees were found near creeks, swamps and the coast. The shell middens were located during a brief inspection of sand dunes at the beach near Pera Head. These vary in composition from the middens recorded by Cochrane at Norman Creek. The Pera Head middens are smaller in size and are dominated by mother of pearl (*Pinctada maxima*) and mud shell (*Polymesoda erosa*) rather than *Marcia hiantina*. The exact location of the ethnographic sites cannot be revealed for Traditional Owner confidentiality reasons, but they are all located within the immediate vicinity of the coast. Woolfe stated that the sites have varying degrees of cultural significance to the Traditional Owners and they request that the sites remain undisturbed by mining activities.

Additional archaeological sites were recorded by RTA staff archaeologists during heritage monitoring work in July and August 2008 (RTA 2009b). These sites were consistent with those recorded previously. A range of drill lines was surveyed between the northern bank of Norman Creek and Boyd Bay. This survey followed the same methodology of earlier surveys. A total of 74 scarred trees was recorded. The majority of these were found within several kilometres of the coast. This work continued during 2009 with a further 106 scarred trees, 22 shell middens and eight stone artefacts identified (RTA 2009c). A smaller number of archaeological sites have been recorded during informal trips to the Project area.

Other surveys in 2008 focused on the proposed port, Boyd mine infrastructure area and tailings storage facility area, and the proposed barge/ferry terminal at Hey Point (Keys 2009a). This resulted in the recording of 37 scarred trees. The remaining Project footprint, including Dam C, the infrastructure corridor and Norman Creek mine infrastructure area, and the tailings storage facility area were surveyed during 2009 (Keys 2009b). Keys (2009b) identified a further 83 scarred trees, five stone artefacts and one historic site that is a former Comalco drilling camp. One of the stone artefacts is an edge ground axe that is regarded as significant by the Traditional Owners involved in the heritage survey. The majority of sites were found near Norman Creek and other drainage lines. A revision of the Dam C footprint and the inclusion of a pump on the Ward River and associated pipeline necessitated an additional cultural heritage survey. This was completed in July 2010 with a further 12 scarred trees recorded in the Dam C survey area and one scarred tree adjacent to the pipeline to the Ward River (Earth and Sea 2010).

Woolfe (2009a and 2009b) also surveyed locations for facilities proposed by Chalco on ML 7024 including a conveyor route and bauxite stockpile. The majority of this work was completed during 2008 and resulted in the identification of 32 scarred trees and two locations with stone artefacts (three artefacts in total). The survey of the proposed conveyor route was completed during 2009 and resulted in the recording of five scarred trees, one of which had previously been recorded.

11.1.4 Environmental Values of the Cultural Landscape

The archaeological sites recorded across the region are one component of a broader cultural landscape that includes features of the natural environment and flora and fauna. Archaeological sites often occur within or near other places of cultural significance and in some cases may be important features of the overall cultural values attributed to the place. Places of cultural significance are not equally distributed across the Project area. They tend to be concentrated in coastal areas and are sometimes associated with prominent features of the landscape such as the coastal bauxite cliffs, waterways and remnant vine forest. The majority of places of cultural significance are associated with oral histories and stories, hence the term "story place" that is

commonly used by local Traditional Owners when referring to these locations. They can also be described as ethnographic sites. Many of these places have traditional names and these are commonly used throughout the wider community. The stories associated with these places relate to the Traditional Owners' beliefs about the creation of country and events that occurred in the past.

Through consultation with RTA the Traditional Owners have indicated that a number of places of cultural significance have clear management protocols that may exclude certain activities. Other places, for example the Amban camping ground, are open for general public use. It is important to recognise that places of cultural significance may be connected to each other through stories or proximity.

The boundaries of the places are often imprecise, so require specific planning to ensure appropriate management. Management details associated with these places have been documented to varying degrees in several reports (Martin 1988, Sommer and Sommer 1994, Woolfe 2007).

Other features of the natural environment also have complex cultural associations. Many of the flora and fauna species in the area have significant cultural heritage value for Traditional Owners. These values have been discussed with Traditional Owners and documented in cultural heritage survey reports (e.g. Dalley 2010). Certain plants may be traditional sources of bush food and or medicine and can also be used to make tools, weapons, shelter and art (e.g. basket weaving). Pandanus is one such example which can be used for basket weaving and making dance costumes while the nuts can also be eaten. Many of the plant species retain contemporary importance as some Traditional Owners living in Aurukun continue to utilise them in a traditional manner. Some animal species living within the Project area are also important to Traditional Owners and are often important sources of bush food (e.g. wallabies, emu, magpie geese, freshwater turtles and fish). Certain animals (e.g. crocodile, emu, some bird species) may have totemic associations to individual Traditional Owners (a person closely identifies with a plant or animal). They may believe that they are related to their totem and there may be taboos associated with it. For instance, many people will not eat an animal that is their totem. Further, some Traditional Owners believe that once deceased they return to country in the form of their totem.

RTA would work with Traditional Owners and the relevant WCCCC sub-committee for the selection and appointment of consultants and development of the scope of ethno-botanical and ethno-faunal studies of the Project area. Information from such studies would be incorporated into management arrangements for the Project area. RTA would also evaluate options to work collaboratively to develop a knowledge database of flora and fauna species of cultural significance in the region.

11.1.5 Significance Assessment

Under the *Aboriginal Cultural Heritage Act 2003* Indigenous parties are responsible for assessing the level of significance of areas and objects of Indigenous cultural heritage. They may be guided in this by a range of information concerning the archaeological, historical and anthropological value of the area and objects. The archaeological significance of the scarred trees, stone artefacts and shell middens has been assessed in each of the cultural heritage survey reports. Shell middens, stone axes and certain examples of woomera scarred trees have been assessed of high significance due to their research potential, preservation and representativeness. Other types of scarred trees and stone artefacts have been assessed as low to moderately significant due to their abundance and poor preservation.

The significance of all indigenous cultural heritage objects in the Project area is being established through consultation with Traditional Owners in accordance with the WCCCA process. Work to-date indicates that story places and shell middens are highly significant for the majority of Traditional Owners. Scarred trees are generally regarded as less significant. The significance of these features to the Traditional Owners would guide future management and mitigation measures.

11.1.6 Potential Impacts and Mitigation Measures

Cultural Heritage Consultation

All formal consultation with Traditional Owners is undertaken in accordance with the process outlined in the WCCCA. RTA is required to provide the relevant WCCCA parties with six months minimum notification prior to undertaking commercial activities, including mining, that have the potential to damage places of cultural heritage value. This notification is in the form of a written work program outlining the location and size of the project area, the nature of the project and a request for the names of Traditional Owners who should be consulted about cultural heritage matters.

RTA consults directly with the Traditional Owners nominated by the WCCCC to establish the scope of any required cultural heritage assessments. The Traditional Owners nominate the names of people they wish to be involved in the heritage assessment. Up to eight, but normally four, Traditional Owners participate in heritage assessment field surveys. Ethnographic surveys are also undertaken and these often involve Traditional Owners from a wider age group. Specific site visits are also undertaken to discuss management issues.

Following the heritage assessment, RTA meets with the Traditional Owners to discuss the heritage assessment report and recommended management of identified cultural heritage sites. The report also describes the proposed commercial activities. The heritage assessment report is submitted to the WCCCC Environment and Heritage Sub-committee. These discussions between RTA, Traditional Owners and WCCCC representatives form the content of Site Protection Plans for specific areas that would be affected by mining and mining-related activity. Once the negotiated Site Protection Plans have been implemented, the RTA manager of the commercial activity would issue a Community, Heritage and Environment permit authorising the activities. The dispute resolution process outlined in the WCCCA would apply if RTA, the Traditional Owners and the WCCCC representatives fail to negotiate a Site Protection Plan.

Cultural Heritage Management Planning

The combined results of the archaeological surveys demonstrate the presence of a range of sites and places of cultural and archaeological value in the Project area. Clear patterns in site distribution have emerged, with the majority of sites situated within several kilometres of the coast. The potential impact of the Project on known archaeological sites has been calculated as a percentage for each site type (refer **Table 11-1**). These results indicate that 82.5% of scarred trees, 88.4% of stone artefacts and 100% of shell middens and ethnographic sites are located outside of the infrastructure footprint and would not be affected. The remaining sites inside the footprint may be affected during construction of the Project. Measures to mitigate these impacts would be developed in consultation with Traditional Owners through the WCCCA process.

Table 11-1 Archaeological Site Types in the Study Area

Site Type	Number in Infrastructure Footprint	Number Outside Infrastructure Footprint	Percentage of Sites Outside Infrastructure Footprint
Ethnographic*	0	19	100%
Scarred Trees	94	444	82.5%
Shell Middens	0	111	100%
Stone Artefacts	5	38	88.4%

* Some of these sites are situated outside of ML6024 and ML7024 but were noted due to their proximity to the Project area

Scarred Trees

Scarred trees are the dominant site type and are most likely to be found within several hundred metres of waterways or the coastal strip. Many of these would not be impacted by the Project

as they are situated within the riparian vegetation buffer. Impacts on scarred trees that are in areas to be cleared would be mitigated in consultation with Traditional Owners through the WCCCA process and, when required, culturally significant scarred trees would be protected by a heritage buffer.

Shell Middens

Shell middens are also common, but are only found in coastal and tidal areas with major shell midden complexes located on both sides of Norman Creek, within the riparian vegetation zone which extends several kilometres upstream of the coast. Several shell mound complexes are also found along the western margin of the Hey River, also in the riparian zone. The barge/ferry terminal south of Hey Point has been positioned so as to avoid one of these large complexes. A sparse background scatter (<5 shells per m^2) of shell often extends between the mounded midden concentrations. This material is sometimes buried beneath the leaf litter and thick wet season growth and is often only visible following fire or removal of the topsoil. If any of this material is uncovered during construction works around the barge/ferry terminal mitigation measures would be developed through consultation with Traditional Owners and relevant WCCCC sub-committee. Wash from the barge and ferry is not expected to cause harm to cultural heritage sites on Deed of Grant in Trust land at Hey Point.

Stone Artefacts

Stone artefacts are very rare in the area and can only be located in areas with adequate ground surface visibility. Several stone axes have been identified associated with shell middens, but these are generally uncommon. The Project would only have a minor impact on known stone artefacts. Several of these are located within the Dam C footprint. Mitigation measures would be developed through consultation with Traditional Owners.

Ethnographic Sites

A number of ethnographic sites have been documented within and adjacent to the Project Area. Several of these are located along the coast between Boyd Bay and the mouth of Norman Creek, but none of these would be adversely affected by the proposed port and associated infrastructure. Another concentration of ethnographic sites occurs between Hey Point and Urquhart Point. These are situated to the north of the barge/ferry terminal and would not be impacted. The management of all ethnographic sites on ML6024 and ML7024 is ongoing with Traditional Owners and is being discussed as part of broader Site Protection Plans under the WCCCA process. RTA is committed to ensuring no impacts from mining on story places and to consulting with Traditional Owners regarding their management.

Potential Cultural Heritage Mitigation Measures

Cultural heritage sites management on other areas of the lease that are currently being mined or are being prepared for mining includes a range of methods developed in negotiation with the relevant Traditional Owner group involved under the WCCCA. The majority of management plans regarding scarred trees involve their removal to areas specified by Traditional Owners, which are usually environmental buffers or outstations.

Stone artefacts are also relocated to specified areas. Shell scatters and middens are of high archaeological and cultural significance and are usually avoided by mining so as to preserve their context and stratigraphy. In some instances, very significant scarred trees are also preserved from mining by the creation of a mining exclusion zone around the scarred tree.

As part of the mine planning process, RTA consults through the WCCCC with Traditional Owners regarding the proximity of mining to places of cultural significance. Often these places are located within the riparian vegetation zone that would not be disturbed, but occasionally they require the creation of a heritage buffer to ensure protection. Traditional Owners associated with the South of Embley area do not readily distinguish between cultural and natural heritage when discussing the management of country. Plants, animals and features of the natural environment are often associated with important cultural information connected to places of significance.

Through consultation with Traditional Owners and the WCCCC SoE Sub-Committee, a scope and timeframe would be agreed upon for the development of a Community, Heritage and Environment Management Plan (CHEMP) as a long-term strategy for the management of land access, fire, flora and fauna, signage, weeds, environmental monitoring and further documentation of places of cultural heritage significance. RTA, the WCCCC SoE Sub-Committee and Traditional Owners would commence development of the CHEMP after RTA and the SoE Sub-Committee have settled the scope of the CHEMP and agreed upon a timeframe for development. The SoE Sub-Committee and RTA would develop the CHEMP in collaboration via an agreed process. It is expected the CHEMP would take approximately 12 months to complete.

RTA only seeks to obtain information for management purposes and the CHEMP would include protocols for managing culturally sensitive information. The CHEMP would include procedures to manage the accidental discovery of cultural heritage materials, including human remains, in the Project area. These procedures would be developed in consultation with the Traditional Owners through the WCCCA and would comply with relevant requirements of the *Aboriginal Cultural Heritage Act 2003*. The procedure would take into consideration the DNRM (2005b) guidelines on *The Discovery, Handling and Management of Human Remains.* RTA has established procedures in use at the current Weipa mining operations that may form the basis for procedures specific to the Project.

The Project would have impacts on scarred trees and stone artefact scatters. Mitigation measures would be developed through consultation with Traditional Owners. Recorded shell middens and ethnographic sites are located outside of the areas for proposed facilities and future mining. The results of archaeological surveys suggest that scarred trees are the site type mostly likely to be impacted by the Project. Other site types are typically found in the riparian vegetation zone around water courses, the coastline and significant vegetation such as thickets of vine forest. The majority of Project facilities are situated outside of this riparian vegetation zone.

Further management work would be undertaken in accordance with the WCCCA process to fully assess the impact of the Project on Indigenous cultural heritage and develop mitigation strategies where required. This would include detailed surveys of all areas identified for future development. The majority of known places of cultural heritage significance are well outside of future mining areas, although access to some of these places may be affected by mine development. RTA would take a proactive approach to the management of places of cultural significance and initiate discussions with the WCCCC and the Traditional Owners to establish separate heritage action plans for each location and incorporate these into the CHEMP. This would ensure the cultural values of these places are effectively managed over the duration of mining in the area.

RTA has considerable experience working with Traditional Owners to manage cultural heritage at the existing Weipa operations. Management strategies have been developed with Traditional Owners to ensure that Indigenous sites are managed in a culturally appropriate manner. These include the creation of heritage buffers within mining areas to protect scarred trees and shell middens, the relocation of scarred trees and stone artefacts outside of mining areas and the creation of scarred tree keeping places. Significant cultural heritage places are often protected by signage and all employees are required to complete cultural awareness training. Specific Project inductions are undertaken with staff to familiarise them with the relevant heritage protection measures. Traditional Owners are also employed as heritage monitors to observe activities identified as having high potential to uncover cultural heritage not visible during the assessment surveys.

RTA would continue to engage with Traditional Owners to identify and protect cultural heritage places, while also meeting the provisions of the *Aboriginal Cultural Heritage Act 2003*. RTA continues to remain committed to meeting all of its obligations as set out in Schedule 5 of the WCCCA for the conduct of future cultural heritage surveys for new mining areas and development in the Project area. This work would be undertaken in accordance with the WCCCA and, when required, cultural heritage consultants would be jointly appointed by the WCCCC and RTA. RTA also acknowledges that cultural heritage surveys may identify cultural

sites of high significance. RTA would work with the WCCCC and the Traditional Owners to manage these sites and understands that the discovery of these sites may require alterations to mine plans.

11.2 Non-Indigenous Cultural Heritage

11.2.1 Introduction

The assessment of the non-Indigenous heritage (historic) values of the Project area has been a collaborative effort between:

- RTA Weipa Specialist Archaeologist (Justin Shiner) who co-ordinated a number of archaeological field assessments within the Project area and provided information on potential non-Indigenous heritage sites identified within the Project area;
- Historian Geoff Wharton, who has extensive knowledge of the Weipa region and who provided a large amount of background historic and ethno-historic information; and
- Consultant Senior Archaeologist (Stuart Huoys), who was responsible for collating, assessing and reviewing the relevant historic information for the Project area.

11.2.2 Historic Overview of the Project Area

To date, there has been no published authoritative overview of the history of the Weipa region or the Project area. The following historic overview for the Project area has been generated from information provided by Geoff Wharton.

The historic setting of the Project area has been categorised under four broad phases or themes of non-Indigenous activity. These are early European exploration, pastoral activity, the Weipa Aboriginal Reserve period, and mining operations.

Early European Exploration

The earliest known European exploration of the Weipa region occurred in 1606 when Dutchman Willem Janszoon, in the ship the *Duyfken*, reported sighting the Australian coast around the Pennefather River. In November 1802 Mathew Flinders, sailing on the *Investigator*, visited Albatross Bay. On this expedition, Matthew Flinders records the red cliffs located around Pera Head. These red bauxite cliffs are located within the Project area. In 1865, the Jardine brothers over-landed cattle east of Weipa through land that is now part of York Downs Station, on their way through to Somerset on the tip of Cape York. The Jardine brothers' cattle drive was the beginning of pastoralism in the Weipa region.

Pastoral Activity

In 1882 the first cattle station was established in the Weipa region, at Batavia Downs. In 1884 the York Downs cattle station was established by Arthur Cox of Sydney and William Lakeland of Cooktown. There are still a number of large cattle stations within the Weipa region such as York Downs, Watson River and Merluna.

The Project area is known to have been utilised for cattle production during the early to mid 1900s and was associated with the Weipa Aboriginal Mission cattle industry (McNaughton 2007). Commercial cattle operations are now absent from the Project area.

The Weipa Aboriginal Reserve

In 1896 the "Aborigines Mission Reserve, Embley and Mission Rivers" was gazetted in the Cook District. This reserve, which later became known as the Weipa Aboriginal Reserve, comprised an area of approximately 647km² and covered the majority of what is now the Project area. The bounds of the Weipa Aboriginal Reserve were surveyed by J.T. Embley in 1897, and in June 1898 the Weipa Aboriginal Mission Station was established by Rev. Edwin Brown at Spring Creek, near the headwaters of the Embley River. In 1903, the boundary of the Weipa Aboriginal Reserve was extended out to around 48km south of the Archer River. Soon afterwards, in 1904, the Aurukun Aboriginal Mission Station was established by Rev. Arthur Richter.

In 1913 Rev. Edwin Brown and his wife Thekla Brown temporarily left the Weipa Mission Station for the purpose of establishing a mission outstation in the Hey River district. The establishment of the mission outstation is believed to have been in response to a proposal to have some of the land south of the Embley River excised from the Weipa Aboriginal Reserve. The mission outstation is believed to have operated for a period of at least five years.

One of the more notable events during this period was the re-location of the Weipa Aboriginal Mission from Spring Creek to Jessica Point (where Napranum is located today). The move took place over a period of two years between 1931 and 1933, and was overseen by the then Superintendent of the Mission, Rev. Samuel McKay.

On 17 November 1965 the new Weipa mission village was officially opened by the Queensland Minister for Education, Hon. J.C.A. Pizzey. This village was situated close to and slightly north of the original riverside village at Jessica Point. The village layout became the streets of today's Napranum community.

In 1988, a Deed of Grant in Trust (DOGIT) was acquired by the Napranum Community Council for areas of land in the Weipa region totalling 2,014km² (known as Napranum DOGIT). Most of this land was formerly part of Comalco's Special Bauxite Mining Lease No. 1 (SBML1) (refer **Section 11.2.2 Mining Operations**) and, prior to the 1958 grant of that mining lease, had been part of the Weipa Aboriginal Reserve land.

Mining Operations

Harry Evans, a geologist with Consolidated Zinc Pty Ltd, was searching for oil on Cape York Peninsula accompanied by two local Indigenous men, Old Matthew (also known as Wakmatha) and George Wilson (also known as Piiramu), in 1955 when he discovered bauxite deposits at the Jump Up Plateau near the site of the original Weipa Mission. In 1956, Enterprise Exploration Pty Ltd (a subsidiary of Consolidated Zinc Pty Ltd) commenced exploration, surveying, mapping and drilling of the Weipa bauxite deposits. In that same year the Top Camp (a mining camp) was established by Enterprise Exploration on the banks of the Embley River close to the present day Napranum.

The vast majority of the Project area is within mining lease ML 7024. The mining lease was originally issued in 1958 by the Queensland Government as SBML1 and was renamed ML 7024 in 1990. The original lease covered an area of approximately 6,164km². By 1995, the lease had been reduced to cover an area of 2,513km².The grantee of the mining lease SBML1 was Comalco (Commonwealth Aluminium Corporation Pty Ltd). Comalco was subsequently re-named Rio Tinto Aluminium Limited (RTA) in 2006.

Mining lease ML 6024 covers a small portion of the Project area near the Hey River and is a connecting lease between the central and southern components of ML 7024. The lease was created as ML3 in 1985 and was subsequently renamed ML 6024 in 1990.

More intensive mineral exploration commenced following the grant of SBML1 (now M L7024) in 1958 and in 1963 the first beneficiation plant and wharf facilities were completed at Evans Landing, now part of the modern township of Weipa. The first commercial bauxite mining commenced at East Weipa and the first commercial shipments were made in 1963. Several years later, new beneficiation and ship loading facilities were constructed at nearby Lorim Point, with the first commercial shipment loaded in 1967. These facilities, although expanded and modernised, are still in use today.

The Weipa township was established in association with the commencement of commercial bauxite mining operations. In 1967 the new residential area of Weipa North was officially opened, as was the Weipa North State School. In 1968 the capacity of bauxite processing facilities at Weipa increased from 3.2 to 7.5 million tonnes per annum. Weipa North was later renamed Weipa and has witnessed the addition of several new suburbs over the years.

11.2.3 Results and Discussion

State and National Heritage Registers

A search of the Queensland Heritage Register was undertaken to determine if there are any registered sites located within the bounds of the Project area. The search results show that there are no registered non-Indigenous sites located within the Project area.

A search of the Australian Heritage Places Inventory found no places protected under the *Environmental Protection and Biodiversity Conservation Act 1999* (Cwlth) on the National Heritage List. In addition, there are no European cultural heritage places on the Register of the National Estate.

Local Government Heritage Registers

A search of the cultural features code of the Town Planning Scheme for the Shire of Cook revealed no non-Indigenous cultural heritage sites identified on either ML 7024 or M L6024. Weipa Town Authority, Napranum Aboriginal Shire Council and Aurukun Shire Council do not have heritage registers.

Non-Indigenous Heritage Sites

The Project Area has been the focus of a number of archaeological surveys over the past five years (Cochrane 2006a, 2007; Woolfe and Guse 2006; RTA 2009b and 2009c). The survey transects walked as part of these surveys cover the vast majority of the Project area. Background research as part of these assessments indicated that substantial non-Indigenous heritage sites were unlikely to exist in the Project area. These surveys have been mainly concentrated on locating and recording Indigenous heritage sites; however, as part of the assessment any potential non-Indigenous heritage sites that were encountered were also recorded.

In the course of the survey assessments a total of seven non-Indigenous heritage sites were identified within the Project area. The majority of these sites appear to be associated with early exploration drilling for bauxite, extending back to the 1950s and 1960s. The following text provides a summary description for these sites. The summary details for each potential non-Indigenous heritage site are presented in **Table 11-2**.

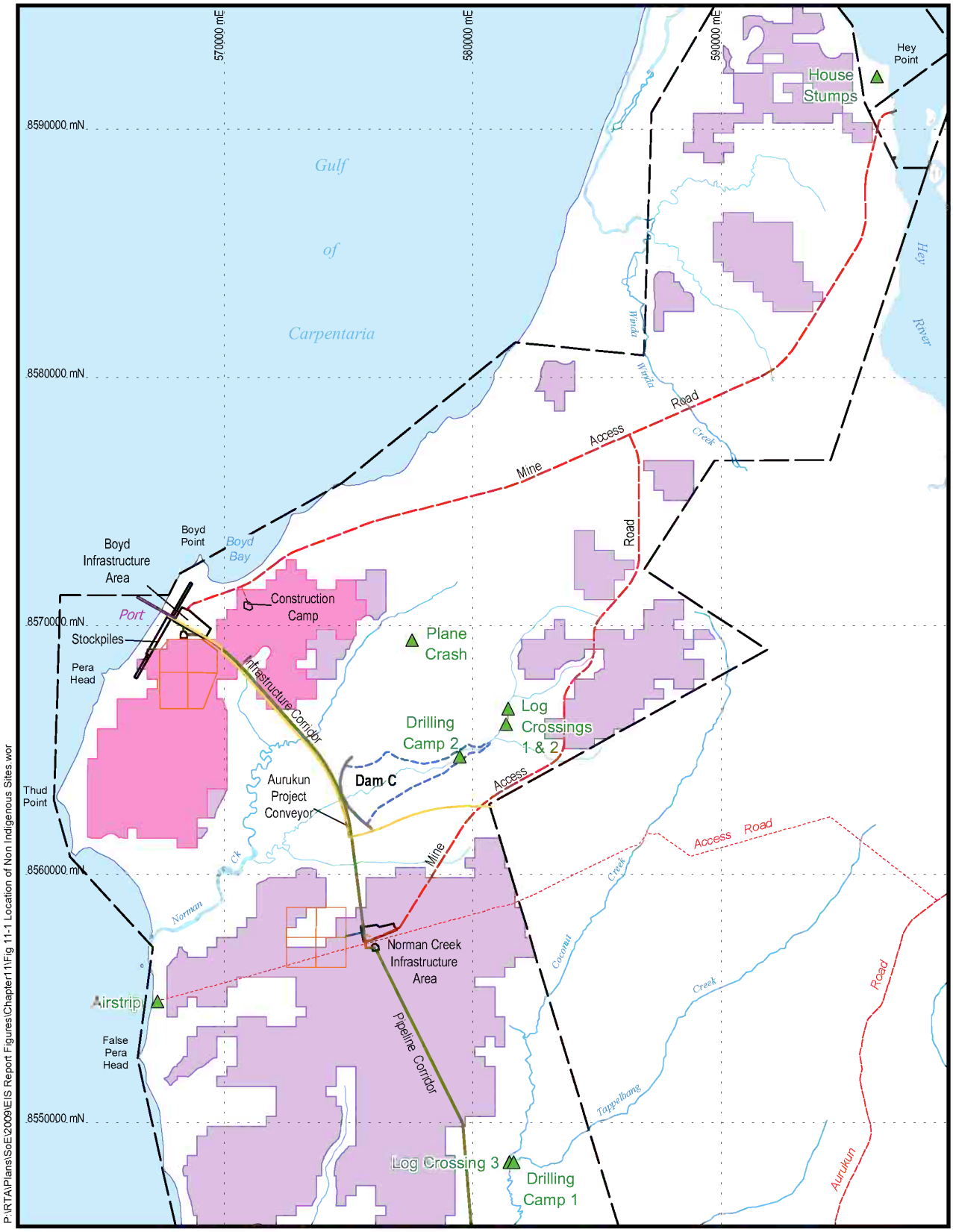
Table 11-2 Summary Details of Non-Indigenous Heritage Sites in the Study Area

Site Name	Description
Air strip	Disused air strip and associated concrete slab and pole at False Pera Head
Log Crossing 1 Norman Creek	Sawn log crossing on Norman Creek
Log Crossing 2 Norman Creek	Sawn log crossing on Norman Creek
Log Crossing Ward River	Sawn log crossing on Ward River
Drilling Camp 1	Remnants of a drilling camp have been reported as being present in the general vicinity of the log crossing on the Ward River
Drilling Camp 2	Remnants of a drilling camp have been recorded near an unnamed creek north of Norman Creek
House Stumps*	Remnants of house stumps in vicinity of Hey Point believed to no longer remain

* Site is outside the Project area.

Air Strip

There is an overgrown airstrip near False Pera head believed to have been constructed in the area in the 1950s or 1960s as part of early mineral exploration in the area. The airstrip was suitable for use by light aircraft. Associated with this airstrip is a concrete slab and pole (possibly for a windsock), as well as a small bottle dump (refer **Figure 11-1**).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Carpentaria
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Winda Winda Creek
Road
Access
Mine
Road
Boyd Point
Boyd Bay
Boyd Infrastructure Area
Port
Stockpiles
Pera Head
Construction Camp
Infrastructure Corridor
Plane Crash
Drilling Camp 2
Log Crossings 1 & 2
Aurukun Project Conveyor
Dam C
Access
Thud Point
Mine
Access Road
Norman Creek
Norman Creek Infrastructure Area
Airstrip
False Pera Head
Pipeline Corridor
Coconut Creek
Road
Tappelbang Creek
Log Crossing 3
Drilling Camp 1
Aurukun Road
P:\RTA\Plans\SoE\2009\EIS Report Figures\Chapter11\Fig 11-1 Location of Non Indigenous Sites.wor
RTA Mining Lease boundary
Township
Road/track
Freshwater dam
Tailings storage facility
Non Indigenous Site
Mining Years 1 -13
Mining Years 14 - 40
South of Embley Project
Fig. 11-1: Location of Non-Indigenous Sites
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Datum/Projection: GDA94/MGA Zone 54
Date: 16/07/2010

Log Crossings

Three log creek crossings have been identified in the Project area, two of these being situated on Norman Creek and the other on the Ward River. Each of these log crossings consists of a series of sawn logs placed horizontally across the watercourse. The log crossings are thought to have been constructed during the early mineral exploration phase in the 1950s to 1960s.

Drilling Camp

Mr Glenn White, a long-term RTA mine planning employee, reported that the area around the log crossing on the Ward River was also the location of a residential drilling camp. Efforts to re-locate this camp during archaeological surveys have been unsuccessful. It is possible that any remnant features associated with this site have subsequently been destroyed through flooding or fire. The camp is believed to have been established in the 1960s as part of early mineral exploration in the area. Another former drilling camp was identified on an un-named creek north of Norman Creek during an archaeological survey in 2009. There is little left at the camp other than rusted 44 gallon drums and some condiment bottles.

House Stumps

Mr Geoff Wharton reported having been shown some house stumps in the vicinity of Hey Point in the early 1990s. Mr Wharton is of the opinion that these house stumps are likely to be part of the remnants of a small satellite mission village established by Rev. Brown around 1913. The village was thought to have been established in response to a proposal to have some of the land south of the Embley River excised from the Weipa Aboriginal Reserve (Geoff Wharton: Pers comm). The site is not located on ML6024, or ML 7024 (refer **Figure 11-1**).

A targeted heritage inspection to locate the house stumps near Hey Point was completed in 2009 under the direction of Traditional Owners who may have been aware of its location. The survey team was unable to find the house stumps at the supposed location and have subsequently concluded the site no longer remains or that local knowledge of the exact location is insufficient to find the site at this point in time. The wooden house stumps would be vulnerable to burning by the frequent fires in the area and may have disappeared.

Weipa Aboriginal Reserve

The Project area was originally part of the Weipa Aboriginal Reserve. Aboriginal Reserves in Australia are now recognised as historic locations (sites), despite the presence or absence of associated physical structures or remains. This is based on the concept of the historic landscape, and the association of this landscape with important phases in history.

Other Non-Historical Features

In addition to the sites described above, there are a number of other physical features associated with non-Indigenous activity in the Project area. These features generally date to within the past 30 years and cannot technically be classified as heritage sites. These include:

- the remnants of two fishing huts (one at Waterfall and one at the mouth of Norman Creek) believed to date to the 1970s;
- a plane crash site which dates to 1993, in which several people perished, marked by a plaque near Norman Creek; and
- a camp used by a transient man during the 1980s, located around Hey Point.

Given the extensive archaeological surveys that have been undertaken within the Project area, it is unlikely that any additional non-Indigenous heritage sites are present.

11.2.4 Site Significance Assessment

The following provides an outline of the processes used to assess the significance of the non-Indigenous cultural heritage sites within the Project area.

Assessment Guidelines

There are several different ways of defining types of significance, and many practitioners have developed their own system of significance assessment. However, as Pearson and Sullivan (1995) point out, there seems to be a general advantage in using a set of criteria that is already widely accepted. In Australia, cultural significance is usually assessed against the Burra Charter guidelines and the Australian Heritage Commission guidelines (ICOMOS 1988, 1999). Assessment of all known non-Indigenous heritage sites presently recorded within the Project area against the Queensland Heritage Register criteria (which are consistent with the Burra Charter and Australian Heritage Commission guidelines) indicate they do not have a level of cultural heritage significance to warrant listing on the Register.

Significance of Non-Indigenous Heritage Sites

The significance of the six non-Indigenous heritage sites identified within the Project area has been assessed in accordance with the guidelines of the Burra Charter. The significance assessment for the sites and the rationale behind this assessment is presented in **Table 11-3**.

In addition to these seven sites, the majority of the Project area has been assessed as being a low to moderate historic site or landscape, on the basis of its association with the Weipa Aboriginal Reserve. Hundreds of Aboriginal Reserves were established and operated within Australia throughout the 1800s and 1900s. These Reserves are now generally recognised as being representative of an important phase in Australia's history and the interaction of early European settlers with the local Indigenous populations.

Table 11-3 Significance Assessments of Non-Indigenous Heritage Sites

Site Name	Significance Assessment	Rationale for the Significance Assessment
Air strip	Low Local Significance	The site has been assessed as being of low local significance on the basis of its historic values associated with early mineral exploration in the Weipa region. The physical elements of the site are still generally intact.
Log Crossing 1 Norman Creek	Low Local Significance	Both sites have been assessed as being of low local significance on the basis of their historic values associated with early mineral exploration in the Weipa region. The physical elements of the site are still generally intact.
Log Crossing 2 Norman Creek	Low Local Significance	
Log Crossing 3 Ward River	Low Local Significance	The site has been assessed as being of low local significance on the basis of its historic values associated with early mineral exploration in the Weipa region. The physical elements of the site are still generally intact.
Drilling Camp 1 Ward River	Low Local Significance	The site has been assessed as being of low local significance on the basis of its historic values associated with early mineral exploration in the Weipa region. The site has not been able to be re-located, and as such the physical condition of the site is not known.
Drilling Camp 2 Norman Creek	Low Local Significance	The site has been assessed as being of low local significance on the basis of its historic values associated with early mineral exploration in the Weipa region. Few physical elements of the site remain.

The Project area as a whole has been assessed as being of moderate local significance. This assessment is based on both the social significance of the landscape to the local Indigenous people (being part of the original Weipa Aboriginal Reserve), and the historic significance of the area to non-Indigenous and Indigenous people alike.

None of the identified non-Indigenous heritage sites, or the Project area as a whole, are assessed as being of state or national significance. Hence, the identified sites do not warrant nomination for inclusion on the Queensland Heritage Register or the Australian Heritage Places Inventory.

11.2.5 Potential Impacts and Mitigation Measures – Non-Indigenous Heritage Sites

Site Specific Mitigation Strategies

The following provides a set of mitigation strategies for the non-Indigenous heritage sites identified in the Project area.

The Project area

The Project area as a whole has been assessed as being an historic site or landscape, although one in which the remains of built heritage are largely absent, and has been assessed as having a moderate significance to the local community. The Project area is not assessed as being of sufficient significance to warrant the constraint or restriction of any proposed activities.

House Stumps

This site has been assessed as being of low to moderate significance on a local level. A targeted heritage survey to locate the house stumps was completed in 2009 and the team was unable to locate the site. It is highly likely the house stumps have been destroyed by fire and no longer exist. If the house location was found and the stumps were disturbed, the site is not assessed as being of sufficient significance to warrant protection. In the unlikely event of the site being re-discovered, the following mitigation measures should be implemented:

- If the site is not located within area to be disturbed by the Project, then the site should be retained in-situ. As an ongoing protective measure, the site should be fenced off to prevent accidental impacts. In addition, interpretative signage should be developed for the site, and erected in the immediate vicinity.
- In the unlikely event the site is located within the footprint of Project development, then prior to development work proceeding the site should be accurately recorded and photographed, and the information lodged with the local government authority and/or the local historic society.

Log Crossings

The three log crossing sites have all been assessed as being of low significance on a local level. The sites are located outside the Project footprint and would not be impacted by mining-related disturbance. If the log crossings were to be disturbed, the sites are not assessed as being of sufficient significance to warrant protection.

The three sites have previously been recorded and photographed. There are no further heritage management requirements for these sites.

Air Strip and Associated Features

The air strip site has been assessed as being of low significance on a local level. The site is in an area that would not be impacted by mining-related activities. If the air strip was to be disturbed, the site is not assessed as being of sufficient significance to warrant protection.

The site has previously been recorded and photographed. There are no further heritage management requirements for this site.

Drilling Camps

The drilling camp sites have been assessed as being of low significance on a local level. The site near Norman Creek is in an area that may be potentially disturbed by Dam C. If the drilling camp near the Ward River was to be located and subsequently disturbed, the site is not assessed as being of sufficient significance to warrant protection.

Other Non-Historical Features

The plane crash site, fishing huts and transient man's camp would not be disturbed by the Project. In the event that there is a requirement to operate in any of these locations the

management of these sites would be discussed with the relevant interested parties. The Traditional Owners would be consulted through the WCCCC to determine any interests of the Traditional Owners in the management of these sites. Surveys would be undertaken ahead of mine development with involvement of Traditional Owners to identify and clarify the significance of specific areas and to use this information to prioritise high risk sites. RTA, in consultation with Traditional Owners, would designate and enforce agreed buffers around these sites. The 1993 plane crash site would be included. A search of the Australian Heritage Places Inventory found no places protected under the EPBC Act on the National Heritage List.

11.3 Unanticipated Discovery Procedures

Indigenous cultural heritage discovered through systematic surveys or in an unanticipated manner is managed through the process set out in the WCCCA and described in **Section 11.1.6**.

In the event that any bones suspected of being of human origin are found, the site would not be disturbed and the find would be reported to the Queensland Police Service.

Extensive literature reviews and archaeological surveys have been undertaken within the Project area and it is very unlikely that any additional non-Indigenous heritage sites are present.

In the event that previously unidentified non-Indigenous heritage sites are located within the Project area during the course of mining activity, the following six-step unanticipated discovery process would be implemented. These measures would ensure that requirements under the *Queensland Heritage Act 1992* (Qld) are followed, particularly in relation to the duty not to interfere with archaeological artefact discoveries. The heritage provisions of the EPBC Act do not apply to new discoveries not on the National Heritage List.

Step 1 If any Project personnel, contractors or subcontractors believe they have discovered or uncovered non-Indigenous heritage materials, the individual should notify machinery operators that are working in the general vicinity of the area in question that earth disturbance works should stop immediately.

Step 2 A buffer protection zone of 20m x 20m would be established around the suspected heritage site or items. No unauthorised entry or earth disturbance would be allowed within this "heritage zone" until such time as the suspected heritage items have been assessed, and appropriate mitigation measures have been carried out.

Step 3 An archaeologist or suitably qualified historian would carry out an assessment of the heritage find. This would include assessment against the criteria for inclusion on the Queensland Heritage Register under the *Queensland Heritage Act 1992*.

Step 4 Based on the findings of the assessment, appropriate management recommendations would be developed for the heritage find. The Traditional Owners would be consulted through the WCCCC to determine any interests the Traditional Owners may have in the find.

Step 5 Once endorsement has been obtained, the prescribed management recommendations would be carried out by the appropriate personnel. The Traditional Owners would be consulted through the WCCCC to determine any interests of the Traditional Owners in the management of these sites.

Step 6 On the completion of the prescribed management works, construction works may recommence.

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Environmental Impact Statement

for South of Embley Project

Section 12
Visual Amenity

12 VISUAL AMENITY

This section describes the current visual amenity of the Project area, identification of visual receptors, and the assessment methodology and evaluation of Project visual impacts. This assessment considers the visual impacts within the Project footprint and surrounding public areas that are likely to provide a view of the proposed Project components.

12.1 Evaluation Methodology

The visual evaluation methodology is based on the assumption that the visual quality of the landscape increases as:

- relief and topographic ruggedness increases;
- vegetation patterns become more diverse;
- the proportion of natural and agricultural landscapes increases and the proportion of built (unnatural) landscapes decreases; and
- the presence of water forms increases.

Visual impacts are predominantly subjective and strongly related to the sensitivity of the viewing source. Potentially sensitive locations can include:

- residences (especially those within 1km);
- major and secondary roads;
- recreational areas and tourist destinations; and
- heritage sites.

The visual impact assessment for the Project area involved the following components:

- targeted visual site appraisal conducted in August 2008. Other visual assessments and photography were completed during the course of environmental field work, which included both wet and dry season inspections (between October 2007 and May 2009);
- 3D modelling of the proposed port; and
- an assessment of the potential impact of the proposed infrastructure on the existing landscape character.

12.2 Existing Visual Characteristics

The Project area is located south of Weipa and consists of terrestrial, freshwater and marine environments. The Project area is situated in a remote location and is not easily accessible from surrounding communities. Current land access to the Project area is restricted to dirt tracks (via Beagle Camp Access Road), which are accessible only during the dry season. The Project area can also be reached by boat. There are no buildings or infrastructure present within the footprint of the area to be disturbed by mining and related infrastructure, the proposed port area or the Hey River barge/ferry terminal area. The proposed Humbug barge terminal is adjacent to the existing Humbug Wharf and the proposed Hornibrook ferry terminal is adjacent to the existing Lorim Point East Wharf.

The Project area is predominantly a homogenous relatively flat bauxite plateau landform covered by 25 to 35m high Darwin Stringybark woodlands (refer **Plate 12-1**). The Project area is mostly undisturbed apart from vehicle tracks and lines cleared for exploration drilling.

Plate 12-1 Exploration Drilling Track through Darwin Stringybark Woodland

The main freshwater watercourses within the Project area include the Ward River, Norman Creek and Winda-Winda Creek. These watercourses are relatively undisturbed (refer **Plate 12-2**). Norman Creek and the Ward River flow into large mangrove-lined estuaries.

The Embley and Hey Rivers border the northern portion of the mine lease area (ML 7024) and separate it from Weipa. The Embley River's estuary is up to 3km wide and includes a built environment view of wharf structures and buildings in the Port of Weipa, while the Hey River is relatively undisturbed along its length.

The visual contrast within the largely uniform landscape of the Project area occurs where the bauxite plateau meets streams, estuaries or the coast.

Plate 12-2 Ward River

The western portion of the Project area (excluding the proposed port infrastructure outside ML 7024) is bound by the Gulf of Carpentaria. Bauxite cliffs from 7 to 20m high occur along various parts of the coastline, most notably between Boyd Point and Thud Point. The red bauxite overlaying a band of white kaolin clays forms an aesthetically prominent landscape (Abrahams *et al.* 1995; **Plate 12-3** and **Plate 12-4**).

Plate 12-3 Bauxite Cliffs between Pera Head and Boyd Point

Plate 12-4 Bauxite Cliff

12.3 Visual Receptors

There are no permanent residences in the Project area and the nearest communities are located away from the main Project components (refer **Figure 12-1**). The nearest residential areas are in Weipa and Napranum, located 40km north of the proposed port, and Aurukun, located 40km south of the proposed port. The closest mining areas are 4km from Napranum and 15km from Aurukun.

Cattle grazing is the predominant agricultural land use in the wider Weipa region. However, the Project area is not grazed and no rural homesteads are located near the Project area. The closest cattle stations to the Project area are:

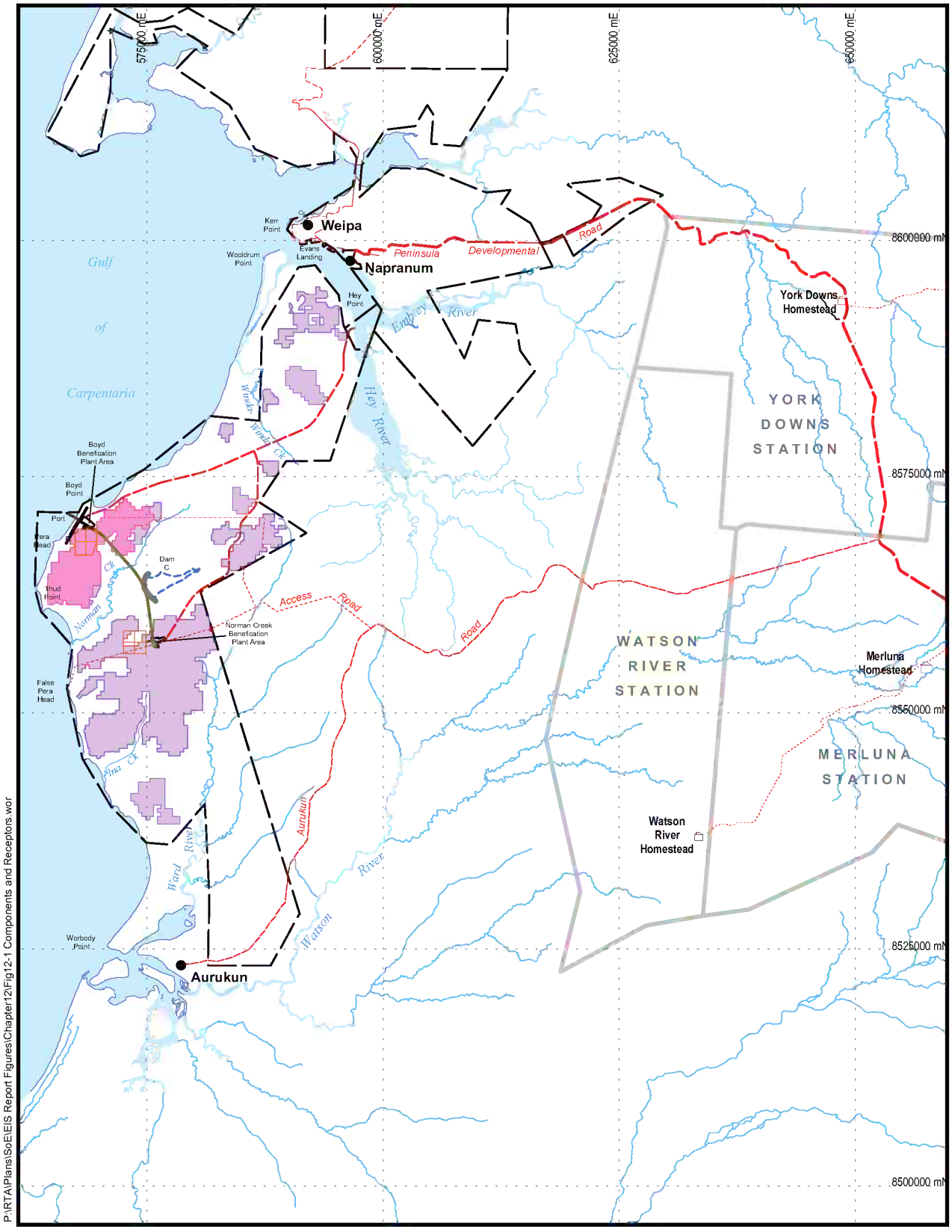
- "Watson River", located approximately 50km south-east;
- "York Downs" (previously called "Sudley"), located approximately 50km north-east; and
- "Merluna", located approximately 70km east.

The primary viewpoint of the Project is from coastal and estuarine waters. The Gulf of Carpentaria waters adjoining the Project area are used by professional, recreational and tour-guided fishing operations.

There are five estuaries in the vicinity of the Project area, only one of which occurs entirely within it (Norman Creek estuary). The others only partially occur within the Project area but have catchments that drain it (Ward River, Triluck–Roberts Creek, Leithen Creek and the Embley–Hey River system). Estuaries within the Project area are utilised by recreational and tour guided fishing groups on an intermittent basis. The Embley River is used by commercial and recreational vessels utilising the Port of Weipa.

Traditional Owners regularly visit outstations in the Project area, including Amban (False Pera Head), Waterfall (near Ina Creek), and Six Ti-Tree (located a short distance south of Ina Creek) during the dry season to go camping, fishing and undertake other activities. The major Project components are not visible from these locations. However, they may be visible while travelling en route to these areas. Access to these locations is discussed in **Section 16.3.2**.

There are no gazetted public roads that traverse the Project area south of the Embley River and hence no viewpoints accessible from public roads. However, the general public do use various tracks in the Project area. Members of the general public wishing to access the lands covered by the Project area require a permit from the Aurukun Shire Council (refer **Section 14.1.1**).



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RTA Mining Lease boundary
Township
Road/track
Tailings storage facility
Mining Years 1 -13
Mining Years 14 - 40

South of Embley Project

Fig. 12-1: Project Components and Visual Receptors

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Datum/Projection: GDA94/MGA Zone 54 Date: 01/04/2011

12.4 Potential Impacts and Mitigation Measures

The main visual elements of the Project and potential impacts on receptors are discussed below in terms of day and night.

12.4.1 Port

The proposed port would be constructed between Boyd Point and Pera Head and include an approach jetty, wharf (four berths) and two ship loaders (at full capacity). The approach jetty would be approximately 568m long and the wharf, at maximum capacity, would be approximately 696m long. The proposed port would consist of an "I" berth aligned perpendicular to the shoreline (refer **Figure 12-2**). A 3D simulation for Stage 1 of the proposed port facilities, which includes two berths and one ship loader, is presented in **Figure 12-3**.

Total height of the wharf and jetty would be approximately 17m above lowest astronomical tide (LAT) and the top of the ship loaders would be approximately 40m above LAT. The height of the proposed port facilities would be comparable with the height of the Darwin Stringybark woodlands on top of the bauxite cliffs. Where possible, the approach jetty, wharf and ship loaders would be painted in a colour that minimises visual impacts, while adhering to marine safety standards.

The proposed port infrastructure would be directly visible from vessels using Gulf of Carpentaria waters in the vicinity of Boyd Point and Pera Head, although the visual impacts are anticipated to be low, owing to the height of the natural cliffs and vegetation and the transitory nature of visits to the area.

Lighting would be required at the proposed port for night operations. Due to the remote location of the site and lack of other lighting sources, lights on the proposed port would be visually prominent and are expected to create a "glow" in the night sky. RTA would implement a lighting plan at the port to mitigate the potential effects of altered above water, night-time light regime on sea turtle hatchlings (refer **Section 6.9.4.3**). RTA would work with the Western Cape Communities Coordinating Committee and Department of Environment and Resource Management (DERM) through an adaptive approach to minimise the impacts of changes to the light regime during both the construction and operation phases of the proposed port on marine turtles, while still allowing a safe working environment. The following factors would be considered:

- ensuring lighting is minimised overall to that which is essential for safe and efficient operation of the facility;
- reducing lighting when there are no ships at berth or being piloted in the area;
- shielding and/or recessing lights to minimise light spill;
- installing long wavelength lights; and
- any other lighting options that further reduce impacts to marine turtles while allowing for the safe and efficient operation of the port facility.

RTA propose an adaptive approach to work with the Traditional Owners and DERM to minimise the impacts of changes to the light regime during both the construction and operation phases of the proposed port on marine turtles, while still allowing a safe working environment.

Nocturnal fauna in the immediate vicinity may be affected by lighting, although any impacts are expected to be localised.

12.4.2 Mine Infrastructure Areas

The bauxite product stockpiles would be located a few hundred metres east of the proposed port site (refer **Figure 12-2**), behind a natural vegetation buffer of 25m to 35m high Darwin Stringybark woodlands. The stockpiles would include two stackers and two reclaimers (at maximum capacity) to handle the product bauxite. The maximum height of the stockpiles and stackers/reclaimers would be approximately 30m. The stockpiles and facilities would not

adversely affect the skyline as the height is comparable with the height of the Darwin Stringybark woodlands.

The Boyd beneficiation plant would be situated approximately 1km east of the proposed port site, behind a natural vegetation buffer of Darwin Stringybark woodlands and behind the product stockpiles, and thus would not be visible from vessels using the Gulf of Carpentaria. The plant would be approximately 20m high. A tailings storage facility would be constructed adjacent to the beneficiation plant and at final capacity would be approximately 22m high. The infrastructure area would also include a power station and general infrastructure buildings (e.g. warehouse, workshops; refer **Section 2**).

Any visual impacts from the stockpile and plant areas are considered to be low due the setback distance from the coastline and the retention of the vegetation buffer.

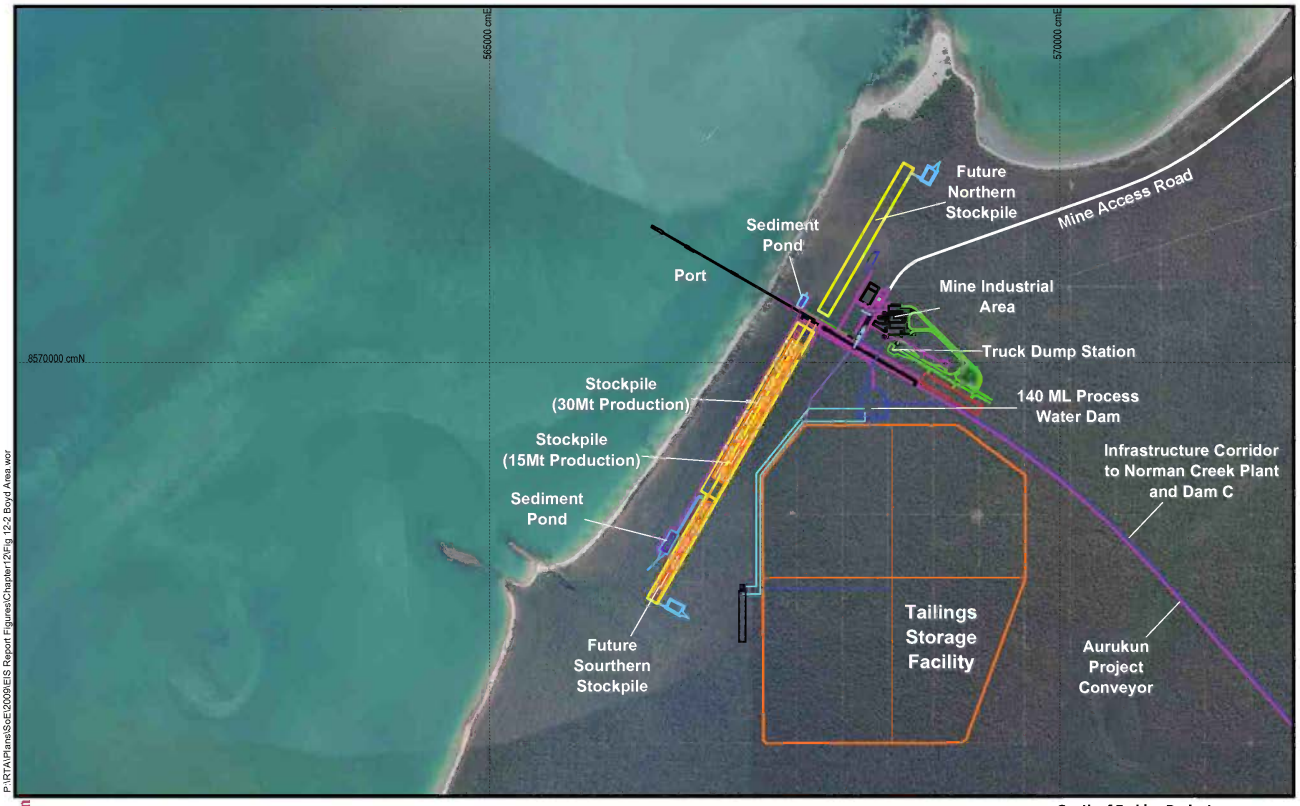
Lighting would be required at the stockpiles and plant areas for construction and operations. Directional lighting located on the stackers and reclaimers is proposed for these areas in preference to permanent tower lighting to minimise light spill. Lighting at the Boyd infrastructure area is expected to create a "glow" in the night sky. Nocturnal fauna in the immediate vicinity may be affected by lighting, although any impacts are expected to be localised and of a minor nature. The potential impacts and management of lighting on marine turtles is discussed further in **Section 6.9.4.3** and other fauna in **Section 7.19.1**.

The Norman Creek beneficiation plant would be located approximately 15km south-east of the Boyd beneficiation plant and away from viewpoints such as the coastline or the Beagle Camp Access Road. The facilities would be similar to that of the Boyd beneficiation plant. Some lighting would be present on the beneficiation plant and mine industrial area buildings to enable night-time operations. Given the distance from the coastline and natural vegetation buffer, light glow from this facility is not anticipated to add appreciably to that from the proposed port.

12.4.3 Mining

Mining would involve clearing vegetation and extraction of ore from shallow pits (refer **Section 2.4**). Mining involves removing around one metre of soil and overburden above the bauxite and then excavating the bauxite (which has an average thickness of 3.4m). Generally the subsoil and overburden stripped from a new mining area would be taken directly to an existing mined-out area that is awaiting rehabilitation. In circumstances when operational requirements prevent stripped material being directly re-spread, such as at commencement of operations, it would be temporarily stockpiled. The final landform would not have any out-of-pit dumps of excavated wastes or soil. The final landform would be at a lower elevation than the original landform due to the removal of the bauxite, but the overall slope of the landform would be similar. Vegetation would be retained within environmental buffers along the coastline and beside waterways. Mining would be excluded within the buffer areas (refer **Section 7.9.2**). There are no visual receptors within the mining areas. Given the minimal topographic changes associated with mining, the retention of vegetation buffers, the revegetation with local native species (refer **Section 3.10.5**) and the lack of visual receptors, visual impacts are considered negligible.

Lights from mining equipment are likely to have only a negligible impact, if any, on nocturnal fauna.



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South of Embley Project

Fig. 12-2: Boyd Infrastructure Area and Port

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Rio Tinto Alcan

South of Embley Project

Fig. 12-3: Port Site

Date: 20/07/2010

12.4.4 Barge and Ferry Terminals

The proposed Humbug barge terminal and the Hornibrook ferry terminal would be located on the northern bank of the Embley River, adjacent to the existing Humbug and Lorim Point East Wharves respectively (refer **Plate 12-5** and **Plate 12-6**). The Hey River barge/ferry terminal would be sited on the western bank of the Hey River (refer **Plate 12-7**) approximately 6km south of Napranum. The Hey River Terminal would not be visible from Napranum (refer **Plate 12-8**).

The barge/ferry terminals involve minor developments on the shoreline of the Embley and Hey Rivers. The terminals would include barge landings and ferry pontoons, small car parks and covered walkways all below the skyline of the natural vegetation (refer **Section 2.7.2**). Lighting would also be required at the terminals, although this would be minimal and designed to minimise nuisance lighting. The Humbug and Hornibrook terminals would be situated within existing industrial areas and are not expected to affect the visual aesthetics of the area. The Hey River Terminal would be located within an undeveloped section of the Hey River. It is not directly visible from Napranum (refer **Plate 12-8**); however, a low glow from lighting at the terminal may be visible. The Hey River terminal would have low impact on the visual amenity of the Hey River given the small scale of the facility.

Plate 12-5 Proposed Location of the Humbug Barge Terminal

Plate 12-6 Proposed Location of the Hornibrook Ferry Terminal

Plate 12-7 Proposed Location of the Hey River Barge/Ferry Terminal

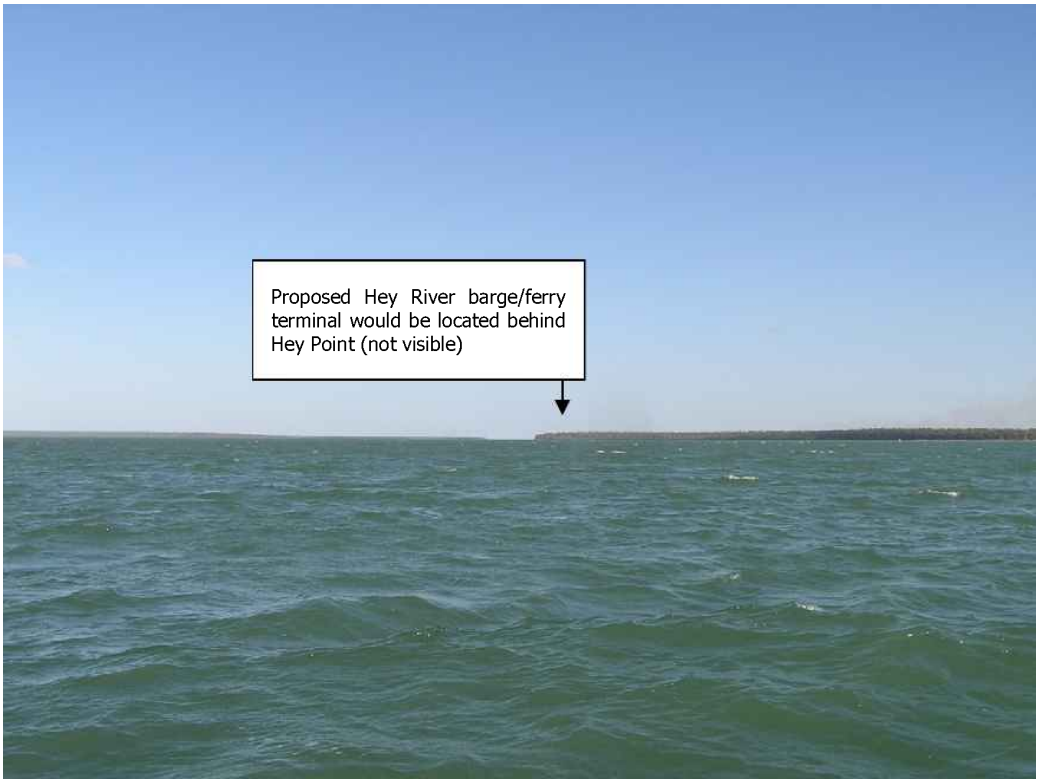

Plate 12-8 View from Napranum toward Hey Point

12.4.5 Other Infrastructure

Other infrastructure such as water pipelines, overland conveyors, roads, the water supply dam and a construction camp would be required for the Project. Access to the site would be restricted and there are no anticipated public viewpoints of these elements; therefore mitigation measures are not proposed. Due to the remoteness of the site, lights from mine-related vehicular traffic would not be visible from any residences. Traffic on the Mine Access Road would be infrequent at night and lights from vehicles are unlikely to have an impact on nocturnal fauna.

A temporary construction camp would be built for the initial construction phase of the Project and decommissioned once construction has been completed. The construction camp would be approximately 1km from the coastline and would be screened by a natural vegetation buffer of Darwin Stringybark woodlands. The construction camp facilities would be single storey, typically less than 10m in height and would not be visible from the coastline. Lighting would also be required at the camp, although this would be minimal and designed (e.g. shielding) to minimise night glow and nuisance lighting.

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Environmental Impact Statement

for South of Embley Project

Section 13
Waste

13 WASTE

This section provides a summary of relevant waste management regulations, describes the waste that would be generated by the Project, and details waste management strategies that would be adopted to prevent or mitigate environmental impacts.

13.1 Waste Management Regulations

The regulatory requirements governing waste management are provided within the *Environmental Protection Act 1994* (Qld) (EP Act), the *Environmental Protection Regulation 2008* (Qld) (EP Regulation) and associated *Environmental Protection (Waste Management) Policy 2000* (Qld) (EPP (Waste), and the *Environmental Protection (Waste Management) Regulation 2000* (Qld).

The regulatory requirements relating to waste from international shipping vessels are provided within the Commonwealth *Quarantine Act 1908* (Cwlth) and the *Quarantine Regulations 2008* (Cwlth).

The main objectives of the regulatory requirements are to:

- minimise the impact of waste on the environment, particularly so far as it directly affects human health;
- minimise the amount of waste generated;
- promote efficiency in the use of resources;
- promote the use of wastes as a resource (i.e. reuse and recycling), and
- otherwise achieve continuous improvement in the standard of waste management activities.

13.1.1 Waste Definition

The EP Act defines "waste" as anything that is:

- left over, or an unwanted by-product, from an industrial, commercial, domestic or other activity, or
- surplus to the industrial, commercial, domestic or other activity generating the waste.

The EP Regulation defines "general waste" as waste other than regulated waste. Regulated wastes are defined as commercial or industrial waste and of a type or containing constituents defined in Schedule 7 of the Regulation (e.g. tyres, batteries, mineral oils, and organic solvents).

The EPP (Waste) defines regulated waste, as any waste:

- that contains a significant quantity and concentration of a hazardous contaminant; or
- that exhibits hazardous characteristics because of its toxicity, carcinogenicity, mutagenicity, teratogenicity, flammability, corrosivity, reactivity, ignitability or infectiousness, through its physical, chemical or biological characteristics, or
- that may cause environmental harm if improperly transported, treated, stored, disposed or otherwise managed.

13.2 Waste Generation

The major sources of waste generation from the construction, operational and decommissioning phases of the Project are shown in **Table 13-1**, **Table 13-2** and **Table 13-3** respectively.

13.2.1 Construction Wastes

The wastes anticipated to be generated by construction activities of the Project and their management are shown in **Table 13-1** and are based on experience at other Rio Tinto construction projects in Queensland. The wastes are for the entire construction period unless otherwise specified.

Air emissions, including particulates, fumes and odours, their potential impact to environmental values during the construction phase, and their control measures are described in **Section 9**.

Table 13-1 Construction Wastes

Waste Type	Source(s)	Approximate Quantity (produced over construction period)	Detailed descriptions in other Sections of this EIS
Green waste/cleared vegetation	Clearing of vegetation for construction of Mine Access Road, site construction camp, and mine infrastructure area.	98,900 tonnes	Section 7.9 Section 13.3.6
Excavated material (rock and earth)	Ferry/barge facility access, Mine Access Road and mine infrastructure.	Minor amounts	Section 13.3.3
Excavated waste (dredged material)	Port, Humbug RORO terminal Hornibrook ferry terminal Hey River barge/ferry terminal	6,500,000m^3 10,700m^3 19,000m^3 13,700m^3	Section 6.5.1 Section 6.5.2 Section 6.5.2 Section 6.5.2
General solid wastes including putrescible & organic (food waste/scraps), paper, packaging (e.g.: cardboard, plastic, styrofoam), inert plastic (e.g. plastic cups, plastic wrap), aluminium cans etc	Construction offices and site construction village.	310 tonnes	Section 13.3.6
Broken concrete and concrete materials	Left over concrete from site infrastructure area and site construction village.	50 tonnes	Section 13.3.6
Steel/metal off cuts	Ferry/barge facilities, mine infrastructure and site construction village.	40 tonnes	Section 13.3.6
Timber pallets and off-cuts	Ferry/barge facilities, mine infrastructure and site construction village.	20 tonnes	Section 13.3.6
Tyres	Workshop	100 tyres	Section 13.3.6
Batteries	Workshop	20 tonnes	Section 13.3.6
Sewage from temporary facilities (prior to commissioning of Sewage Treatment Plant)	Construction areas	Minor amounts	Section 13.3.7
Sewage Treatment Plant waste and residues (sewage sludge)	Construction offices and construction village.	3 tonnes	Section 13.3.7
Sewage Treatment Plant effluent	Construction offices and construction village.	97ML (Volume would vary depending on number of personnel living and working on the site.)	Section 13.3.7
Hydrocarbon wastes (e.g. waste oil and containers, oily water, grease-trap waste, grease, black jack, oil filters and oily rags)	Workshop	45 tonnes waste 5 tonnes waste oil	Section 19.1
Paints and resins	Ferry/barge facilities, mine infrastructure and construction village.	Minor amounts	Section 19.1

13.2.2 Operational Wastes

The waste produced as a direct result of mine operation is detailed in **Table 13-2**. The volumes expected to be generated in the Project area under each production scenario have been estimated on a pro-rata basis from the existing Weipa operations and ship waste is based on information from the North Queensland Bulk Ports Corporation Limited (NQBP).

There would be no out-of-pit dumps for waste rock or subsoil. Air emissions, including particulates, fumes and odours, their potential impact to environmental values during the operational phase, and their control measures are described in **Section 9**.

Table 13-2 Operational Wastes

Waste Type	Source(s)	Approximate Quantity produced per annum	Other relevant Sections of this EIS
Green waste/cleared vegetation	Clearing of vegetation for mining areas	15Mdpt – 14,000 t/a 30Mdpt – 27,000 t/a 50Mdpt – 56,500 t/a	Section 7.9
Excavated waste - dredged material	Port Humbug RORO terminal Hornibrook ferry terminal Hey River barge/ferry terminal	890,000m^3 Minor amounts Minor amounts Minor amounts	Section 2.6.1
Tailings	Beneficiation plant	15Mdpt – 6.5 Mt/a 30Mdpt – 12.9 Mt/a 50Mdpt – 21.5 Mt/a	Section 5.2.5 Section 5.4 Section 13.3.4
Oversize material	Beneficiation plant	Variable	Section 13.3.5
General mine site wastes including putrescibles & organic (food waste/scraps), paper and cardboard, plastic and wood products (e.g. damaged timber pallets, treated timber), clean rubber hose, computer and electrical equipment, gloves.	Workshop, offices	15Mdpt – 380 t/a 30Mdpt – 760 t/a 50Mdpt – 1,300 t/a	Section 13.3.6
Reusables – intact wooden pallets.	Workshop, office	Minor amounts	Section 13.3.6
Scrap metal recyclables (e.g. beneficiation screens, conveyor rollers, scrap steel, bulk swarf, clean drums).	Mine plant, including administration, workshops	15Mdpt – 480 t/a 30Mdpt – 970 t/a 50Mdpt – 1,600 t/a	Section 13.3.6
Other solid recyclables – including printer toner cartridges, aluminium cans.	Workshop, office	15Mdpt – 1 t/a 30Mdpt – 2 t/a 50Mdpt – 3 t/a	Section 13.3.6
Tyres Light vehicle tyres Heavy vehicle tyres	Vehicle workshops	 15Mdpt – 24 t/a 30Mdpt – 47 t/a 50Mdpt – 79 t/a 15Mdpt – 676 t/a 30Mdpt – 1,351 t/a 50Mdpt – 2,252 t/a	Section 13.3.6
Conveyor belt (reusable)	Conveyor	Variable	Section 13.3.6
Batteries (recyclable)	Trucks and light vehicles	15Mdpt – 26 t/a 30Mdpt – 53 t/a 50Mdpt – 88 t/a	Section 19.1
Clinical waste	First-aid clinic	15Mdpt – <1 t/a 30Mdpt – <1 t/a 50Mdpt – <1 t/a	Section 13.3.6
Sewage Treatment Plant solid waste and residues (sludge).	Offices, vehicle workshop, bathhouse, ships.	1 t/a	Section 13.3.7
Waste oil (recyclable)	Vehicle workshop, power station	15Mdpt – 658 t/a 30Mdpt – 1,316 t/a 50Mdpt – 2,194 t/a	Section 13.3.7 Section 19.1
Waste grease	Workshop	15Mdpt – 13 t/a 30Mdpt – 27 t/a 50Mdpt – 44 t/a	Section 13.3.6 Section 19.1
Oily rags, oily absorbent matting and oil filters.	Vehicle workshops	Disposed off-site: 15Mdpt – 27 t/a 30Mdpt – 55 t/a 50Mdpt – 91 t/a Recycled off-site: 15Mdpt – 10 t/a 30Mdpt – 21 t/a 50Mdpt – 34 t/a	Section 13.3.6 Section 19.1
Liquid hazardous wastes (e.g. solvents, lubricants, coolant, paints, resins, etc),	Maintenance workshops, vehicle wash down, conveyor, site infrastructure, chemical	15Mdpt – <1 t/a 30Mdpt – 1 t/a	Section 13.3.7 Section 19.1

Waste Type	Source(s)	Approximate Quantity produced per annum	Other relevant Sections of this EIS
	storage areas, laboratory	50Mdpt – 2 t/a	
Treated Sewage Treatment Plant (STP) effluent	Boyd and Norman Creek STPs	15Mdpt – 3 ML/a 30Mdpt – 5 ML/a 50Mdpt – 7 ML/a	Section 13.3.7
Ship waste (including putrescible waste)	Australian and overseas shipping vessels	15Mdpt – 90 t/a 30Mdpt – 170 t/a 50Mdpt – 275 t/a	Section 13.3.8
Ballast water	Bulk carrier vessels	No discharge of high-risk ballast water in Australian waters.	Section 13.3.8

13.2.3 Decommissioning Wastes

The waste produced as a direct result of decommissioning at the end of the mining operation is detailed in **Table 13-3**. Note it is not possible at this time to estimate the quantity of waste for the decommissioning phase. A Waste Management Plan would be prepared prior to decommissioning.

Table 13-3 Decommissioning Wastes

Waste Type	Source(s)	Other relevant Sections of this EIS
General mine site wastes including putrescibles & organic (food waste/scraps), paper and cardboard, plastic and wood products (e.g. damaged timber pallets, treated timber), clean rubber hose, computer and electrical equipment, gloves	Site infrastructure and mining areas	Section 3.10.9 Section 13.3.6
Concrete	Site infrastructure areas	Section 3.10.9 Section 13.3.5
Steel, scrap metal	Ferry/barge facilities, site infrastructure	Section 3.10.9 Section 13.3.5
Tyres	Workshop	Section 3.10.9 Section 13.3.5
Liquid hazardous wastes (e.g. hydrocarbons, solvents, lubricants, coolant, paints, resins, pesticides and mercury from thermometers)	Maintenance workshops, vehicle washdown, conveyor, site infrastructure, chemical storage areas, laboratory	Section 3.10.9 Section 13.3.6 Section 19.1
Sewage Treatment Plant (STP) solid residues	STP sludge drying ponds	Section 3.10.9 Section 13.3.6

13.3 Waste Impacts and Management

13.3.1 Waste Management Strategy

The waste management strategies proposed for the Project consider waste from the concept and planning stages through design, construction, operation and decommissioning. The strategies aim to minimise environmental harm that could occur if wastes are not managed properly and contaminants impact environmental values.

The strategy ensures compliance with regulatory requirements as a minimum and incorporates the waste minimisation hierarchy in order of preferred options:

- waste avoidance;
- waste re-use;
- waste recycling;
- energy recovery from waste, and

- waste disposal.

Waste generated on the Project site during the construction, operation and decommissioning phases would be minimised through:

- waste stream characterisation and separation;
- assessment of waste reduction opportunities for identified waste; and
- management of waste in accordance with the waste minimisation hierarchy.

Waste streams would be assessed for potential reuse, and if a feasible reuse option is not available, the waste would be transported to a licensed disposal facility by a licensed waste transporter. Wastes would be stored appropriately to prevent pollution until they are transferred off-site (refer waste management infrastructure in **Figure 13-1**).

The strategy would also address monitoring, tracking and reporting of waste. RTA would consult with the relevant Western Cape Communities Co-ordinating Committee Sub-committee about waste management strategies for the Project.

Cleaner Production

Cleaner production is the continual effort to prevent pollution; reduce the use of energy, water and material resources; and minimise waste in the production process. Generally, cleaner production can be achieved through any or all of the following techniques:

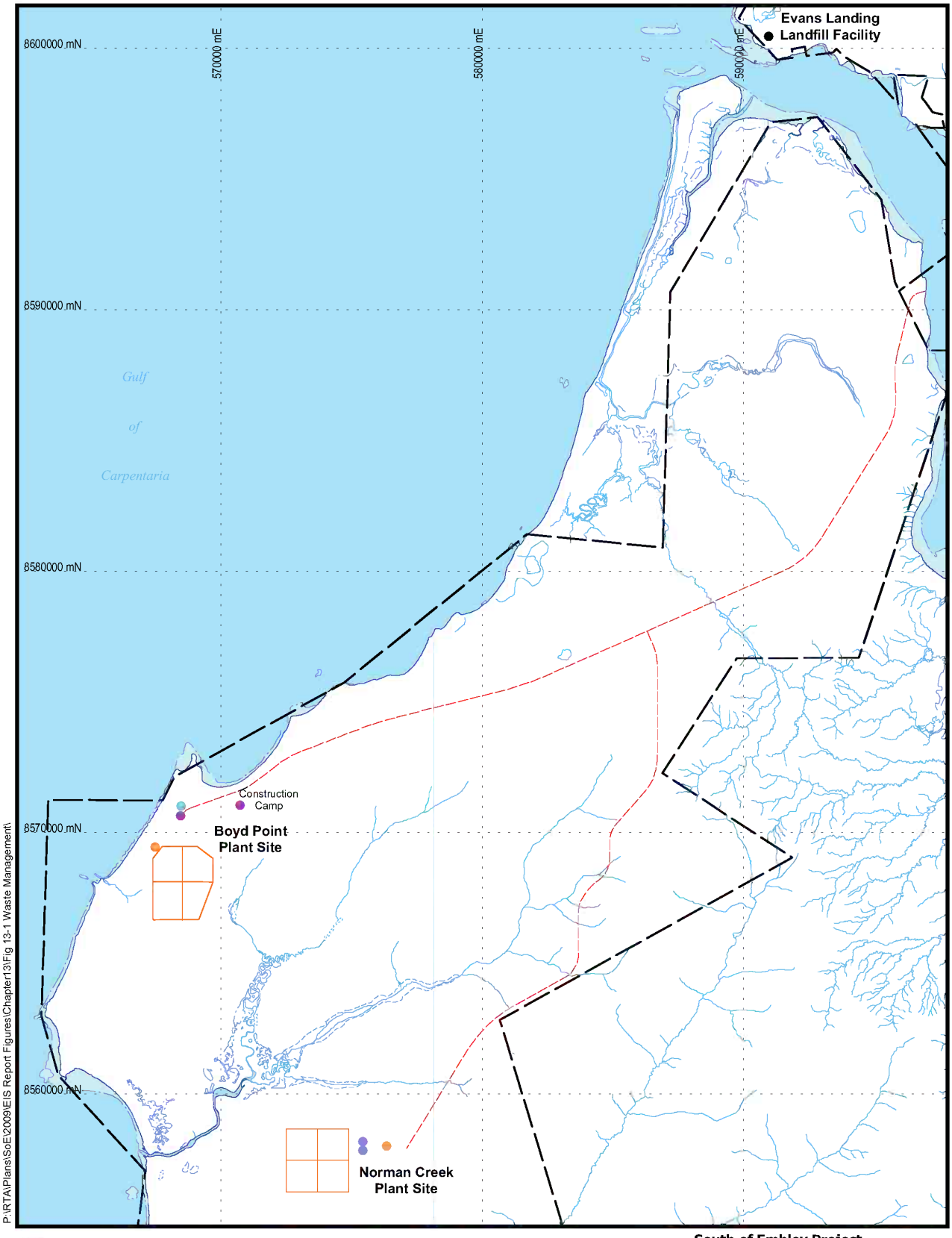
- input substitution (this is not readily available to this Project);
- product reformulation (this is not readily available to this Project);
- production process modification (achieved through selection of the best available practical technologies);
- improved operation and maintenance (achieved through selection and use of the most appropriate processes and equipment, and routine maintenance of that equipment);
- reuse of resources that are otherwise wastes (achieved through off-site recycling); and
- closed-loop recycling – where a product is recycled and used again in the same form.

Aspects of the Project that contribute to cleaner production outcomes include:

- ensure appropriate energy intensity and production efficiency of product bauxite, such as generating power at the load source as far as practical to avoid transmission line losses and reducing height of the beneficiation plant to minimise energy required to lift ore;
- use of the most appropriate processes and equipment for operation and maintenance, such as the reuse of wastewater within the mine water management and beneficiation plant systems, and
- recycling of steel and waste oil.

The Project would generate few wastes that would have a market demand. Off-site recycling is often cost prohibitive due to the remote operations, however the Project would undertake recycling where feasible to do so. The current Weipa mining operations recycle scrap steel, batteries and toner cartridges at third-party facilities and this would also be implemented for the Project. Some other wastes are recycled or reused on-site, such as pallets and conveyor belt. Separate skips would be provided to maintain segregation and maximise economic reuse and recycling, in preference to disposal to landfill.

Adequate separation of components of the waste stream at the point of generation would be practiced by the Project, for example, the segregation of batteries and waste oil, to allow for recovery, where feasible. The Project would review the marketability of its waste for recycling and reuse on a regular basis.



Lease boundary
Proposed mine access road
Drainage
Tailings storage facility

Sewage Treatment Plant
Bioremediation Landfarm
Oversize Material Stockpile
Landfill Facility

Rio Tinto Alcan

South of Embley Project

Fig. 13-1:
Waste Management
(Approximate Areas)

N

0 5km

Datum/Projection: GDA94/MGA Zone 54 Date: 26/10/2010

Waste Monitoring

Waste monitoring and auditing would be undertaken at the Project site. The purpose of monitoring waste management activities and outcomes on-site include:

- assessing actual waste results and comparing with predicted impacts and mitigation measures;
- monitoring for potential environmental impacts, and
- providing baseline data to enable continuous improvement of waste avoidance, reduction and management measures throughout the Project.

Waste Tracking

Certain types of regulated waste are defined as "trackable waste" in Schedule 1 of the *Environmental Protection (Waste Management) Regulation 2000* (e.g. waste oil, clinical waste, sewage sludge, etc). Generators of trackable waste must record prescribed information about the waste and provide it to the transporter.

The treatment, storage and transport of regulated waste requires an Environmental Authority under the *EP Act (1994).* Where a contractor carries out these activities, the contractor would be required to hold the appropriate approvals.

Procedures for identification of regulated wastes and an appropriate waste tracking system for those wastes would be developed as part of the site's environmental management system.

Waste Reporting

The National Pollutant Inventory (NPI) is a National Environment Protection Measure endorsed by the National Environmental Protection Council. The NPI is a database designed to provide information on the types and amounts of certain substances being emitted to the land, air and water.

The objectives of the NPI are to:

- help industry and government with environmental planning and management;
- give the community up to date information about substance emissions and transfers from industrial facilities; and
- promote waste minimisation, cleaner production, and energy and resource efficiency (DEWHA 2009f).

All NPI information is publicly available through the NPI website (http://www.npi.gov.au/).

The NPI sets out the requirements for reporting, including how a facility triggers a reporting obligation and what substances are on the reporting list. The current Weipa operations trigger the NPI because some of its emissions exceed the threshold levels for reporting. RTA would therefore continue to estimate and report emissions to the NPI annually for the whole Weipa operation once the Project commences.

In reporting waste emissions to the NPI, RTA would refer to the relevant Emission Estimation Technique Manual produced by the Department of Sustainability, Environment, Water, Population and Communities (DSEWPC) for each of the activities associated with bauxite mining. The key activities relevant to the Project are:

- mining;
- fuel storage; and
- power generation.

13.3.2 Air Emissions

Air emissions, including particulates, fumes and odours, their potential impact to environmental values, and their control measures are described in **Section 9**.

13.3.3 Excavated Wastes

Excavated wastes include surplus soil and overburden, waste rock, dredged material and contaminated soil.

Topsoil, subsoil and overburden are stripped prior to mining the bauxite layer underneath. The predominant soil type over the Project area is Red Kandosol. Overburden ranges from lateritic sandy-clay loam to light clay. Geology and soils are described in detail in **Section 3.2** and **Section 3.4** respectively.

Generally the soil and overburden stripped from a new mining area are taken directly to an existing mined-out area that is awaiting rehabilitation. In circumstances when operational requirements prevent stripped material being directly re-spread, such as at commencement of operations, it is temporarily stockpiled in the mining area as close as practical to either the location where it has been stripped or where it is planned to be placed. The final landform would not have any out-of-pit dumps of excavated wastes. The progressive rehabilitation process is described further in **Section 3.10** and topsoil management is described in **Section 3.10.4**.

The potential impacts and management of on-shore acid sulphate soils are discussed in **Section 3.9** and the acid sulphate soil potential of sediments excavated by dredging activities is discussed in **Section 6.5**. However, based on the Project design and material characteristics, the impact is anticipated to be low.

Dredged Materials

The National Assessment Guidelines for Dredging (Commonwealth of Australia 2009) requires applicants for sea dumping permits to carry out waste prevention audits with the goal of identifying and controlling contamination sources.

A waste prevention audit has not been undertaken as the material to be dredged is clean and there are currently no port-related or adjacent catchment related point or diffuse contaminant sources in the proposed port area. As described in **Section 1.6.10**, the high cost of dredging provides a financial incentive to reduce dredge volumes as much as possible. Alternative waste management strategies to sea disposal are described in **Section 1.6.11**.

Some practical measures to reduce loss of bulk material into the marine environment during dredging operations include the following:

- barge door seals to be in good condition;
- specifications for trailing suction hopper dredge used during port development dredging will including low wash hull-design, below keel discharge and electronic positioning systems;
- taking loaded hopper dredge to spoil disposal areas and discharging material as soon as possible to minimise clays settling and adhering to the hopper lining; and
- developing a Dredge Management Plan to aid the even distribution of material over the spoil grounds.

Disposal of material dredged from the proposed port, Humbug RORO barge terminal, Hornibrook ferry terminal, and Hey River ferry/barge terminal and its impact is described in **Section 6.5**.

Contaminated Soil Remediation

Standard procedures for the storage, handling, disposal and spill response for potentially hazardous waste materials would be adopted to minimise potential of generation of contaminated soil (refer **Section 19.1**).

Sites that become contaminated would be investigated, managed and remediated in accordance with the requirements of the contaminated land provisions of the EP Act. Hydrocarbon contaminated soil would be excavated and treated on-site using bioremediation techniques in an on-site landfarm. Landfarm areas would be constructed near the sludge drying ponds at the

Boyd and Norman Creek infrastructure areas. The area would be bunded and water runoff collected in the site's water management system. Soil would be remediated to a level that meets the objective for final land use in accordance with the *Draft Guidelines for the Assessment and Management of Contaminated Land in Queensland* (EPA 1998).

13.3.4 Tailings

The principal mineral waste at the site would be tailings from the processing of the bauxite, known as beneficiation. Beneficiation involves separation of the bauxite and waste materials through screening, crushing, washing and dewatering. No chemicals are added to the process. This process produces tailings consisting of water, fine bauxite pisolite, sands and clays. The particle size of tailings is less than 0.6mm. Approximately 0.4Mt of tailings is produced for every 1Mdpt of bauxite.

Characterisation

The Information Sheet *"Determining dams containing hazardous waste"* (EPA 2003) outlines the steps to determine if a dam contains hazardous waste resulting from mineral processing activities.

Tailings generated by the Project are expected to be similar to that currently generated at Weipa and Andoom. Representative samples were collected from the existing East Weipa and Andoom tailings storage facilities and analysed for the specified tailings constituents used to define a hazardous dam (EPA 2003). In addition, tailings solid, crude ore and bauxite product samples from East Weipa and Andoom, and crude ore samples from the Project area, were analysed for metals and evaluated in terms of enrichment (Rio Tinto 2009a). A summary of the ore, tailings solid and tailings liquid results (Rio Tinto 2009b) are presented in **Table 13-4** and **Table 13-5** respectively.

The available data on the metal content of bauxite ore from the Project area and existing Weipa operations, and bauxite product from East Weipa and Andoom, are also presented in **Table 13-4**.

The data show that bauxite ore and tailings:

- do not trigger the DERM environmental investigation limit (EIL) for contaminated land in Queensland (EPA 1998);
- are not significantly enriched in any metal when compared to average crustal abundance using the Geochemical Abundance Index (GAI) (Bowen 1979). The DME/DEH (1995) guideline entitled *Assessment and Management of Acid Drainage* states "*a GAI of greater than three indicates significant enrichment to a level that warrants further examination*". None of the metals have a GAI greater than three; and
- tailings and bauxite product are not enriched in any metal when compared to crude bauxite ore.

An earlier assessment of fine tailings from Andoom by the National Research Centre for Environmental Toxicology (Noller 2002) concluded:

"The chemical properties of Andoom ultrafine tailings, being essentially soil, suggest that there is unlikely to be any hazard associated with leaching by tropical rainwater as the material is already highly leached".

Given the GAI of one for aluminium in tailings, the assessment by Noller (2002) and the concentration of aluminium in recovery slots, aluminium in tailings is not expected to have a significant impact on the environment.

Tailings solid samples were leached using two different procedures (refer **Section 8.15.1)**. The maximum concentration of aluminium in leachate was 10µg/L, less than the median concentration in freshwater streams (18µg/L) in the Project area. Based on these results, leaching of aluminium from tailings is not anticipated to have an adverse affect on the environment.

Table 13-4 Metal Concentrations in Bauxite Ore and Tailings

Material Type	Total Element Content (mg/kg or %)								EPA Criteria for Hazard Waste	DERM EIL	Average Crustal Abundance	Geochemical Abundance Index (GAI)							
	Crude Ore*			Blended* (Andoom and East Weipa)			Tailings##					Crude Ore			Blended (Andoom and East Weipa)			Tailings	
Site / Parameter	South of Embley	Weipa	Andoom	Product Bauxite	Coarse Tailings	Fine Tailings	Andoom	Weipa	mg/kg	mg/kg	mg/kg or %	South of Embley	Weipa	Andoom	Product Bauxite	Coarse Tailings	Fine Tailings	Andoom	Weipa
Reference	1	2	2	2			3		4	5	6								
Aluminium	29.3%#	29.0%	28.9%	30.1%	23.5%	31.1%	ND	ND	na	na	8.2%	1	1	1	1	1	1	ND	ND
Arsenic	<5##	15	18	17	9	10	0.2	0.4	500	20	1.5	ND	3	3	3	2	3	0	0
Boron	ND	ND	ND	ND	ND	ND	<50	<50	15,000	na	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cadmium	ND	<1	<1	<1	<1	<1	<0.1	<0.1	100	3	0.11	ND	ND	ND	ND	ND	ND	0	0
Chromium	ND	155	175	160	100	25	ND	ND	na	(50)^	100	ND	0	0	0	0	0	ND	ND
Cobalt	ND	12	16	9	11	15	6.1	1.1	500	na	ND	ND	ND	ND	ND	ND	ND	0	0
Copper	<5##	5	15	<5	<5	17	3	0.3	5,000	60	50	0	0	0	ND	ND	0	0	0
Iron	5.6%#	4.6%	9.5%	6.3%	3.6%	4.9%	ND	ND	na	na	4.1%	0	0	1	ND	ND	0	ND	ND
Lead	7##	31	24	36	24	33	12	6.4	1,500	300	14	0	1	0	1	0	1	0	0
Manganese	ND	185	160	160	180	240	ND	ND	na	500	950	ND	0	0	0	0	0	ND	ND
Mercury	ND	ND	ND	ND	ND	ND	<0.1	<0.1	75	na	ND	ND	ND	ND	ND	ND	ND	ND	ND
Nickel	<2##	20	11	7	11	19	3.6	1.4	na	60	80	0	0	0	0	0	0	0	0
Selenium	ND	ND	ND	ND	ND	ND	<1	<1	na	na	0.05	ND	ND	ND	ND	ND	ND	ND	ND
Zinc	<5##	30	20	10	15	20	0.8	0.6	na	200	75	0	0	0	0	0	0	0	0

Method: * XRF ** ICP-MS ^ Cr III only
EIL: Environmental Investigation Level
ND: No Data
na: not applicable
References:

1. Rio Tinto internal data. # Mean of 50 samples from drill cores taken in 2006 and ## Mean of two samples analysed in September 2009
2. Smith (1985)
3. Rio Tinto internal data. Mean of two whole *in situ* tailings samples taken in May and September 2009.
4. EPA (2003)
5. EPA (1998)
6. Bowen (1979)

Table 13-5 Analysis of Weipa and Andoom Tailings Liquid

Analyte	Units	Andoom tailings liquid	East Weipa tailings liquid	EPA Criteria for hazardous waste	ANZECC (95%) Freshwater (receiving waters) trigger
pH	pH unit	8.1	6.1	5-9 inclusive	NA
EC	µS/cm	909	24	4000	NA
Aluminium	µg/L	302***	21***	NA	0.055*
Arsenic	mg/L	<0.001	<0.001	1.0	0.013**
Boron	mg/L	0.07	<0.05	5	0.370
Cadmium	mg/L	0.0001	<0.0001	0.01	0.0002
Cobalt	mg/L	<0.001	<0.001	1.0	NA
Copper	mg/L	<0.001	<0.001	1.0	0.0014
Lead	mg/L	<0.001	<0.001	0.5	0.0034
Mercury	mg/L	<0.0001	<0.0001	0.002	0.0006
Nickel	mg/L	<0.001	<0.001	1.0	0.011
Selenium	mg/L	<0.01	<0.01	0.05	0.011
Zinc	mg/L	<0.005	<0.005	20	0.008
Chloride	mg/L	0.185	25	2500	NA
Fluoride	mg/L	0.1	<0.1	2	NA
Sulphate as SO_4	mg/L	57	<1	1000	NA

Notes: NA – not established
* pH>6.5
** assumes all arsenic as As V
***mean value from May and September 2009

The solids and liquid results indicate that the concentrations of all constituents are at least an order of magnitude less than the specified criteria (EPA 2003) for hazardous waste and therefore the tailings are not hazardous. Tailings liquid results have been compared with ANZECC/ARMCANZ (2000) freshwater guidelines, however it should be noted this is a conservative screening approach as these guidelines are designed for receiving waters and not intended to be applicable to closed, managed waste systems. The ANZECC default criteria are guidelines developed to protect aquatic ecosystems based on risk assessment principles. Nevertheless, when compared the concentration of all measured constituents in tailings water is less than the ANZECC guidelines, with the exception of aluminium.

Bauxite processing would utilise water from a combination of sources including; recycled process water, freshwater dams, and artesian water. This mix is similar to the existing Andoom beneficiation plant. Artesian water typically has an electrical conductivity of at least 1800µS/cm. The existing East Weipa beneficiation plant relies on a smaller proportion of artesian water for processing.

Some seepage is expected from the bottom of the tailings storage facility and a slot is positioned down gradient to recover such water. In 2009 samples were collected from recovery slots near the existing tailings storage facilities and the concentration of dissolved aluminium was found to be less than, or similar to, that of tailings liquid (Rio Tinto 2009b). This indicates water moving through the tailings does not become enriched in aluminium.

Tailings Storage Facility Construction and Operation

Alternatives considered for the method of tailings disposal are described in **Sections 1.6.6** and **1.6.7**. Alternatives considered for the location of tailings storage facilities are described in **Section 1.6.9**.

The tailings storage facilities for the Boyd beneficiation plant would be located close to, and south of, the plant (refer **Figure 13-1** for general location and **Figure 2-7** for layout). The

tailings storage facility for the Norman Creek beneficiation plant would be located close to the plant (refer **Figure 13-1** and **Figure 2-8**). Prior to commissioning of each beneficiation plant, the economic bauxite reserves within the each tailings storage facility footprint would be mined and the ore stockpiled ready to be fed to the plant. This approach would avoid sterilization of economic bauxite reserves and reduce the extent of clearing of vegetation.

The final Boyd tailings storage facility would have an area of approximately 580ha and a capacity of approximately 182Mt. The final Norman Creek tailings storage facility would have an area of approximately 580ha and a capacity of approximately 204Mt.

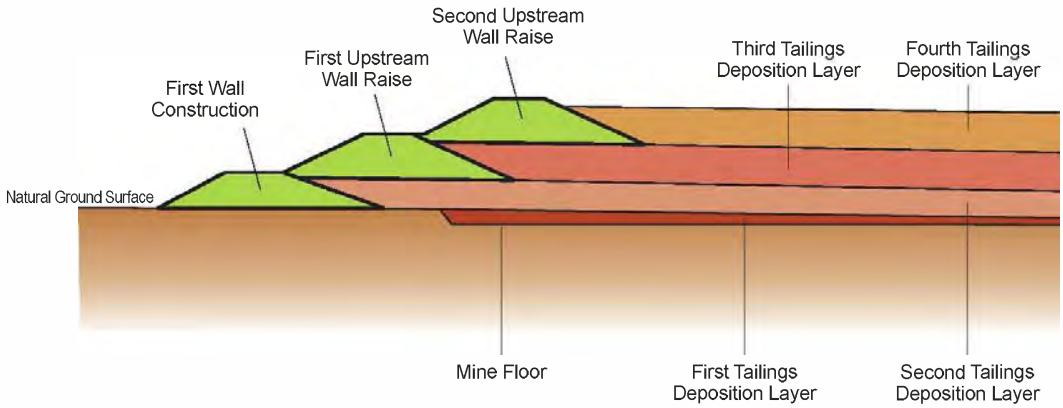
Tailings storage facility walls would be built on in-situ bauxite profile and designed to keep the phreatic surface below the structural toe of the wall. Wall construction materials would comprise a selective mix of red soil underlying the topsoil, low-quality bauxite/clay mix, kaolin clay and ironstone where locally available (refer **Figure 13-2** for a typical cross-section). The design is based upon the *Guidelines on Tailings Dam Design, Construction and Operations* by the Australian National Committee on Large Dams (ANCOLD 1999).

The tailings slurry would be pumped to the tailings storage facility and released from a perimeter pipeline located on the wall. The tailings solids would beach and suspended solids would settle out and water would be decanted from the cell and pumped back to the beneficiation plant for reuse in processing. The tailings storage facilities are divided into cells to facilitate the cycling of tailings perimeter deposition within a cell, and between cells, to enhance formation of a broad tailings beach adjacent to the perimeter walls that dries quickly to a consistent density over its full depth. There would be some initial seepage from the base of the cell, which would reduce over time as the fine tailings builds up a less permeable layer. A slot would be constructed down gradient of each tailings storage facility to capture seepage, which would also be pumped back to the beneficiation plant (refer **Section 5.2.2**). As discussed previously, based on experience at Andoom and East Weipa, the water quality of seepage is not expected to pose an adverse risk to the environment.

The tailings storage facilities would be designed so that on 1 November each year, there is sufficient storage allowance to contain rainfall runoff generated by a 1 in 50 year Average Recurrence Interval (ARI) 2-month wet season. In addition, the spillway would be designed to pass a 1 in 1000 year ARI flow event (refer **Section 5.2.2**).

13.3.5 Oversize Material

Oversize rock (i.e. material greater than 25mm in diameter) is generated by the beneficiation process as rejected material. It is benign and is therefore suitable for use in road construction. This material would either be stockpiled for use in construction of roads, tailings storage facility walls and so on, or reprocessed into product. A short-term stockpile of approximately 4,000 tonnes would be located at each of the beneficiation plants. A longer-term stockpile of approximately 100,000 tonnes would be located between the product stockpile and the tailings storage facility. If stockpile capacity is reached the excess material would be either returned to a mined-out area and rehabilitated or reprocessed into product.



Rio Tinto Alcan

South of Embley Project

Fig. 13-2: Tailings Storage Facility
Typical Embankment Cross Section

Date: 26/10/2010

13.3.6 Solid Waste

The quantity and characteristics of solid waste expected to be generated during the construction and operation of the Project have been shown previously in **Table 13-1** and **Table 13-2**.

Colour-coded, labelled bins would be used to segregate and collect general waste, recyclables and regulated solid waste. The bins would be located throughout offices, maintenance and construction camp areas to achieve maximum economic waste recovery. These bins would be emptied into larger bins or skips regularly. All smaller bins and skips would have lids, to reduce the potential for wind-blown litter or attracting insects and pests.

General wastes would be collected regularly and transported for disposal at the licensed Weipa Waste Management Facility at Evans Landing (also known as the Evans Landing Landfill, refer **Figure 13-1**). The facility also receives waste from the current RTA Weipa operation, township and Napranum township.

Some solid wastes, such as cardboard packaging, wooden pallets, and conveyor belt would be reused on-site for other purposes where practical. Scrap steel, batteries, toner cartridges, and other recyclables would be recycled off-site by third parties where feasible.

Regulated wastes would be stored in appropriate locations and conditions, until they can be transported off-site by a licensed regulated waste contractor. This waste would be tracked according to regulatory requirements, and delivered to a licensed regulated waste receiver for treatment and/or disposal.

Heavy vehicle tyres would be retread where feasible to maximize their use prior to ultimate disposal. RTA are investigating take-back and recycling or waste-to-energy options, however feasibility is currently limited. Stored tyres awaiting disposal would be stockpiled in a place where there is minimal risk of tyres causing fire hazard or contamination to land or waters. Stockpiles would be in volumes less than 3m in height and 200m^2 in area and at least 10m from any other tyre storage area. All combustible material, including vegetation, would be removed within 10m of any waste tyre storage area. If a suitable alternative option cannot be identified, tyres would be disposed of to a facility licensed to accept regulated waste.

Clinical waste is a regulated waste stream, which is included in the Evans Landing landfill license. This waste stream is expected to comprise mainly of sharps and soiled bandages and other material that would be produced by the site medical clinic and the Emergency Services section.

The amount of waste generated by the construction of the Project is expected to be relatively minor and within the existing capacity of the Weipa Waste Management Facility. Where practical, the existing landfill would be expanded to accommodate waste from SoE as required. If a new facility is required in the future, RTA or their licensed waste contractor would seek approval to establish and operate such a facility.

Based on the proposed management measures, potential impacts are anticipated to be low.

Green waste

Consideration would be given to the selective extraction of structural-grade timber in the Project area prior to mining, where practicable and where the timber can be beneficially used. The cleared vegetation would be pushed into windrows and burnt with the following controls implemented.

- Firebreaks of appropriate width for the cleared and surrounding vegetation;
- Fire fighting equipment and persons trained in use of the equipment and fire fighting shall be available;
- Planning in accordance with weather conditions, and monitor weather during burning events;
- Notification of adjoining landholders.

13.3.7 Liquid Waste

The quantity and characteristics of liquid waste expected to be generated during the construction and operation of the Project have been shown previously in **Table 13-1** and **Table 13-2**. All liquid wastes would be managed in accordance with relevant regulatory requirements.

Waste oil, chemicals and paints

Regulated liquid wastes to be produced by the Project would include waste oil and small amounts of chemicals and paints.

Waste oil would be stored in tanks in accordance with AS 1940:2004. The current Weipa operation has, until recently used waste oil as a fuel source in the calcination plant. Since this plant was decommissioned, RTA has been investigating alternative uses for waste oil, including options with other RTA sites. If a suitable energy recovery option cannot be identified internally, the waste oil would be removed from the site, along with waste paint and thinners by a licensed regulated waste contractor, and tracked according to regulatory requirements to a licensed regulated waste receiver for treatment and/or disposal.

Sewage

During the initial construction phase, prior to the Sewage Treatment Plant (STP) being commissioned, the construction areas would be serviced by portable ablution facilities and sewage would be stored in holding tanks and regularly trucked back to Weipa by a licensed regulated waste transporter for treatment. This method would also be utilised if temporary mobile construction camps were used for the Mine Access Road or an accommodation barge used during dredging of the Port.

Once constructed, the construction camp would be serviced by a package STP (refer **Figure 13-1**). The treated effluent would be recycled for dust suppression, landscape watering or other appropriate uses on-site that are suitable for the quality of water. In this case, the main risk to use of recycled water is the potential health risk of pathogens on the workforce. It is proposed the criteria for this water discharge should be safe for most end uses, including those that could involve occasional human contact.

The *Water Quality Guidelines for Recycled Water Schemes* (DNRW 2008) recommend the use of national or industry guidelines for irrigation for uses other than food crops. One of these, the *National Guidelines for Water Recycling: Management Health and Environmental Risks* (National Resource Management Ministerial Council *et al.* 2006), recommend water used for landscape irrigation; including trees, shrubs and public gardens, should contain *Escherichia coli* (*E. coli*) levels of less than 100 cfu/100mL.

Water Supply (Safety & Reliability) Act 2008 (Qld) does not apply to water service infrastructure used for mining purposes, however in absence of defined criteria the water quality criteria for pathogens referred to under this Act (defined in Schedule 3D of the *Public Health Regulation 2005*) is proposed. The *E. coli* criteria for Class A Recycled Water are shown in **Table 13-6**. The regulations specify if a sample exceeds the criteria, then a follow-up sample must be taken which must meet the "follow-up sample criteria". The annual criterion applies to an annual rolling average.

Table 13-6 Standard for Quality of Class A Recycled Water

Factor	Frequency of Sampling	Criteria	Follow-up Sample Criteria	Annual Value
E. coli	Weekly	100 cfu/100mL	10 cfu/100mL	10 cfu/100mL found in 95% of the samples taken for a 12-month period

The STP at the construction camp would be designed and operated to treat water to meet the *E. coli* criteria for Class A Recycled Water defined in Schedule 3D of the *Public Health Regulation 2005* (refer **Table 13.6**).

During the operational phases, a gravity sewerage system would deliver raw sewage from the infrastructure areas to a lift station, which would pump sewage into a permanent STP located near the Boyd infrastructure area (refer **Figure 13-1**).

In later operational phases, a second STP would be required at the proposed beneficiation plant in the Norman Creek infrastructure area (refer **Figure 13-1**), which would be operated in a similar way to the Boyd STP.

Once operational, sewage generated at the infrastructure areas would be treated using a biological aerobic modular system. The effluent from the secondary process would be treated to provide Class A Recycled Water.

The construction camp STP would be designed to a capacity of 630 people, while the Boyd and Norman Creek STPs would each be designed to a capacity of 150 people. Based on the predicted average workforce, the volume of effluent treated under each production scenario would be:

- 90kL/day during construction;
- 8kL/day at 15Mdptpa;
- 15kL/day at 30Mdptpa, and
- 20kL/day at 50Mdptpa.

The effluent would be pumped to the process water pond for re-use in the beneficiation plant (refer **Figure 5-8** and **Figure 5-9**). By meeting the Class A Recycled Water quality, and through dilution with other process water, the use of STP effluent is expected to have a low health risk to the workforce.

Each sewage treatment plant would have a sludge drying bed to dry the small amount of sludge that would be generated. Water would be decanted and pumped back to the process water pond. The sludge drying beds would be capped and rehabilitated or the sludge buried in pit at the end of the Project life.

Monitoring of *E. coli* concentrations would be carried out regularly at the STPs to verify performance of the plants.

13.3.8 Ship Waste Disposal

Table 13-1 and **Table 13-2** show the quantity and characteristics of ship waste expected to be generated during the operation of the Project.

Solid Waste

Ships would not generate substantial volumes of wastes at the site as most ships visiting the proposed port would have onboard incinerators.

Waste from Australian vessels would be managed with the site's operational waste management system.

If overseas ships are used for transport of bauxite they would be required to manage waste in accordance with Australian Quarantine Inspection Service (AQIS) requirements, which involves sealing waste in animal and leak-proof containers or a sealed room or; incinerating all animal waste, organic refuse, galley scraps or waste in an incinerator onboard the ship. Cans, bottles, ash from the incinerator, and any other inert waste may be removed from an overseas ship following inspection by AQIS officers and then disposed of at Evans Landing landfill.

Weipa does not currently have any facilities for treatment of waste that does not meet the AQIS requirements, therefore any of this type of waste would need to be stored on the ship in a sealed area and disposed of at another port or outside Australian waters in accordance with the International Maritime Organisation's MARPOL Convention.

Sewage

Most ships visiting the proposed port would have onboard STPs. The *Transport Operations (Marine Pollution) Act 1995* (QLD) and *Regulation 1995* regulates the discharge of sewage in coastal waters. Section 48A of the Act requires ships operating in "nil discharge areas" to be able to hold or treat sewage. "Nil discharge areas" are defined in the Regulation based on the number of people on the ship, the distance from a wharf and coastlines, and the quality of effluent from the Boyd infrastructure area STP.

Ships' sewage would be managed in accordance with these requirements. Where required, facilities would be provided to allow sewage to be pumped out for treatment.

Washings and slops

Oily water or "washings and slops" are generated on-board ships as a result of tank drainings, tank washings, and other oily mixtures. The contaminated water is collected on board in a "slop tank". It is an offence to discharge oil into coastal waters under the *Transport Operations (Marine Pollution) Act 1995*. Ships would either be required to retain oil-contaminated slops and washings on board or facilities would be provided to remove and treat oil-contaminated water.

Ballast Water

Ballast water is water carried in vessel tanks for stability. The discharge of ballast water from dredging equipment or bulk carriers into the Gulf of Carpentaria carries a risk of introduction of foreign marine species into local waters.

In Australia, there are existing protocols in place to minimise the risk of marine pest incursions and the early detection of an incursion if one occurs.

The *Australian Ballast Water Management Requirements* (DAFF 2008), details the controls to minimise the risk of introducing harmful aquatic organisms into the local marine environment. These mandatory requirements are implemented through the *Quarantine Act 1908* (Cwlth) and are administered by AQIS.

Under these requirements, the following types of ballast water are considered "low-risk":

- fresh water from any source;
- ballast water that has been exchanged at an approved location (mid-ocean) by an approved method;
- ballast water of which at least 95% was taken up in mid-ocean, or
- ballast water of which at least 95% was taken up inside Australia's territorial sea.

There are no specific constraints on the discharge of "low-risk" ballast water within Australian ports. Vessels originating from within Australia, such as those that would be expected to travel between Gladstone and the proposed port, are expected to contain "low-risk" ballast water. Any vessels that contain ballast water that does not meet the "low-risk" definition would be required to manage the ballast water in accordance with the requirements for "high-risk" ballast water.

"High risk" ballast water is defined as all salt water originating from ports and coastal waters outside Australia's territorial sea. All vessels arriving in Australia from international waters are required to submit a report to AQIS declaring whether or not they have complied with Australia's mandatory ballast water management requirements. These requirements prohibit the discharge of "high-risk" ballast water into Australian Territorial seas. Several options are available to achieve this requirement:

1. Vessels that do not need to discharge ballast water do not need to carry out any foreign ballast water management. However, the carriage of "high-risk" ballast water into Australian territorial sea is discouraged. For any ships exporting bauxite, this is not really an option as it is likely they would need to discharge ballast water prior to loading;

2. Tank-to-tank transfer – vessels may transfer "high-risk" ballast water from tank to tank within territorial sea, provided appropriate management of the risk of unauthorised ballast discharge is undertaken, or
3. Full ballast water exchange may be undertaken outside Australian territorial waters. This may be carried out either by sequential exchange, flow through, or dilution methods, which have demonstrated results of 95% volumetric exchange. It is also recommended that ballast exchanges be conducted as far away as possible from any land mass and in water at least 200m deep.

All bulk carriers owned and contracted by Rio Tinto would manage ballast water through a Ballast Water Management Plan, which would comply with the Australian mandatory requirements and the *International Convention for the Control and Management of Ships' Ballast Water and Sediments* (IMO 2004).

Any international vessel used for dredging operations would be inspected for introduced marine pest species and cleaned if necessary prior to establishment (refer to **Section 6.9.4.6**).

The early detection of an incursion of marine pest species from ballast water or hulls is an important measure in reducing the risk of impact. The Port of Weipa was surveyed for endemic biota and introduced species in October 1999 and the results reported in Hoedt *et al.* (2001). The survey primarily focussed on habitats in the vicinity of the berths in the Embley River. Samples were also collected at the shipping channel outside the mouth of the river. No pest species designated by the Australian Ballast Water Management Advisory Committee (ABWMAC) were detected in the survey.

One recognised introduced species, the green algae *Caulerpa racemosa*, was collected at the Port of Weipa. Only one specimen of this species was collected from the sampling area outside the mouth of the Embley River. This species was not abundant within the samples suggesting that it is probably not having an adverse impact on native biota. One cryptogenic species, which has previously been recorded in Australian waters, was collected, the barnacle *Balanus amphitrite*. This species is regarded as a cosmopolitan fouling species and its worldwide distribution suggests a long history of introduction. Two non-identified species of Gammarids (*Leucothoe sp.* and *Maera sp.*) appear to be species not recorded from Australian waters. Similarly, a *Gammarid* genus (*Listriella*), not reported for Australia, was recorded in low abundance at the Port of Weipa. Other species, of unknown origin, were also found in low numbers suggesting, like the introduced species, these do not have a major impact on the port's native biota.

The detailed baseline survey of the Port of Weipa has been supplemented since 2006 by inspection, every three months, of larval monitoring devices installed in the port, and targeted surveys by the Department of Employment, Economic Development and Innovation (formerly the Department of Primary Industries and Fisheries) of high-risk areas in the port. This monitoring was instigated following the discovery of the high-risk species Asian green mussel (*Perna viridis*) on a non-trading vessel that had been in the Port of Weipa. No Asian green mussels or other non-indigenous species have been detected since the monitoring began in 2006 (PCQ 2009).

RTA would complete baseline monitoring, followed by three-monthly mussel larval monitoring in the vicinity of the new port at such time that overseas ships are utilised. If an abnormal growth of organisms is detected, an appropriate response would be developed in consultation with relevant regulatory authorities. Monitoring procedures would follow methodology adopted by the Port of Weipa.

If the proposed management measures were implemented, including continued implementation of the ballast water requirements, the risk of impact of management of shipping waste is considered to be low.

Environmental Impact Statement

for South of Embley Project

Section 14
Transport

14 TRANSPORT

Road access to the Weipa area is currently by way of the Peninsula Developmental Road (PDR). The Port of Weipa on the Embley River is used for shipment of bauxite from the existing mining operations to Gladstone and deliveries of cargo and fuel for mining operations and the Weipa township. Weipa is serviced by a local airport. The regional road network is shown in **Figure 14-1** and the Port of Weipa facilities and Weipa airport are shown in **Figure 14-2**.

This section provides an assessment of transport impacts, presented as separate sub-sections for each project-affected mode of transport (road, rail, air and sea). The legislative framework required for transport infrastructure works are addressed in **Section 1.9**.

14.1 Road

14.1.1 Existing Infrastructure

The road network in the vicinity of the Project is largely undeveloped, with vehicle access restricted to minor vehicular tracks (refer **Figure 14-3**). Current road access to the site is from the PDR via Aurukun Road, Beagle Camp Access Road, Pera Head Access Road, and Amban Access Road (the "access roads"), which traverse the adjacent mineral development licence (MDL) 378. There are no gazetted public roads on the portion of ML 7024 that lies south of the Embley River.

Peninsula Developmental Road

The PDR is a State-controlled road between Mareeba and Weipa. At present, the road is largely unsealed, however, funding by the Federal and Queensland governments have focussed on upgrades of the road under the Roads of National Importance Program, including the 15km between Lakeland and Laura. Other proposed upgrade works are being considered by the Queensland Department of Transport and Main Roads (DTMR 2009). These are predominantly related to pavement construction, however, two additional bridges are proposed at Carols Crossing and Ruth Creek. These bridges are located on the PDR section 90B between Mt Molloy and Laura.

The PDR has a posted speed limit of 60km/hr in urban areas, ranging up to 110km/hr along some sections. Pavement width along sealed sections varies between 2.6m and 32.4m, and averages 7.5m.

The unsealed sections of the PDR can be rough and corrugated. During the wet season, the road is prone to closure. Load limits can vary during the wet season from five tonnes between Coen airport and Weipa to 25 tonnes between Laura and Coen. Reduced visibility due to dust can be a safety hazard during the dry season.

Coen Bridge has a load limit of 10 tonnes (without a permit) and up to 20-25 tonnes (with a permit). A bypass of the Coen Bridge is currently being constructed and it is expected to be completed in 2010. Other load-restricted structures include the Laura Bridge and Archer causeway. In addition, the PDR is subject to washouts during the wet season which can create traffic hazards.

Between Napranum and Weipa, the PDR is also known as Kerr Point Road and John Evans Drive. It is the main thoroughfare for employees travelling from Weipa to work at RTA's East Weipa operations. It is a sealed, two-lane road. The section of this road within the Weipa Town Boundary is maintained by Weipa Town Authority (WTA) (with the assistance of RTA) and the section outside the Town Boundary and within the Mining Lease is maintained by RTA.

A bus service operates on this section of road to transport children between Napranum and the school at Weipa.

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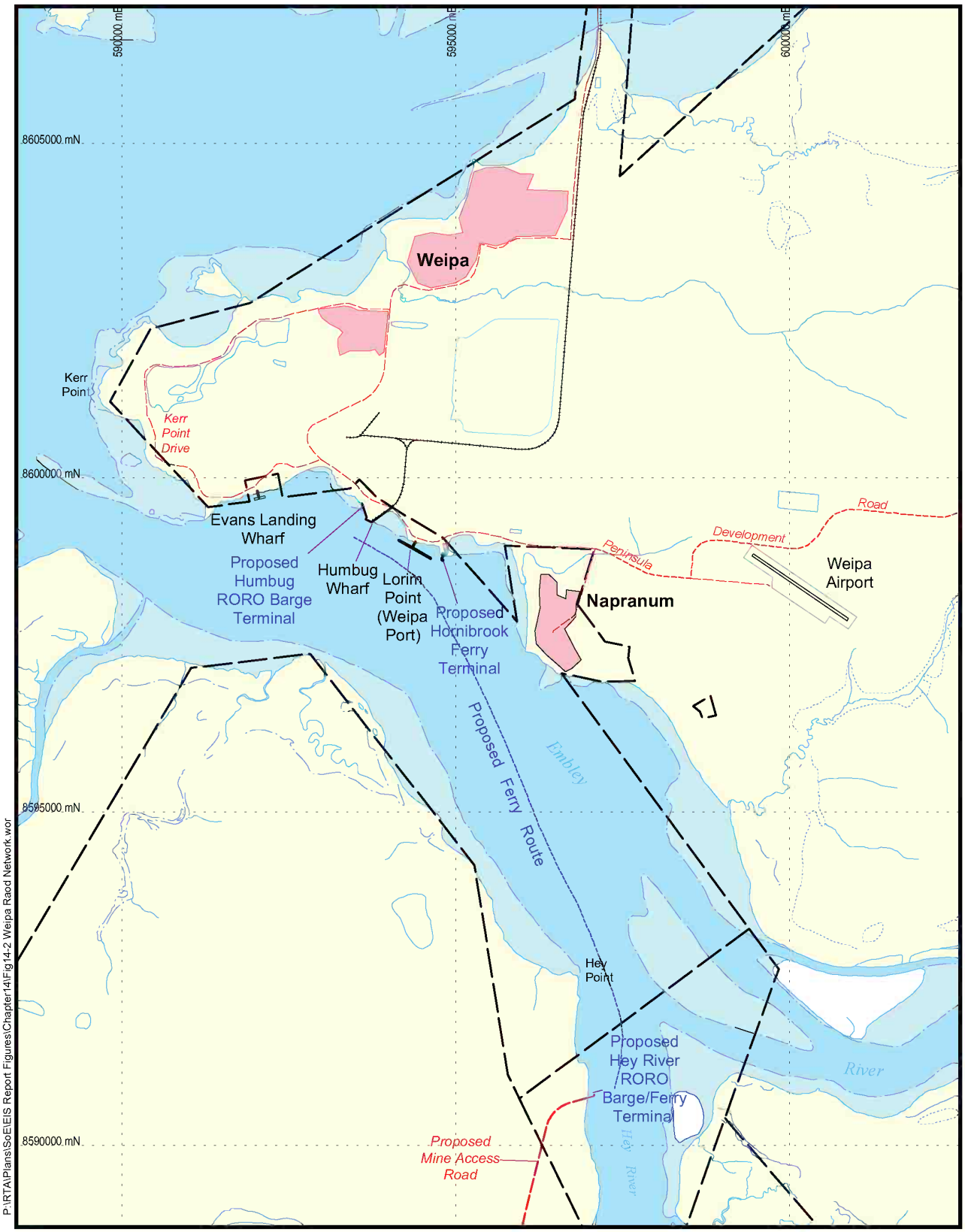
Rio Tinto Alcan

Fig. 14-1: Cape York Regional Road Network



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Lease boundary
Township
River
Road
Rail line

South of Embley Project

Fig. 14-2: Weipa Area Transport Infrastructure

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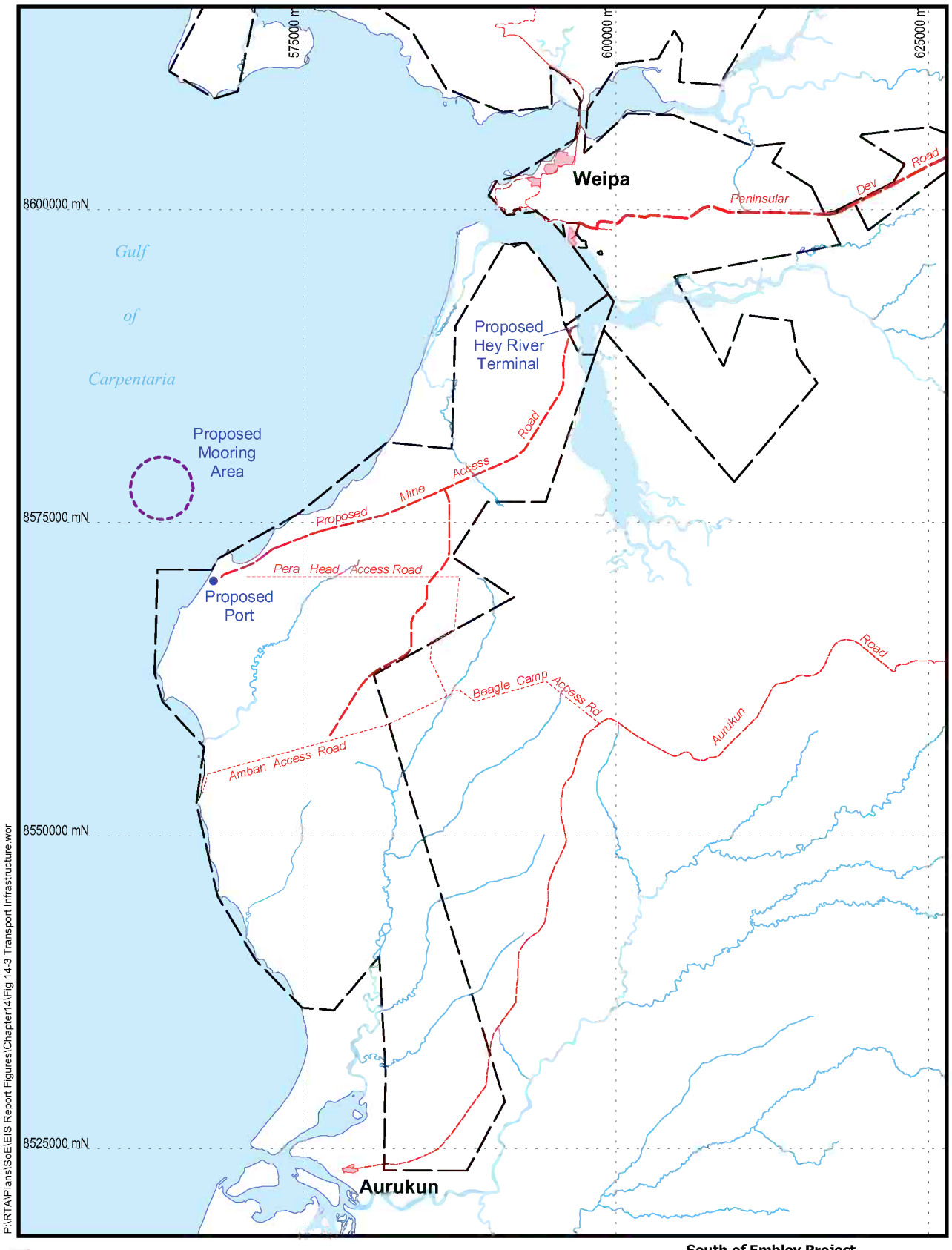
Datum/Projection: GDA94/MGA Zone 54 Date: 01/04/2011



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Lease boundary
Township
Drainage
Road/track

South of Embley Project

Fig. 14-3: Transport Infrastructure

N

0 5 10 15km

Datum/Projection: GDA94/MGA Zone 54 Date: 01/04/2011

Rio Tinto Alcan

Kennedy Highway

The Kennedy Highway is a State-controlled sealed highway, which runs from Smithfield near Cairns, to Mareeba and on to about 40km south of Mount Garnet. Planned infrastructure improvements detailed in the *Roads and Implementation Program – Far North Region* include minor realignments, asphalt resurfacing and hardship resumptions (DTMR 2009).

The Kennedy Highway has a posted speed limit of 60km/hr in urban areas, ranging up to 100km/hr along some sections. Pavement width varies between 4.7m and 23.3m and averages at 9m.

There are no load restricted structures along the portion of the Kennedy Highway that are likely to be used by people travelling to the Project area.

Aurukun Road

Aurukun Road (also known as Aurukun Access Road) connects the township of Aurukun with the PDR. The Aurukun Road is largely unsealed and is subject to the same safety hazards. It is maintained by Aurukun and Cook Shire Councils.

Under the *Local Government (Aboriginal Lands) Act 1978* (Qld), permission must be obtained from Aurukun Shire Council for entry to all Shire lands. Aurukun Road is predominantly used by residents of Aurukun travelling to Weipa or Cairns, and by some people accessing the area for recreational purposes. Freight is brought into Aurukun by road weekly during the dry season. During the wet season road access is restricted and a barge delivers freight fortnightly.

14.1.2 Existing Traffic Volumes

The most recent traffic flow figures for the PDR and the Kennedy Highway are as indicated in **Table 14-1**. The information was supplied verbally by DTMR, Fitzroy District, and is provided in terms of the Average Annual Daily Traffic (AADT) and the proportion of heavy vehicles. The AADT is a common measure of traffic volume equivalent to the total volume of traffic passing a roadside observation point, over the period of one year, divided by the number of days in the year.

Table 14-1 Existing Traffic Flows

Road	Section	2007 AADT	% Heavy Vehicles
32A Kennedy Highway	Cairns to Kuranda	7,610	10%
	Kuranda to Mareeba	4,675	10%
90A PDR	Mareeba to Mt Molloy	2,180	13%
90B PDR	Mt Molloy to 30km	500	19%
	30km to 145km	410	13%
	145km to Laura	140	25%
90C PDR	Laura to Coen	95	26%
90D PDR	Coen to Weipa	90	27%
	Kerr Point Road/John Evans Drive	500(1)	10%(2)
Aurukun Road	PDR turnoff to site (via the access road turnoff)	21(1)	Insufficient data

(1) Estimated (2) Estimated based on urban road

Background traffic volumes for Kerr Point Road and John Evans Drive could not be sourced, and have therefore been estimated based on employee numbers, the population of Napranum, and the PDR traffic volumes. It is likely most employees' vehicles would be light vehicles, however for the purposes of a conservative impact assessment, 10% of the vehicle movements are assumed to be heavy vehicles.

Background traffic volumes for Aurukun Road were not available, and have therefore been estimated based on the population of Aurukun.

14.1.3 Existing Pavement Loads

Existing pavement loads, in terms of Equivalent Standard Axles (ESAs), on the PDR and the Kennedy Highway are as indicated in **Table 14-2**. ESA is a measure of the cumulative damaging effect to pavement of the design traffic. It is expressed in terms of the equivalent number of 80 kilonewton (kN) axles passing over the pavement. These have been calculated using the heavy vehicle proportions provided in **Table 14-1** and an ESA conversion factor of 3.2. A conversion factor of 3.2 has been applied as it is the DTMR adopted value for background traffic.

Table 14 – 2 Existing Pavement Loads (2007 ESAs)

Road	Section	Existing Annual ESA
32A Kennedy Highway	Cairns to Kuranda	888,848
	Kuranda to Mareeba	546,040
90A PDR	Mareeba to Mt Molloy	331,011
90B PDR	Mt Molloy to 30km	110,960
	30km to 145km	62,254
	145km to Laura	40,880
90C PDR	Laura to Coen	28,850
90D PDR	Coen to Weipa	28,382
	Kerr Point Road / John Evans Drive	58,400(1)
Aurukun Road	PDR turnoff to site (via the access roads)	Insufficient data

(1) Estimated.

14.1.4 Proposed Traffic Routes

Use of the current road access arrangements (that is, via the PDR, Aurukun Road, and the access roads) would be required during the early construction phase. The option exists to shorten travel distances by extending the Beagle Camp Access Road westward to join the conveyor alignment for the proposed Aurukun Project and the infrastructure corridor from Dam C to the Boyd Infrastructure Area (see **Figure 1-3**).

Once the new barge/ferry terminals and Mine Access Road are established, primary access to the site would be via the proposed barge/ferry terminals on the Embley and Hey Rivers (refer **Section 2.3.1** for description), as follows:

- Barges would travel between a roll-on, roll-off (RORO) barge terminal near the Humbug Wharf on the north side of the Embley River, to a combined barge/ferry terminal on the western side of Hey River;
- A passenger ferry would travel from a new ferry terminal at Hornibrook Point on the north side of the Embley River to the new Hey River barge/ferry terminal, and
- A new Mine Access Road would link the Hey River terminal to the Project operations (refer **Section 2.7.2** for a description of this road).

Use of the current road access is expected to be extremely limited during the operational phases of the Project. There are no proposed new/alterations to public road infrastructure required by the Project, other than the mitigation strategies for the Humbug barge terminal and Hornibrook ferry terminal intersections described in **Section 14.1.7**.

Construction Phase

Workforce

The construction workforce would be based in a camp near the Boyd infrastructure area. The workforce roster is yet to be determined, and therefore the impact assessment is based on the conservative assumption that the workforce is on a fortnightly rotation. At the beginning and end of each rotation workers would travel on a bus, initially via the PDR, Aurukun Road, and the access roads. Once facilities have been constructed the workers would be transported by either car or bus from Weipa or Weipa airport to the Hornibrook ferry terminal, by ferry to Hey River, and then travel by the Mine Access Road (on-lease) to the construction camp at the beginning and end of each rotation.

Equipment and Materials

The majority of equipment and materials would be transported by sea, from Cairns to Weipa. Cargo ships and barges would predominantly be unloaded at Evans Landing or Humbug Wharf and cargo would be loaded onto trucks. Initially, the trucks would need to travel by road via Kerr Point Drive, the PDR and Aurukun Road to the site, until barge facilities have been constructed at Hey River (approximately six months into the construction period). At this time the loaded trucks would be transported by barge from Humbug Wharf to the Hey River Terminal and then by the Mine Access Road (on-lease) to the site. Temporary barge/ferry terminals may be constructed at Hey River as part of the early works program to reduce transportation of cargo by road. Some equipment and materials required for the commencement of construction may be brought ashore by barge between Boyd Point and Pera Head, and at Hey Point. RTA has previously utilised Hey Point in a similar manner. Such use would be subject to agreement with the Napranum Shire Council.

Once the barge facilities and Mine Access Road is established, the primary heavy vehicle usage of roads external to the site during construction would be deliveries of aggregate for concrete from Archer River Quarry to the site. Aggregate will predominantly be sourced from borrow pits within the Project area using internal roads, however, for the purposes of a conservative impact assessment it has been assumed that 20% of deliveries are from the Archer River Quarry. The quarry is located approximately 200km south-east of Weipa and 100km south of the Aurukun Road turn-off via the PDR.

Operational Phase

Workforce

When operating, the employee types are divided into three categories:

- SoE-based workforce – employees and contractors are likely to be based in Weipa and would commute to the site daily by driving to the Hornibrook ferry terminal where they would leave the vehicle, and then catch the ferry to Hey River where a bus transports them to the workplace;
- Administration staff – these personnel would live in Weipa and work in Weipa at the current RTA main facility, located opposite the proposed Hornibrook ferry terminal; and
- Day and night staff – these personnel would also live and work in Weipa, but are differentiated from the administration staff because their working shifts cover a full 24-hour period. The day and night staff would typically be lab technicians as well as those personnel responsible for maintenance activities. They would also work at the RTA main facility.

Visitors to the Project site or Weipa administration office are likely to follow similar routes, however transport such as a hire car, taxi or bus would transport them from the Weipa airport.

Equipment and Materials

The majority of equipment and materials would continue to be transported by sea from Cairns to Weipa.

Cargo ships and barges would predominantly be unloaded at Humbug or Evans Landing wharves and cargo would be loaded onto trucks. The loaded trucks would then be loaded onto barges at the Humbug barge terminal and transported to the Hey River barge/ferry terminal. The trucks would then drive off the barge and travel by the on-lease Mine Access Road to the site. Should any heavy vehicles need to bring supplies by road from Cairns, they would take the Kennedy Highway and the PDR. However, as with existing Weipa mining operations, external road network use would be limited.

Extracted bauxite would be transported using a network of internal haul roads and conveyors to the beneficiation plant prior to being shipped to its final destination from the proposed port.

14.1.5 Proposed Traffic Generation

Traffic generated by the proposed development has been estimated from the heavy vehicle haulage and employee requirements during both construction and operational phases of the Project. Trip generations are based on the number of staff required at each shift, the number of shifts each day, and assumed vehicle occupancy of 1.2 people.

Trip generations are expressed in "vehicle trip ends" (vte). This is an expression for the sum of both directions of a trip (i.e. the sum of in and out movements). Vte per day is taken as the average daily vehicle movement assuming the operational week is seven days.

Construction Phase

During construction, employees would be housed on the Project area for the duration of their shift rotation. Trips on the external road network would therefore only be generated when employees leave the construction camp and travel to Weipa or the airport for their scheduled days off. Shuttle buses would be provided for transport of personnel between the site and Weipa or Weipa airport.

It has been calculated the employee trip generation for both average and peak construction periods would be four vte per day. These trips would initially be via the PDR and Aurukun Road until ferry terminals are constructed.

Prior to the establishment of the barge terminals and Mine Access Road, heavy vehicle trip generation during the first six months of construction is likely to include the following deliveries of materials and equipment via the PDR, Aurukun Road, and the access roads:

- Four to five deliveries per day will be made to transport fuel and supplies from Evans Landing Wharf, Lorim Point Wharf, or Humbug Wharf to the site. It is assumed one of these deliveries will be fuel transported in B-double trucks (i.e. two vte/day), and four deliveries will be supplies transported via flat bed semi-trailer (i.e. eight vte/day), and
- 20 deliveries per week (i.e. 5.7 vte/day) would be made transferring buildings (dongas) and equipment from Weipa to the site. These vehicles would be flat bed semi-trailers with an additional trailer.

For the purposes of a conservative impact assessment, a weekly delivery from Cairns to the site by road train (flat bed semi-trailer with additional trailer), via the PDR from the east, has been assumed.

The peak trip generation (for the first six months of construction) between Weipa and the site would be 19.7 vte/day on the PDR and 20 vte/day on Aurukun Road.

Once the barge facilities and Mine Access Road are established, the primary heavy vehicle usage of roads external to the site during construction would be the delivery of aggregate from Archer River quarry to the site. Aggregate would predominantly be sourced from borrow pits within the Project area using internal roads. However, for the purposes of a conservative impact assessment, the traffic generation calculations assume 20% of aggregate would be sourced from Archer River Quarry. This would result in approximately 12,900t of aggregate to be transported from Archer River Quarry, which equates to approximately 215 deliveries using a truck and four-axle trailer. During the peak delivery period, up to four vehicles would make two trips per day, giving a peak vehicle frequency of 16vte/day. The frequency is then expected to reduce and deliveries would occur as required.

The Aurukun Road assessment includes a 5% contingency for shuttle bus trips post-barge establishment, to cover events such as the barge breaking down.

This information has been summarised and is included in **Table 14-3**.

Table 14 – 3 Trip Generation – Construction Phase

Purpose of Trip	Sections of Road Used	Peak Vehicles Per Day (vte[1])	Average Annual Vehicle Movements
Construction phase until barge facilities established (approx 6 months)			
Fuel transport	Weipa to site (via PDR, Aurukun Road and the access roads)	2	364
Cargo transport		8	1456
Heavy equipment/buildings transport		5.7	1040
Employee shuttle bus from airport		4	728
Total Daily Vte for 90D PDR between Weipa and Site		**19.7**	**1812**
Weekly delivery from Cairns	Cairns to site (via Kennedy Highway, PDR, Aurukun Road, the access roads)	0.3	52
Total Daily Vte for PDR between Cairns and Site		**0.3**	**52**
Total Daily Vte for Aurukun Road and the Access Roads		**20**	**1864**
Construction phase after barge/ferry facilities established			
Aggregate delivery from Archer River Quarry	Archer River Quarry to site (via PDR, Aurukun Road and the access roads)	16 (peak)	430
Total Daily Vte for 90D PDR between Archer River Quarry and Aurukun Road Turnoff		**16 (peak)**	**430**
5% of shuttle bus trips from airport[2]	Weipa airport to site (via PDR, Aurukun Road and the access roads)	0.2	73
Total Daily Vte for 90D PDR between Weipa and Site		**0.2**	**73**
Total Daily Vte for Aurukun Road and the Access Roads		**16.2 (peak)**	**503**

(1) Vehicle trip ends (Vte).

(2) 5% contingency has been applied to employee related trips via the PDR and Aurukun Road, post ferry establishment.

Operational Phase

It has been assumed that for the Project-based workforce, employees drive from home to the Hornibrook ferry terminal on a daily basis, where they leave the vehicle. The return trip applies. The same rationale has been applied to all other employee types travelling to the Weipa administration office at all phases.

The daily trip generation by workforce based at the Project site as they travel between Weipa and the Hornibrook ferry terminal has been calculated for each of the production scenarios as follows:

- 15 Mdptpa – 180 vte/day;
- 30 Mdptpa – 334 vte/day, and
- 50 Mdptpa – 434 vte/day.

It is anticipated Project production would replace production from current operations north of the Embley River as described in **Section 1.3**. The Project workforce would not exceed that of the existing operations (for production up to 30Mdptpa) and therefore the Project trip generation would be offset by fewer employees travelling to the East Weipa office and existing mining operations. The projected total mining workforce is shown in **Table 16-3** and discussed in detail in **Section 16.2.1 Population Projections**.

Taking this into account, the additional employee trip generation created by the Project on Kerr Point Road and John Evans Drive would be as follows:

- 15 Mdptpa – no additional trips;
- 30 Mdptpa – no additional trips, and
- 50 Mdptpa – approximately 100 additional vte/day.

The projected population of Weipa is expected to increase to more than 4400 people under the 50Mdptpa production scenario as shown in **Table 16-3**. This is an increase of 400 people over the estimated 2007 population. This Project-related increase in population would result in an associated increase in non-employee trips on the PDR between Weipa and Cairns. It has been conservatively assumed that 5% of this population increment travels on the PDR daily, which would result in an additional 19 vte/day between Cairns and Weipa.

For the purposes of a conservative impact assessment, it has been assumed that 5% of the total employee trips occur by light vehicle from Weipa to site via the PDR and Aurukun Road. This is to account for contingencies such as the ferry breaking down. Taking into account the 5% contingency, the Project generated traffic volumes on the PDR, Aurukun Road, and the access roads between Weipa and site are as follows:

- 15 Mdptpa – 9 vte/day;
- 30 Mdptpa – 17 vte/day, and
- 50 Mdptpa – 22 vte/day.

There are no other anticipated development-generated trips during the operational phases as it is intended material and equipment would be barged to the site.

14.1.6 Impact Assessment

Methodology

The methodology for assessment of the proposed development's traffic and transport elements considers the requirements of the *Guidelines for Assessment of Road Impacts of Development* (GARID) (former Queensland Department of Main Roads (DMR) 2006a) and the *Road Planning and Design Manual* (DMR 2006b).

By following the guidelines stipulated within GARID, development generated impacts can be identified and managed, as required by the *Transport Infrastructure Act 1994* (Qld). The requirements of other legislative documents such as the *Transport Planning and Coordination Act 1994* (Qld) and the *Transport Operations (Road Use Management) Act 1995* (Qld) have also been reviewed and information provided accordingly.

Growth Rates

Traffic counts for the PDR and the Kennedy Highway for 2006 and 2007 were sourced from DTMR. These counts were used to gain an estimate of the likely growth rates along each road.

A summary of the 2006 and 2007 AADT, along with the percentage increase over the year, is provided in **Table 14-4**. The weighted average for growth (that is, 2% for PDR and 4% for Kennedy Highway) has been used in the future year analysis. There are insufficient data available to determine the growth rate for Kerr Point Road and Aurukun Road, and therefore a growth rate of 2% has been assumed. These growth rates have been applied linearly for all future year design horizons in the impact assessment.

Table 14 – 4 Traffic Growth Rates

Road	Section	2006 AADT	2007 AADT	Growth Rate (%)	Weighted Average (Growth Rate %)
32A (Kennedy Highway)	Cairns to Kuranda	7300	7610	4.2	4%
	Kuranda to Mareeba	4480	4675	4.3	
90 A,B,C,D (PDR)	Mareeba to Mt Molloy	2180	2180	0	2%
	Mt Molloy to 30km	495	500	1.0	
	30km to 145km	365	410	12.6	
	145km to Laura	145	140	-1.4	
	Laura to Coen	90	95	7.9	
	Coen to Weipa	70	90	29.4	
	Kerr Point Road/John Evans Drive		500(1)	Insufficient data	
Aurukun Road	PDR turnoff to the access road turnoff		21(1)	Insufficient data	2%(1)

(1) Estimated.

The Project schedule adopted for the impact assessment is presented in **Table 14-5**. Given construction would not start earlier than 2010 an assumed base year of 2013 represents the "worst case" scenario in terms of identifying potential operations-related traffic impacts. The DMR Guidelines (DMR 2006a) state a project's impacts are only significant if the traffic generated by the development equals or exceeds 5% of the AADTs or ESAs. The background traffic volumes progressively increase due to general traffic growth. Generally, the traffic volume generated by a project would have a decreasing impact over time as the reference background volume becomes larger. However, in the case of the Project, the Project-generated traffic volumes would increase with production and the impact assessment has been carried out for each of the production scenarios.

Table 14 – 5 Assumed Timing for Growth Rate Application

Phase	Schedule(1)
Construction	Year -3 to -1
Operations 15Mdptpa	Year 1 to Year 13
Operations 30Mdptpa	Year 14 to 30
Operations 50Mdptpa	Year 31 to 40

(1) The actual schedule would depend on the production rate. Expansion would occur when market conditions allow.

Traffic Impact

Using the existing traffic flows and applying the growth rates, an approximate traffic volume (expressed as average daily vehicle movements over one year) with and without the Project can be calculated for each stage of the Project (refer **Table 14-6**).

PDR and Kennedy Highway

For all of the assessed cases, the proposed development is expected to have a negligible impact on daily traffic operations (that is, an increase of less than 1%) on the majority of sections along the PDR and all of the Kennedy Highway (refer **Table 14-6**).

Daily traffic on the PDR between Archer River Quarry and Aurukun Road turnoff would increase from 96 vehicles per day to approximately 104 vehicles per day (an 8% increase) during the peak construction phase when aggregate is being delivered from the Archer River Quarry. Once these deliveries are completed, traffic is expected to decrease.

After production commences, the increase in traffic for the section of the PDR between the Aurukun Road turnoff and Weipa is anticipated to be between 9-22% of background traffic.

While this increase may seem significant, in absolute terms the total daily traffic, inclusive of that generated by the proposed development, is considered to remain at very low levels. RTA would repair any damage caused by Project-related traffic.

During construction there would be more vehicle movements on the load-restricted crossings and structures on the PDR. Haulage during the wet season would be restricted and load restrictions would be adhered to.

Therefore, the proposed development is not expected to have an adverse impact on future year daily operations of the PDR and the Kennedy Highway.

Kerr Point Road/John Evans Drive

Heavy vehicles are expected to travel along Kerr Point Road and John Evans Drive from Evans Landing and Humbug wharves to the PDR during the initial six-month stage of construction, prior to the barge terminal and Mine Access Road being available. However, the proposed development is expected to have a negligible impact on daily traffic operations (refer **Table 14-6**).

Once operating, the Project is unlikely to cause an increase in traffic volume on Kerr Point Road and John Evans Drive until maximum production of 50Mdptpa is reached and the total mining workforce increases. This would result in an increase from an estimated 1000 vehicles to a predicted 1119 vehicles per day (a 12% increase). In absolute terms, the total daily traffic, inclusive of that generated by the proposed development, is considered to remain at low levels. This is not expected to have an adverse impact on daily operations of these roads in future years.

PDR/Hornibrook Ferry Terminal Access Intersection

Project employees would drive to the proposed ferry terminal to be constructed on Hornibrook Point for transport to the Project area. As shown in **Figure 14-4**, vehicular access to Hornibrook Point from Kerr Point Road is currently provided by way of a channelised intersection. Priority is given to through-traffic on Kerr Point Road. This existing intersection includes a dedicated channelised right-turn with associated line-marking and a concrete median on the western approach to separate right-turns from westbound through-traffic.

The southern approach of the intersection has a gravel unsealed pavement.

Mitigation measures for this intersection are proposed in **Section 14.1.7**.

Table 14 – 6 Average Daily Vehicle Movements

Road	Section	Construction (Vte/day)			15Mdptpa (Vte/day)			30Mdptpa (Vte/day)			50Mdptpa (Vte/day)		
		Without Project	With Project	Change	Without Project	With Project	Change	Without Project	With Project	Change	Without Project	With Project	Change
32A Kennedy Highway	Cairns to Kuranda	8,560	8,560.3	<1%	9,629	9,629	0	16,033	16,033	0	31,231	31,250	<1%
	Kuranda to Mareeba	5,256	5,256.3	<1%	5,915	5,915	0	9,850	9,850	0	19,186	19,205	<1%
90A PDR	Mareeba to Mt Molloy	2,313	2,313.3	<1%	2,455	2,455	0	3,176	3,176	0	4,447	4,466	<1%
90B PDR	Mt Molloy to 30km	531	531.3	<1%	563	563	0	728	728	0	1,020	1,039	2%
	30km to 145km	435	435.3	<1%	462	462	0	597	597	0	836	855	2%
	145km to Laura	149	149.3	<1%	158	158	0	204	204	0	286	305	7%
90C PDR	Laura to Coen	101	101.3	<1%	107	107	0	138	138	0	194	213	10%
90D PDR[1]	Coen to Archer River Quarry	96	96.3	<1%	101	101	0	131	131	0	184	203	10%
	Archer River Quarry to Aurukun Road Turnoff		96.3[1] 103.5[2]	<1%[1] 8%[2]									
	Aurukun Road turnoff to Weipa	96	101[1] 96.2[2]	5%[1] <1%[2]	101	110	9%	131	148	13%	184	225	22%
	Kerr Point Road/John Evans Drive	520[3]	525[1] 525[2]	<1%[1] <1[2]	552[3]	561	1.6%	714[3]	731	2%	1,000[3]	1,119[3]	12%
Aurukun Road	PDR turnoff to site (via the access roads)	22[3]	27.1[1] 27.5[2]	23%[1] 25%[2]	24[3]	33	38%	30[3]	47	56%	37[3]	59	59%

(1) First year of construction, including period prior to barge/ferry terminals being constructed.

(2) Average annual daily trips after barge/ferry terminals are constructed and during peak aggregate deliveries from Archer River.

(3) Based on estimate.

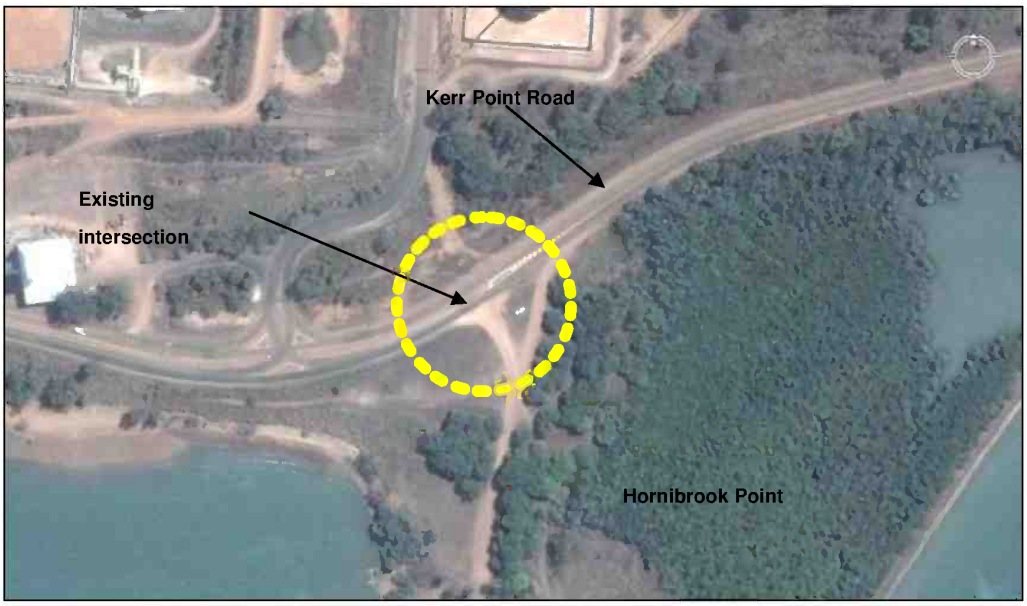

Figure 14 – 4 Existing Intersection – Kerr Point Road/Hornibrook Point

Kerr Point Road/Humbug RORO Terminal Access Intersection

Currently, there is not a formal intersection on the Kerr Point Road for vehicular access to the proposed barge terminal. The indicative location of a proposed intersection is shown on **Figure 14-5**.and discussed further in **Section 14.1.7**.

Figure 14 – 5 Intersection Location – PDR/Humbug RORO Barge Terminal

Aurukun Road

Background traffic volumes could not be sourced for Aurukun Road, and they have therefore been estimated based on the population of Aurukun. During the initial six-month construction phase prior to the commissioning of the barge/ferry terminals, traffic is expected to experience a peak of 20vte/day due to Project-related traffic on the section of Aurukun Road between the PDR and the Access Road turnoff (refer **Table 14-3**). Over the first year, this results in an increase from an estimated average of 22vte/day to an average of 27vte/day (refer **Table 14-6**).

After the barge/ferry terminals are constructed, traffic volumes would reduce until the mine reaches 50Mdptpa production, at which time traffic volumes generated by the Project are again expected to increase by 22vte per day, bringing the total to 59vte/day (refer **Table 14-6**).

While these increases appear to be significant, the increase in absolute terms is minor and the total daily traffic, inclusive of that generated by the Project, shall remain at very low levels. Materials would be brought in via the Aurukun Road only when the road is declared open by the Police and DTMR (i.e. not during wet season closures). Mitigation measures are discussed in **Section 14.1.7**.

Pavement Impact

The impact of the Project, in terms of annual ESAs, on roads during the construction and operational phases are detailed in **Table 14-7**.

The ESAs are calculated from predicted annual heavy vehicle movements using conversion factors provided by the DTMR. It is assumed most heavy vehicles travel to the site loaded and from the site unloaded, with the exception of the bus which transports the workforce, which is assumed to be loaded when travelling in both directions.

The number and type of heavy vehicles related to the impact of population growth on the PDR in the 50Mdptpa scenario is not known. It is assumed most heavy vehicles currently travelling on the PDR would be associated with mining activities. Population growth would predominantly affect town activities, such as travel of individuals or families by light vehicle and haulage of freight of household items. It is therefore assumed 10% of the vehicles generated by population growth are heavy vehicles and a generic ESA conversion factor of 3.2 has been used to assess pavement impact.

During the construction phase, the proposed development is expected to have a marginal to very low impact (i.e. increases of less than 1%) on annual ESAs of most roads. The following roads would experience an increase in pavement impacts of greater than 5% during some stages of the Project (refer **Table 14-7**):

- the PDR between the Archer River Quarry and the Aurukun Road turnoff during the delivery of aggregate;
- the PDR between Weipa and the Aurukun Road turnoff prior to the construction of the barge/ferry terminals and Mine Access Road;
- Kerr Point Road and John Evans Drive prior to the construction of the barge/ferry terminals and Mine Access Road, and during operations at 50Mdptpa, and
- Aurukun Road between the PDR and the Access Road turnoff during the construction phase.

RTA would repair any damage caused by Project-related traffic on these roads.

Once construction is completed and production commences, there would be limited impact on the annual ESAs of Aurukun Road, the PDR, and Kennedy Highway, as it is unlikely heavy vehicles would be using roads external to the site.

Table 14 – 7 Pavement Impact Analysis (ESAs)

Road	Section	Construction			15Mdptpa			30Mdptpa			50Mdptpa		
		Without Project	With Project	Change	Without Project	With Project	Change	Without Project	With Project	Change	Without Project	With Project	Change
32A Kennedy Highway	Cairns to Kuranda	995,510	995,748	<1%	1,124,676	1,124,676	0	1,872,669	1,872,669	0	3,647,772	3,649,991	<1%
	Kuranda to Mareeba	611,565	611,803	<1%	690,915	690,915	0	1,150,424	1,150,424	0	2,240,911	2,243,131	<1%
90A PDR	Mareeba to Mt Molloy	350,872	351,110	<1%	372,772	372,772	0	482,221	482,221	0	675,226	677,445	<1%
90B PDR	Mt Molloy to 30km	117,618	117,856	<1%	124,959	124,959	0	161,648	161,648	0	226,346	228,565	<1%
	30km to 145km	65,990	66,228	<1%	70,109	70,109	0	90,693	90,693	0	126,992	129,211	2%
	145km to Laura	43,333	43,571	<1%	46,038	46,038	0	59,554	59,554	0	83,391	85,610	3%
90C PDR	Laura to Coen	30,581	30,819	<1%	32,489	32,489	0	42,028	42,028	0	58,850	61,069	4%
90D PDR[1]	Coen to Archer River Quarry turnoff	30,085	30,323	<1%	31,963	31,963	0	41,348	41,348	0	57,897	60,116	4%
	Archer River Quarry turnoff to Aurukun Road turnoff	30,085	30,323[2] 32,140[3]	<1%[2] 7%[3]	31,963	31,963	0	41,348	41,348	0	57,897	60,116	4%
	Aurukun Road turnoff to Weipa	30,085	41,941[2] 30,303[3]	39%[2] <1%[3]	31,963	31,963	0	41,348	41,348	0	57,897	60,116	4%
	Kerr Point Road/John Evans Drive	60,759[1]	72,615[2] 60,977[3]	19.5%[2] <1%[3]	64,478	64,478	0	83,410	83,410	0	116,794	130,693	12%
Aurukun Road	PDR turnoff to site (via the access roads)	Insufficient data	12,094[2] 2,055[3] 218[4]	Insufficient data	Insufficient data	156#	Insufficient data	Insufficient data	312#	Insufficient data	Insufficient data	546#	Insufficient data

(1) Estimated.

(2) First year of construction, including period prior to barge/ferry terminals being constructed.

(3) Average annual daily trips after barge/ferry terminals are constructed and during aggregate deliveries from Archer River Quarry.

(4) Average annual daily trips after barge/ferry terminals are constructed, without aggregate deliveries from Archer River Quarry.

Project-related traffic only.

Overland Water Flows

The Mine Access Road has been designed to a level so flooding at an average recurrence interval of one in ten years would result in greater than 300mm floodwater over the road. Such creek crossings would have a negligible impact on overland water flows.

Driver Fatigue

Use of long-haul routes, such as the PDR, may result in driver fatigue and resulting health and safety impacts. As mentioned in previous sections, use of long-haul routes would be minimised where possible as the majority of equipment and supplies would be transported to/from Weipa via ship or barge. Where transport is conducted by road, it would be the responsibility of the transport operator to ensure driver fatigue is managed in an appropriate manner and in accordance with relevant DTMR procedures and standards. RTA employee and contractor fatigue would be managed through existing RTA processes as described in **Section 14.1.7**.

Access to Culturally Significant Areas

There are a number of areas of cultural significance that are accessed by Traditional Owners. Access to active mining areas would be restricted to protect the health and safety of the public and the workforce, however access for Traditional Owners to specific areas, including to outstations in the Project area at Amban (False Pera Head) and Waterfall (near Ina Creek), would be managed in accordance with obligations outlined within the WCCCA.

Pedestrian/Cycle Networks

There would be no impacts to pedestrian or cycle networks as a result of the Project.

Public Transport Networks

The school bus route on the PDR between Napranum and Weipa would not be impacted. Upgrades to intersections are proposed in **Section 14.1.7** to improve safety aspects.

14.1.7 Mitigation Measures

PDR/Hornibrook Ferry Terminal Access Intersection

To ensure operational efficiency and road safety for users of the intersection for the Hornibrook ferry terminal, RTA proposes the intersection be upgraded to the requirements of the *Road Planning and Design Manual* (DMR 2006b). Detailed designs are yet to be carried out but are likely to include the following:

- A right-turn lane with a minimum width of 3.5m;
- Minimum length of right-turn lane (excluding taper) to be 30m;
- Minimum length of taper of right-turn lane to be 12m;
- New left-turn deceleration lane, and
- Sealed pavement on the southern leg providing access to the Hornibrook ferry terminal.

There are no regulatory approvals required for these mitigation works. RTA would complete these works before the start of operations.

Kerr Point Road/Humbug RORO Barge Terminal Access Intersection

To ensure operational efficiency and road safety for users of the intersection for the Humbug RORO terminal, RTA proposes a priority-controlled intersection with a channelised right-turn from PDR, similar to that proposed for Hornibrook Point.

Therefore, it is proposed the intersection be upgraded in accordance with the *Road Planning and Design Manual* (DMR 2006b). Detailed designs are yet to be carried out but are likely to include the following:

- A 3.5m wide passing lane for the right turn with minimum 60m straight lane and minimum 30m tapers, and

- The existing left-hand turn lane into Humbug Wharf would be extended to the new access road to Humbug RORO Barge Terminal.

There are no regulatory approvals required for these mitigation works, however final designs would be agreed with the North Queensland Bulk Ports Corporation Limited (NQBP)

RTA would complete these works before the start of operations.

PDR and Aurukun Road

Materials would be brought in via the Aurukun Road only when the road is declared open by the Police and DTMR (i.e. not during wet season closures).

Heavy vehicle usage along the PDR to Weipa would largely occur during the dry season. The transport operator would confirm the load restrictions along this route prior to transport.

RTA would monitor the road condition and repair any damage to the PDR or Aurukun Road resulting directly from project-related haulage, but would not be responsible for general wear and tear from normal use. RTA would consult with the relevant Shire Councils to develop a suitable monitoring approach.

Driver Fatigue

RTA has implemented a Fatigue Management Standard and Guideline for employees and contractors whilst on site or whilst conducting business on behalf of RTA. Employees and contractors learn about fatigue management through site inductions and are encouraged to assess and manage fatigue by having a break, taking food or drink, or doing physical activity (e.g. stretching or walking). Workers are also required to notify their leader if they feel fatigued and their leader would conduct an assessment. Work and non-work related travel is considered when assessing fatigue-related risks.

RTA has also implemented a Travel Remote Site Health Procedure that includes measures to prevent deep vein thrombosis, which may occur as a result of sitting in a vehicle for long periods at a time. Preventative measures include taking a break every hour, stretching and consumption of at least two litres of water every 24 hours.

Access to Culturally Significant Areas

RTA will continue to manage access for Traditional Owners to specific areas (including Amban, Waterfall, and Six Ti Tree), in accordance with its obligations outlined within the WCCCA. This is discussed further in **Section 16.3.2**.

14.2 Rail Facilities

Bauxite is currently transported from Andoom to Weipa on a 20km single-track rail line. Rolling stock comprises two diesel-powered locomotives and three sets of 35 wagons.

The Project would not use rail for transport. Use of the existing rail line would cease when ore reserves at Andoom are depleted. Therefore, the Project would not impact rail infrastructure.

14.3 Airport

Weipa Airport is located 13km south east of Weipa and is managed by Weipa Air Charter. The airport is currently serviced by QantasLink, with flights leaving Weipa one to three times daily, and two car rental companies. BP Australia currently maintains a fuel facility at the airport.

RTA would work with a regulated airline to ensure additional flights are provided to transport people and supplies to Weipa as required.

Section 16.3.1 describes the feedback received in consultation regarding the airport infrastructure.

Construction Phase

During the construction phase, personnel that are not based in Weipa would be transported from the construction camp to the airport for transportation back to their place of residence for their scheduled days off. It is difficult to determine the number of additional air services that

would be required as it is uncertain what proportion of the construction workforce would not be based in Weipa. However, it is unlikely that, on average, more than one additional air service per day would be required. This is within the capacity of the existing airport infrastructure.

Operational Phase

During the operational phase, personnel would be based in Weipa and therefore the use of the airport would be limited to visitors to the Project site and personal use of people living in Weipa.

Table 16-3 shows the population projections under various production scenarios of the Project. The projections suggest when the Project mine production is at 15Mdptpa, the population of Weipa and Napranum (3502) would be slightly less than the population was in 2007-2008 (estimated at about 4050). The population is projected to decrease to 3327 under the 30Mdptpa production scenario when it is assumed that Andoom closes and all mining takes place south of the Embley River. Significant population increases are not projected to occur until production increases to 50Mdptpa, when the combined Weipa and Napranum population is projected rise to approximately 400 above the peak of 2007-2008. The timing of increased production is subject to market conditions.

Assuming flights increase in proportion with population, even with this population increase, the number of flights leaving Weipa would increase by approximately three each week. This is within the capacity of the existing airport infrastructure.

The Project would not require changes to airport infrastructure.

14.4 Sea Port Facilities

14.4.1 Existing Infrastructure

North Queensland Bulk Ports Corporation Limited (NQBP) is the port authority for the Port of Weipa. The Port of Weipa is primarily involved in the shipments of bauxite from RTA Weipa's existing operations to Gladstone and other markets overseas, as well as deliveries of fuel and general cargo.

There are four berths located at the Port of Weipa that are all operated by RTA and utilised as follows:

- Lorim Point East Berth – bauxite export;
- Lorim Point West Berth – bauxite export;
- Evans Landing Berth – deliveries of fuel and oil, and
- Humbug Point Wharf – deliveries of general cargo.

Maritime Safety Queensland (MSQ) provides pilotage and NQBP undertakes regular dredging to maintain the shipping channel and maintenance of navigational aids. Tug services are provided by a third-party provider.

14.4.2 Existing Port Activity

The Port of Weipa handled 396 ships in 2008–09, carrying 20,348,567 tonnes of bauxite (PCQ, 2010). In addition, 69,271 tonnes of fuel and 39,741 tonnes of general cargo were handled.

14.4.3 Proposed New Infrastructure

Four new marine facilities are proposed as part of the Project. These are described fully in **Section 2** and shown on **Figure 14-2** and **Figure 14-3** and are summarised as follows:

- A new Port would be constructed on ML 7024 between Boyd Point and Pera Head. The proposed port is outside the Port of Weipa limits;
- A new ferry terminal would be constructed on the northern side of the Embley River near Hornibrook Point on NQBP land (the Hornibrook ferry terminal);

- A new RORO barge terminal would be constructed near the existing Humbug Wharf on NQBP land (the Humbug RORO barge terminal), and
- A ferry terminal and RORO barge terminal would be constructed on the southern bank of the Hey River on ML 6024 (Hey River barge/ferry terminal).

A development application would be required for infrastructure on strategic port land. NQBP is an assessment manager for works in this area.

In addition, berthing frames and walkways would be installed on the landward side of the existing Lorim Point east wharf to accommodate the tugs that would be required for the proposed port during adverse weather conditions.

14.4.4 Proposed Shipping Routes

During the initial construction phase, while the new Hey River barge/ferry terminal and the new Mine Access Road to the site are being established, heavy equipment, cargo and fuel would be delivered by ship or barge to Evans Landing or Humbug Wharf. It would then be transported by existing road to the Project site, as discussed in **Section 14.1.1**. Construction of the barge terminals and Mine Access Road would take approximately six months.

Once the new barge terminals are operational, cargo and equipment may be delivered directly to the proposed Hey River barge /ferry terminal (if the draft of the barge allows). Deliveries to the Humbug Wharf or Evans Landing would be unloaded onto either:

- trucks for a RORO transfer from the proposed Humbug RORO terminal to the Hey River barge/ferry terminal, or
- a barge with a shallower draft, suitable for berthing at Hey River, where it would be unloaded.

The workforce would be transported via ferry from the new Hornibrook ferry terminal to the Hey River barge/ferry terminal.

RTA proposes to operate the new port facilities. Bauxite shipments would occur from the proposed port via bulk carriers. The bulk carriers would travel past the Port of Weipa through the Gulf of Carpentaria and, depending on the destination, the Torres Strait shipping route. Ships travelling to Gladstone would continue to transit the Great Barrier Reef via the inner route under pilotage. The Port may also be used for deliveries of some cargo and equipment when required.

14.4.5 Proposed Shipping Movements

Construction

The Port of Weipa would receive deliveries of fuel, cargo, and equipment for the Project at the Humbug, Evans Landing, and Lorim Point wharves. Materials would then be transferred either to vehicles or smaller barges as required for transport to the Project area. The volume and nature of deliveries to the Port of Weipa during construction are shown in **Table 14-8** below.

Some deliveries may be made directly to the new Port site, such as construction materials for the Port.

A small boat would be used to transport workers to the Hey River barge/ferry terminal construction site, and may also be used on an ongoing basis where required. Generally, barges and boats would run as required, however **Table 14-8** provides an estimate of the number of crossings required for the expected volume of cargo and workforce.

The type and rate of use of hazardous substances during wharf construction is described in detail in **Section 19.1**.

Waste from the Project area would be transported by back-haul on the barge to Evans Landfill or transfer stations. The management of waste is described further in **Section 13**.

During construction, bauxite from the existing mining operations at East Weipa and Andoom would continue to be shipped from the Port of Weipa.

Table 14 – 8 Materials Handled at Port of Weipa – Construction

Phase	Deliveries of fuel, cargo and equipment (Inputs)	Transfers of fuel, cargo and equipment from Port of Weipa to Project area	Shipments of bauxite (Outputs)
Construction (prior to establishment of barge and road access)	General supplies would continue to be delivered in containers/loose to Humbug Wharf via the existing Cairns to Weipa barge (approximately 240 tonnes per week for the Project). Fuel would continue to be delivered to Lorim Point and Evans Landing approximately every six weeks (approximately 2,000kL per delivery for the Project). Ten ship deliveries to Humbug Wharf, totalling 2000t of heavy equipment and buildings. The piles for the wharf, part of the proposed port (2000t of steel), would be delivered in two to three shipments to Humbug Wharf.	Ship and barge deliveries would be transferred to the Project area by road. Construction materials for the new wharf would be transferred to the proposed port site by dedicated barge or shipped directly. Workforce travelling to and from Weipa to work on the construction of the Hey River barge/ferry terminal, the Mine Access Road and the construction camp would be transported across the river by small boat from Evans Landing on a daily basis until the construction camp is built.	No change from existing bauxite shipments, subject to demand.
Construction (post establishment of supply route to site)	An average of 130 tonnes/week construction equipment and materials is expected to be delivered during this phase. General supplies would be delivered in containers/loose to Humbug Wharf via the existing Cairns to Weipa barge. An additional weekly service is expected to be required during this phase. Fuel would continue to be delivered to Lorim Point & Evans Landing, approximately every six weeks (about 2000kL per delivery).	Cargo, fuel and construction material would be transferred by barge from Humbug Wharf to Hey Point RORO barge/ferry terminal. On average, there would be one to two barge crossings per day. Some delivery barges from Cairns may travel directly to Hey Point barge/ferry terminal. Construction workforce travelling to and from Weipa at start of roster would be transported to site via ferry from the Hornibrook ferry terminal and then by Mine Access Road (and return at end of roster).	No change from existing bauxite shipments, subject to demand.

Note: all figures approximate.

Operations

Once operations commence, the Port of Weipa would continue to receive deliveries of fuel, cargo, and equipment for the Project at the Humbug and Evans Landing wharves. Materials would then be transferred either to vehicles or smaller barges as required for transport to the Project area. Some delivery barges from Cairns may travel directly to Hey Point barge/ferry terminal. The volume and nature of deliveries to the Port of Weipa during the various production scenarios are shown in **Table 14-9**.

Generally, the barge and ferry would run as required, however **Table 14-9** provides an estimate of the number of crossings required for the expected volume of cargo and workforce. A small boat may be used in place of the ferry if there are only a few people to transport. A small boat or barge may be used to transport people, materials or equipment from the current Port of Weipa to the new Port, where required.

Fuel and other hazardous substances would be delivered via barge. The type, rate of use and management of hazardous substances at the Project site is described in detail in **Section 19.1**.

Waste from the Project area would be transported by back-haul on the barge to Evans Landfill or transfer stations. The management of waste is described further in **Section 13**.

Table 14 – 9 Materials Handled at Port of Weipa – Operations

Production Scenario	Deliveries of fuel, cargo and equipment	Transfers of fuel, cargo and equipment from Port of Weipa to Project area	Shipments of bauxite
15Mdptpa	Small increase in fuel and cargo as Project production replaces depleted East Weipa resources. This would include approximately 38,000kL per annum diesel for the Project.	14 RORO barges per week from Humbug Wharf to Hey River barge/ferry terminal carrying general cargo and fuel. Some barges may travel direct to the Hey River barge/ferry terminal. Operational workforce would be transported from Hornibrook Point ferry terminal to Hey River barge/ferry terminal via ferry at shift change (three to four ferry crossings per day) and then by Mine Access Road to site.	East Weipa production would cease. Shipments from Port of Weipa reduce by approximately half (depending on demand at the time). Up to 150 ships/annum, typically two to three ships loaded per week.
30Mdptpa	No major change to fuel and cargo deliveries as the Project replaces production from Andoom. This would include 70,000kL per annum diesel for the Project.	25 RORO barges per week from Humbug RORO barge terminal to Hey River barge/ferry terminal carrying general cargo and fuel. Some delivery barges may travel direct to Hey River. Workforce would be transported from Hornibrook Point to Hey River via ferry at shift change (three to four crossings per day).	Andoom production will cease. 150 ships/annum would reduce to nil.
50Mdptpa	Cargo deliveries are likely to increase to a total of approximately 40,000 tonnes each year (of which approximately 8,000 tonnes would be attributable to the Project and associated population growth). Approximately 109,000kL diesel for the Project.	40 RORO barges per week from Humbug RORO barge terminal to Hey River barge/ferry terminal carrying general cargo and fuel. Some delivery barges may travel direct to Hey River barge/ferry terminal. Workforce would be transported from Hornibrook ferry terminal to Hey River barge/ferry terminal via ferry at shift change (four to six crossings per day).	Nil bauxite shipments from Port of Weipa.

Note: all figures approximate.

The expected shipments of bauxite from the Port of Weipa under various production scenarios are shown in **Table 14-9**. All bauxite mined in the Project area would be shipped from RTA's new port (refer **Table 14-10**). The shipment of bauxite through the Port of Weipa would reduce when operations cease at East Weipa and, would cease entirely when operations cease at Andoom.

Table 14 – 10 Shipments from Proposed Port

Production Scenario	Type	Quantity*
15Mdptpa	Bulk carrier – customer vessels vary	150 - 215 ships/annum (up to 4-5 ships loaded per week)
30Mdptpa	Bulk carrier – customer vessels vary	300 - 375 ships/annum (up to 7-8 ships loaded per week)
50Mdptpa	Bulk carrier – customer vessels vary	410 - 625 ships/annum(up to 12 ships loaded per week)

Note: all figures approximate.

* Number of ships will vary depending on actual production and size of vessels.

The Port of Weipa facilities are limited to ships up to 255m in length, 12.3m draft, and 85,000 deadweight tonnage (dwt) (PCQ 2010). However, larger ships are available for use, and the proposed port has been designed to accommodate Capesize vessels of up to 185,000 dwt (refer **Table 14-11**).

Table 14 – 11 Approximate Dimensions of Bauxite Ships

	Dedicated Panamax (e.g. RTS Pioneer)	Dedicated Post Panamax (e.g. RTM PIIRAMU)	Capesize
Dead weight tonnage (dwt)*	70,000	90,000	185,000
Bauxite cargo (t)	68,660	88,500	Approx 180,000
Length overall (m)	225	236	295
Draft (m)	12	Up to 12.8	18.1

* Dwt is the maximum weight of a vessel, including the vessel, cargo and ballast.

In the initial phase of the port, RTA proposes to construct and operate port facilities capable of shipping 30Mdptpa, with provision to enable future expansion up to 63Mdptpa. Capacity may be provided for third parties following agreement on suitable commercial terms. For the initial port development for shipping 30Mdptpa, two berths are required. Two extra berths would be added if ship loading capacity was increased to 63Mdptpa.

Ships waiting to berth would generally anchor in an offshore mooring area, west of Boyd Point, (refer **Figure 14-3**) in water approximately 20m deep. However, depending on their ballast, ships may safely be able to anchor in shallower water depths. The specific location of the anchorage areas would be subject to the approval of the operator of the Port, who would direct ships according to conditions at the time through the shipping agent.

14.4.6 Impact Assessment

Shipments from Port of Weipa

The expected shipments of bauxite from the Port of Weipa are shown in **Table 14-10**. The shipment of bauxite through the Port of Weipa would reduce when operations cease at East Weipa. Bauxite mined and processed through the Andoom operation would continue to be shipped via the existing Port of Weipa until these reserves are depleted.

Deliveries to Port of Weipa

During the initial six months of construction it is estimated an additional ten ships would deliver approximately 2000 tonnes of construction materials. This represents only a minor increase in the volume of cargo currently delivered (39,741 tonnes in 2008-2009). Once the Hey River barge/ferry terminal is constructed, deliveries over the remaining construction period are expected to increase to an average of 130 tonnes per week, a 20% increase over current average cargo volume, and increase in frequency by one delivery per week. This is within the capacity of the Port of Weipa.

Up to 30Mdptpa production rate the volume of deliveries would increase in proportion with total production, as the Project would, for the most part, take over production from the existing mining operations north of the Embley River (NoE). The frequency of deliveries is not expected to increase significantly as there is spare capacity on the existing barges.

At 50Mdptpa, the volume of cargo deliveries is expected to be approximately twice that for the current NoE operations. However, the frequency of fuel deliveries would only increase from six-weekly to once every four to five weeks as the shipments would be larger in volume than the current deliveries. This is within the capacity of the Port of Weipa.

Activity in Port of Weipa Limits

An increase in the movement of vessels within the Port limits increases the risk of collision, resulting in a safety incident or environmental harm.

Table 14-8 and **Table 14-9** summarise the expected deliveries and transfers of cargo and fuel, as well as bulk shipments of bauxite by the Port of Weipa. Currently, approximately two cargo barges and seven bulk carriers are handled by the Port of Weipa each week. The

number of bulk carriers travelling within the Embley River would decrease as production decreases from Weipa operations NoE. There are no data available on the current use of the river by other commercial or recreational boats, however, given the low population it is anticipated to be relatively minor.

During the initial construction phase before the ferry and barge terminal are constructed, general supplies and fuel would continue to be delivered at the same frequency as current NoE operations. There would be approximately 12-13 ship deliveries over this six-month period of heavy equipment and buildings, as well as piles for the proposed wharf. Some equipment would be transferred across the river to the construction site of the Hey River barge/ferry terminal and a small boat would be used to transfer people on a daily basis. This minor increase in vessel traffic is unlikely to increase the risk of collision.

During the remainder of the construction period, an additional weekly cargo delivery is expected. Barge crossings would occur as required, but are expected to be on average one to two times per day. The ferry would be used to transfer people across the river at the start and end of their roster. This minor increase in vessel traffic is unlikely to increase the risk of collision.

Under the 15Mdptpa production scenario, when bauxite exports are still occurring from NoE operations, it is estimated there would be approximately four to five bulk carriers loaded each week at Lorim Point. It is also anticipated there would be approximately 14 barge crossings per week between Humbug RORO barge terminal and the Hey River barge/ferry terminal and 28 ferry crossings between Hornibrook ferry terminal and the Hey River barge/ferry terminal. While this increase may seem significant in relative terms, the total daily ship movements within the Port of Weipa, inclusive of that generated by the proposed development, is considered to remain at low levels. Ship movements are regulated by the Port operator and the width of the Embley River allows ample space to render collisions between vessels unlikely.

In the 30Mdptpa phase, bauxite exports from the Port of Weipa are expected to decrease until there are no more exports. It is estimated during this phase there would be 25 RORO barge crossings per week and 28 ferry crossings each week. Therefore, although barge and ferry transfers increase, the reduction in bulk carrier movements would reduce the likelihood of collision. The movement of vessels would continue to be managed by the Port operator, further reducing the risk to low.

Once the Project reaches 50Mdptpa production, the movement of vessels on the Embley and Hey Rivers from Humbug RORO barge terminal and the Hey River barge/ferry terminal would be approximately 40 RORO barge crossings each week. Additionally, it is estimated there would be approximately 40 ferry crossings each week from the Hornibrook ferry terminal to the Hey River barge/ferry terminal.

There would be no bulk carriers on the Embley River by the time the Project reaches 50Mdptpa. Therefore during this phase, the risk of collision between bulk carriers and other vessels in the Port of Weipa will be negligible.

Product Spillage

Product spillage into the marine environment can occur from routine loading operations. Bauxite is non-hazardous and the risk of impact to marine ecology is considered to be low. Mitigation measures are proposed in **Section 14.4.7** to reduce the likelihood of spills.

Fuel, Oil and Chemical Spills

Accidental fuel, oil and chemical spills related to shipping activities can have impacts on the marine environment as well as marine fauna. The risk of a spill associated port operations associated with the project is considered low for the following reasons.

- The Port of Weipa is currently limited to vessels up to 90,000dwt. Cape Size vessels (185,000dwt) rather than panamax or post-panamax vessels (approx 70,000dwt and 90,000kt) would be used for the transport of bauxite from the proposed port site. Therefore, the probability of vessel incidents occurring resulting in accidental fuel, oil or

chemicals would be lower than if the proposed port was restricted to the smaller vessels.

- The proposed port would be remote from other shipping routes.
- There would be no bulk fuel deliveries to the proposed port.
- There would be no refuelling of bulk carriers at the proposed port.

Commercial and Recreational Fishing

The proposed mooring area is in an area of the Northern Prawn Fishery utilised by commercial trawlers. The area is also utilised for recreational fishing, although the most preferred reefs for fishing are in shallower water.

Table 14-10 shows the number of ships that would be loaded each week at each production level. Ships that cannot be brought directly into berth would be anchored in the mooring area shown in **Figure 14-3**.

RTA aims to minimise the amount of time bulk carriers would be anchored. Modelling carried out by RTA indicates at a production rate of 15Mdptpa there would be two berths operating at the proposed port and the mooring area will be utilised 11 times each year for an average of five hours each time. Therefore, the total estimated time the mooring area would be utilised is 55 hours in a year, or approximately 0.6% of the time.

At 30Mdptpa, when the Port would be operating two berths, the mooring area would be utilised 81 times each year for an average of 9.3hr each time. The total estimated time the mooring area would be utilised is 753hr in a year, or approximately 9% of the time.

Modelling has not yet been carried out for a production rate of 50Mdptpa, however at this time the proposed port would be extended to four berths, and it is expected utilisation of the anchorage area would be less than for the 30Mdptpa production scenario.

Fishing vessels are permitted to operate within mooring areas. MSQ requires commercial fishing boats keep clear of anchored bulk carriers. This means a small proportion of available fishing ground would be temporarily unavailable while vessels are anchored in the area.

Other Impacts

Potential impacts that may arise as a result of the construction of port and wharf infrastructure and some operational aspects are assessed in other sections of this EIS, including:

- **Section 6.5** and **Section 6.9.4. Marine** – potential impacts from dredging, and from lighting on marine fauna;
- **Section 7.8 Terrestrial Flora and Fauna** – impacts from construction of barge/ferry terminals;
- **Section 10.5 Noise** – potential impact of construction noise on marine ecology;
- **Section 12.4.4 Visual** –visual assessment of port and barge/ferry terminals, and
- **Section 13.3.8 Waste** – management of ballast water and other ship waste.

14.4.7 Mitigation Measures

Port of Weipa

The construction of the RORO barge terminal at Humbug Point would have minimal impact on the existing Evans Landing and Humbug Wharf. Infrastructure in the Humbug RORO barge terminal area would be designed to ensure safe and efficient operations in this area. This facility would be operated by RTA in accordance with MSQ requirements.

The Hornibrook ferry terminal is located upstream of the Lorim Point bulk carrier berth and the ferry would travel upstream to the Hey River barge/ferry terminal, thereby reducing potential impact within the bulk carrier shipping passage.

Initial consultation carried out with NQBP and MSQ has not indicated any major concerns with the Project. Further consultation would be carried out as detailed design is carried out.

Product Spillage

Several control measures would be adopted to minimise the risk of product spillage, including:

- In order to prevent bauxite spillage from the ship loader tripper, a catch tray would be positioned under the tripper to catch spillage from the inclined section of belt. The material collected from the tripper catch tray would be directed to the head-end sump and then pumped onshore to a sediment holding pond;
- Three-stage belt scraping with water sprays would be positioned at the conveyor head pulley to clean the belt. The scrapings and the water used for belt cleaning would be directed into the head end sump for pumping onshore into sedimentation ponds;
- The wharf conveyor would be designed with variable speed drives to provide controlled belt starting, thereby minimising the potential for bauxite spillage;
- Belt drift switches would be installed on the wharf and ship loading conveyor that shuts down the conveyor drives if a belt moves from the designed position. Training idlers that track the belts would also be installed.
- When loading ships, the product reclaimer would be stopped, and the conveyor allowed to empty, before the ship loading boom travels between hatches to prevent bauxite spillage onto the deck of the ship, and
- A sealed maintenance area would be provided at the end of the wharf so the ship loading boom can be serviced and cleaned within a bunded area. Runoff from this sealed maintenance area would be directed to the head end sump for pumping back to shore.

Interaction between Vessels in Proposed Port Area

Navigational aids would be installed for the proposed port in accordance with MSQ requirements to assist navigation of bulk carriers through the shipping channel. Maintenance dredging of the shipping channel would be carried out as required (refer to **Section 6.8.3** for marine impacts and mitigation measures associated with dredging).

MSQ's *BoatSafe Workbook* (MSQ 2007) requires that when bulk carriers are underway they would need to avoid operating commercial fishing vessels. MSQ also requires that if bulk carriers are already anchored, commercial fishing boats would need to slow to six knots within 30m of the vessel and keep clear of it. Navigation lights are required by all vessels at night to assist in the prevention of collisions.

Environmental Impact Statement

for South of Embley Project

Section 15
Consultation

15 CONSULTATION

An extensive program of community consultation and stakeholder engagement has been undertaken to assist in the preparation of the EIS for the Project. The following section provides details of the identification of key stakeholders, development and implementation of a consultation and engagement program appropriate for the Project, and the recording of feedback received from individuals and organisations on a diverse range of subjects.

The objectives of the community consultation process are:

- to identify stakeholders who have an interest in the Project;
- facilitate two-way engagement with stakeholders, providing accurate, timely and relevant information on the Project;
- identify any concerns or potential issues stakeholders may have with the Project;
- explore areas of the Project with the potential to have a positive impact on communities;
- develop appropriate strategies to mitigate any concerns; and
- address stakeholder issues and concerns during the EIS process.

For the purpose of community consultation, the local community area has been defined as the communities and surrounding areas of the Western Cape region, including Aurukun, Napranum, Weipa and Mapoon. This region encompasses the members of the general public and the organisations (including government, industry, service providers, regional landholders and community groups) likely to be adversely or positively affected by the Project.

15.1 Methodology

The community consultation process was designed to enable opportunities for ongoing community and stakeholder feedback during the preparation of the EIS. The process was designed to be in accordance with Rio Tinto's Community Relations Standard, in particular with respect to instigating mutually acceptable and understood consultation procedures which are culturally appropriate. To facilitate consultation, dedicated personnel within the RTA Weipa Community Relations Team were appointed to coordinate consultation and engagement activities and to provide a link between the communities and the Project Team. Consultants assisted the RTA team with some of the consultation activities.

With respect to consultation and engagement activities with Traditional Owners, RTA developed a schedule of activities to be conducted each quarter and formally submitted this to the relevant Western Cape Communities Coordinating Committee (WCCCC) sub-committees for consideration. The WCCCC sub-committees provided advice on the structure and methodology of the engagement and the names of the Traditional Owners to participate. This ensured activities were conducted in a culturally appropriate manner and the appropriate people participated.

Details of the consultation undertaken with various stakeholder groups and the key issues raised are provided in **Section 15.2**. A full discussion on the social and environmental issues raised by stakeholders and RTA's proposed mitigations strategies are set out in **Section 16, Social Impact Assessment (SIA).**

15.1.1 Stakeholder Identification

Prior to the commencement of consultation, a scoping study was undertaken by Sustainable Solutions (Social Impact Assessment consultants) and RTA personnel to define the key stakeholders who would be potentially directly and/or indirectly affected by the Project. This list was reviewed and expanded throughout the consultation and engagement program. This process also included the identification of Traditional Owner families and individuals whose traditional lands may be affected by the Project.

The key stakeholders include people defined as "affected parties" under the *Environmental Protection Act 1994* (Qld) (EP Act), including the Wik and Wik Way people, who have native title

over the land covered by the Project area, as well as the relevant local governments for the Project area. The definition of "affected parties" under the *Environmental Protection and Biodiversity Conservation Act 1999* (Cwlth) (EPBC Act) encompasses those who have suffered loss or damage as a result of a contravention of the Act and therefore there are no "affected parties" with respect to the Project.

The range of stakeholders and members of the general public provided with the opportunity to participate in the consultation process is summarised in **Table 15-1**.

Table 15 - 1 Key Stakeholders

Category	Group
Government	State and Federal government-elected representatives State and Federal government agencies and service providers Cook, Aurukun, Napranum and Mapoon Shire Councils Weipa Town Authority (WTA)
Non-government organisations and local community groups	Cape York Land Council Community justice groups Cultural heritage bodies
Traditional Owners and Aboriginal groups	Wik & Wik Way Traditional Owners whose traditional lands are directly impacted by the Project Other Traditional Owner groups across the Western Cape who are signatories to the Western Cape Communities Coexistence Agreement (WCCCA) and Ely Bauxite Mining Project Agreement (EBMPA). Western Cape Communities Trust and Coordinating Committee (WCCT and WCCCC) WCCCC SoE Project Sub-committee Ely Bauxite Mining Project Coordinating Committee
Industry, local business and service providers	Local businesses and service providers operating throughout the Western Cape region (Aurukun, Napranum, Weipa, Mapoon) North Queensland Bulk Ports Corporation Limited (NQBP) Weipa Chamber of Commerce Recreational and professional fishing groups Tourism operators
General public and residents of local communities	Aurukun, Napranum, Weipa, Mapoon
Regional landholders	Pastoral lease holders and managers, including: Merluna Station York Downs Station Watson River Station Batavia Downs Station Bertiehaugh Station – Steve Irwin Wildlife Reserve
Employees and contractors	RTA and local contractor employees based on the Western Cape

15.1.2 Consultation Tools

A range of consultation tools have been utilised to meet the objectives of the community consultation process. These included:

- Project DVD;
- Project newsletters and feedback forms;
- Freecall number;
- Direct stakeholder contact, including telephone calls and face-to-face meetings;
- Website;
- RTA employee communications;

- Public information sessions;
- Public displays; and
- Advertisements.

Project Newsletters

Two editions of an eight-page Project newsletter were prepared and distributed to key stakeholders across the Western Cape region and throughout Queensland in June 2008 and March 2009 respectively. One thousand copies of each newsletter were printed and distributed widely in the communities of Weipa, Aurukun, Napranum and Mapoon, including copies left on counters at offices, libraries, reception areas of local businesses and in local and state government offices.

The key information in the newsletters included:

- project background;
- information about the proponent;
- timetable detailing Project milestones;
- an outline of the EIS process;
- opportunities for the community to be involved in the EIS process, and
- contact details for the Project team to encourage community input (email address, reply-paid address, freecall number).

Copies of the two newsletters are provided in **Appendix A**.

Public Information Sessions/Public Displays

Public information sessions were held in Weipa on 17 September, Aurukun on 17 September, Napranum on 15 September and Mapoon on 16 September, 2008. The sessions provided interested community members with an opportunity to have input into the EIS process. Information about the Project was displayed at the sessions, including maps of the Project, copies of Project newsletters and photographs of the current mining operations at Weipa. RTA staff members were available to provide information about the Project and discuss any potential issues or concerns.

Additional information sessions would be held in each of these communities in the lead-up to and during the EIS public comment period.

Webpage

A webpage on the RTA website was developed to provide information on the Project. The webpage included:

- a general overview of the Project;
- links to Project newsletters; and
- contact details for the Project Team.

The Queensland Department of Infrastructure and Planning (DIP) website also carries information and documents relating to the EIS, such as the *Initial Advice Statement* and EIS *Terms of Reference*.

Employee Communications

RTA internal communications, including internal newsletters, email communication and General Manager Operation's updates provided information about the Project to employees and contractors to ensure they were familiar with the Project, and aware of opportunities to participate in the EIS process.

Personal and Group Briefings

These meetings targeted key individuals and groups in the neighbouring communities, including Traditional Owner groups, regional landholders, and local, regional and state government representatives. A Project overview was given, the EIS process outlined and feedback sought on potential issues or concerns. Maps of the proposed infrastructure and photographs of similar existing infrastructure were used to explain the Project.

Advertising

The Draft Terms of Reference for the EIS were prepared by the Coordinator-General and released for public comment from 17 January to 16 February 2009. Advertisements were placed by DIP in local, State and National newspapers to solicit public comment. A total of 21 submissions were received, including 18 from advisory agencies and three from members of the public and organisations.

Freecall Number and Email

A freecall number was featured on materials and communications regarding the Project. It provided an opportunity for community members to go directly to the people involved with the EIS process. The freecall number has nation-wide coverage and is answered in Brisbane by Project staff. An email address was established and advertised on promotional material. Emails sent to this address are received by the Project team.

Project DVD

A 10 minute Project DVD, produced in plain English, was developed for use during, and as follow-up to, individual and group briefings and during public displays. The DVD included an overview of the Project and the EIS process, maps of the proposed infrastructure, and an introduction to the bauxite mining process. Details of how stakeholders can seek further information about the Project and opportunities to provide input into the EIS process are also included in the DVD.

Media Releases

Media releases were made to support the stakeholder engagement process, focusing on the announcement of the EIS, key milestones and consultation opportunities (e.g. public information sessions/displays, meetings). A number of key stakeholders, for example the WCCT, were directly advised of announcements, by fax or telephone call, before any public announcements were made. Media releases were an additional communication tool, not the main source of information for stakeholders.

15.2 Community Consultation and Issues Raised

Following the identification of stakeholders, a consultation and engagement program was developed to ensure the consultation activities were conducted in an appropriate manner to meet the specific needs of each stakeholder group.

An initial community consultation period commenced in July 2008 and included briefings with stakeholders concerning the public announcement of the EIS and consultation with community stakeholders. In addition to the initial consultation period, comments were received from community stakeholders throughout the preparation of the EIS.

The feedback provided throughout the consultation process was recorded on event logs, collated and analysed by stakeholder group. A summary of the topics most frequently raised by each stakeholder group is presented in **Table 15-10**. Due to the diversity of stakeholders consulted and the wide variety of Project components, feedback was received across a range of subjects. The feedback provided during the consultation process was considered in the Project's Social Impact Assessment (SIA) and the key issues raised during the consultation were considered during Project planning and design.

The details of who was consulted, and a summary of the feedback they provided has been presented in the following categories:

- Federal and State Government agencies and service providers;
- Local government;
- Community groups;
- Traditional Owners and other Aboriginal groups;
- Recreational and professional fishing groups;
- Industry and local businesses;
- General public, and
- Regional landholders.

15.2.1 Government Agencies and Service Providers

The Project team held a series of consultations and presentations for Government agencies and service providers to introduce the Project. Agency and service providers were invited to provide feedback. **Table 15-2** provides a summary of the issues raised.

Table 15 - 2 Government Agency and Service Provider Consultation and Issues Raised

Timings	Stakeholder	Purpose	Issues Raised
(Various) May-June 2008	DIP (Brisbane)	Provide briefing about the Project, discuss Initial Advice Statement (IAS).	EIS process under *State Development and Public Works Act* (QLD) (SDPWO) and determination of "Significant Project for which an EIS is required".
21 May 2008	Queensland Department of Environment and Resource Management (DERM) (Brisbane)	Discuss marine turtle surveys and potential impacts.	Potential mitigation measures to minimise impacts on turtles, including lighting controls.
27 June 2008	Maritime Safety Queensland (MSQ) (Cairns)	Provide the Regional Harbour Master with a briefing about the Project.	General discussion on maritime safety of proposed port and barge and ferry operations.
21 July 2008	DERM (Cairns)	Provide Environmental staff with briefing about the Project.	General discussion on information provided. EIS Process.
6 August 2008	Department of Sustainability, Environment, Water, Population and Communities (DSEWPC) (formerly Department of the Environment, Water, Heritage and the Arts) (Canberra)	Provide DSEWPC (formerly DEWHA) with briefing about the Project, including findings of environmental studies to date.	Referral under EPBC Act. Controlling provisions of EPBC Act. Marine disposal of dredged spoil and permitting.
7 August 2008	Queensland Police Service (QPS) (Aurukun)	Information gathering to support the SIA.	
18 August 2008	Aboriginal and Torres Strait Islander Partnership (ATSIP)	Information gathering to support the SIA.	

Timings	Stakeholder	Purpose	Issues Raised
	(Aurukun)		
20 August 2008	QPS (Weipa)	Information gathering to support the SIA.	
10 September 2008	Queensland Health (Weipa)	Information gathering to support the SIA.	
10 September 2008	QPS (Weipa)	Information gathering to support the SIA.	
6 January 2009	North Qld Bulk Ports (NQBP) (Brisbane)	Provide briefing about the Project.	Dredging and spoil volumes. Facilities located on Strategic Port Land.
27 January 2009	DIP (Social Impact Unit)	Discussion about content of SIA.	Agreement on definition of "local community area". Structure of Social Impact Management Plan. Cumulative impact. Presentation of consultation output.
3 February 2009	DIP, DERM, DTMR, Queensland Department of Employment, Economic Development & Innovation (DEEDI), NQBP, and Department of Communities (DoC).	Briefing on the Project for government advisory agencies.	Agencies provided advice on particular areas of interest to be included in Terms of Reference for EIS.
4 February 2009	DIP, DERM, DEEDI, NQBP, DoC, DTMR and QPS (Cairns)	Briefing on the Project for government advisory agencies.	Agencies provided advice on particular areas of interest to be included in Terms of Reference for EIS.
19 July 2009	DERM (Brisbane)	Discuss mitigation measures for potential impacts on marine turtles.	Survey methods. Dredging. Lighting controls. Ghost nets. Feral pig control.
24 July 2009	DERM (Townsville)	Technical briefing on proposed water supply for the Project.	Modelling of impact on artesian aquifer. Modelling of surface water supplies from dams. Regulatory matters for surface water and groundwater supply.
18 August 2009	DERM (Brisbane)	Briefing on proposed water supply for the Project.	Impact on artesian aquifer and surface waters. Regulatory matters for surface water and groundwater supply.
6 January 2010	DERM (Brisbane)	Briefing on proposed water supply for the Project.	Impact on surface waters.

Timings	Stakeholder	Purpose	Issues Raised
26 May 2010	DIP (Brisbane)	Project briefing and discuss interpretation of some Terms of Reference items.	Proposed water supply, explanation of Terms of Reference for EIS.
6 September 2010	DSEWPC (Canberra)	Provide DSEWPC with briefing about changes to port aspects of the Project.	Submission of replacement Referral under EPBC Act.
8 April 2011	DSEWPaC (Canberra)	Discussion on EIS	Impacts, mitigation measures and survey methods related to EPBC Act listed flora and fauna.

15.2.2 Local Government

Commencing in July 2008, RTA conducted Project briefings and consultation with local Shire Councils throughout the Western Cape region. This included Mapoon, Napranum, Aurukun, and also the Weipa Town Authority (WTA). **Table 15-3** provides a summary of the consultation sessions and issues raised.

RTA and Project team personnel have consulted and engaged with local government authorities with regards to the potential impacts of the Project on these neighbouring communities. This has included initial Project briefings, consultation sessions and Project updates presented at Council meetings. RTA has also provided Project newsletters to each Shire Council office.

Table 15 - 3 Local Government Meetings and Issues Raised

Timing	Stakeholder	Format	Issues Raised
August 2008	Mapoon Aboriginal Shire Council	Face-to-face meeting	Public versus mine access only for mine road infrastructure. Concerns improved access to the area south of the Embley may increase the amount of alcohol being illegally transported into communities with alcohol management plans. Proposed amendments to shire council boundaries. Impact on Napranum from noise and lights associated with barge/ferry operations on the Embley River. Impacts of dredging for barge/ferry operations. Opportunities for RTA to share infrastructure and potentially reduce environmental impacts. Employment opportunities for residents during construction and operations. Economic development/business development opportunities. Crime and anti-social behaviour in local communities. Opportunities for the Project to have a positive impact on the social well-being of residents of local communities. Establishing a permanent presence in the community near the proposed Project (e.g. Aurukun).
July 2008 June 2009 July 2010	Napranum Aboriginal Shire Council	Face-to-face meetings	
July 2008 May 2009	Aurukun Shire Council	Face-to-face meetings	
July 2008 September 2010	WTA	Face-to-face meeting	

15.2.3 Community Groups and Organisations

The community groups and organisations consulted included community justice groups in Napranum and Aurukun, and Wik Projects (the registered cultural heritage body for ML 6024 and the portion of ML 7024 located south of the Embley River). **Table 15-4** provides a summary of the consultation sessions conducted and the key issues raised by these groups.

Table 15 - 4 Community Group Consultation and Issues Raised

Timing	Stakeholder	Format	Issues Raised
July 2008	Aurukun Community Justice Group	Group meeting	Environmental impact on wetlands and swamps. Impact of dams proposed on Norman Creek and Ward River. Rehabilitation processes and lessons from area of mining lease north of the Embley River. Cultural heritage management planning. Buffer zones. Management of traffic and transport on the Hey River - Boyd Mine Access Road. Employment opportunities associated with the Project in construction and operation. Employment and training models to increase representation of Wik and Wik Way Traditional Owners in the workforce. Opportunities for economic development as a result of the Project. Law and order. Alcohol and substance abuse. Impact of dredging. Ongoing access to sea and land. Ongoing community consultation and engagement.
August 2008 September 2008	Wik Projects Limited	Face-to-face meeting	
September 2008	Napranum Community Justice Group	Group meeting	

15.2.4 Traditional Owners and Other Aboriginal Groups

The proposed area for development of the Project is recognised as the traditional lands of the Wik and Wik Way people. Whilst most of the members of this group continue to reside in Aurukun, a number also reside in Napranum, Weipa and other communities throughout the Cape.

The WCCCA was signed in March 2001 and is an Indigenous Land Use Agreement (ILUA) covering the land within the boundaries of RTA's mining leases (ML 7024 and ML 6024). The WCCCA was registered with the Native Title Tribunal under the *Native Title Act 1993* on 24 August 2001.

The parties to the Agreement include eleven Traditional Owner Groups (including Wik and Wik Way Traditional Owners) of the area covered by ML 7024 and M L6024, four Shire Councils (New Mapoon, Mapoon, Napranum and Aurukun), Comalco (now Rio Tinto Alcan), the Queensland Government and the Cape York Land Council on behalf of the Native Title parties.

The WCCT and the WCCCC were established out of the WCCCA. The role of the WCCCC is to monitor, implement and review the WCCCA, ensuring all parties to the Agreement meet their obligations.

The activities proposed for the area of the mining lease south of the Embley River would all be guided by the WCCCA. As such, RTA's current obligations related to the Weipa operations would also apply to the Project. RTA has provided draft versions of environmental documents such as the *EPBC Act* Referral and the EIS to the WCCCC for review and comment in accordance with the provisions of the WCCCA.

In 2008, the members of the WCCCC, including Traditional Owners for the area of the mining lease south of the Embley River, the Wik and Wik Way People, endorsed the establishment of the SoE Project Sub-committee. The Sub-committee is chaired by a member of the WCCCC and has representatives from the Wik Way Traditional Owner Group, RTA and members who give representation to the parties represented on the WCCCC. The purpose of the Sub-committee is to provide a forum in which Traditional Owners and RTA can consult, review, provide advice and make recommendations to the WCCCC related to the activities of the Project feasibility study, including the EIS.

During 2009, the Sub-committee has met quarterly to review and monitor the implementation of RTA's Traditional Owner engagement schedule and work plan, and to monitor the completion

of environmental studies and cultural heritage surveys and receive updates on the management of the Project.

In June 2009, RTA and the WCCCC agreed on a process whereby Traditional Owners would obtain independent advice regarding the content of draft EIS chapters. This process involved RTA submitting draft EIS chapters, WCCCC having these independently reviewed and providing recommendations back to RTA for response. RTA compiled responses to each of the recommendations and communicated these back to the members of the Sub-committee and WCCCC. Where necessary, the draft EIS was then amended to ensure the concerns of the Traditional Owners were appropriately addressed.

In addition to the consultation and engagement activities undertaken by RTA, the WCCT has also undertaken extensive consultation with the Directors and Members of all its Boards and Committees and with Traditional Owners residing in Mapoon, Napranum and Aurukun. The key issues raised and feedback from this consultation is presented to the Sub-committee and has been incorporated into the WCCCA EIS Review process.

Plate 15-1 shows the Wik Way Traditional Owners hosting a special meeting of the WCCCC on country at Boyd Bay to discuss the establishment of the Sub-committee.

In addition to aforementioned groups, other local Aboriginal groups include the members of the Ely Bauxite Mining Project Agreement (EBMPA) Coordinating Committee and the Traditional Owner groups who are signatories to this agreement. Whilst the traditional lands of these groups are not directly affected by the Project, many of these groups are also signatories to the WCCCA. RTA has provided ongoing Project updates to this group throughout the EIS process.

Plate 15-1 Traditional Owner Meeting on Country at Boyd Bay

A summary of consultation activities conducted and the issues most commonly raised by Traditional Owners is presented in **Table 15-5.** Consultation activities included a field trip to the Ely Dam north of Weipa (refer **Plate 15-2**). The SIA (refer **Section 16**) expands on this feedback and proposes strategies to mitigate the negative impacts of the Project and to promote positive impacts and opportunities.

Table 15 - 5 Traditional Owner Consultation and Issues Raised

Date	Stakeholder	Purpose	Location	Issues Most Frequently Raised
Community visits – 2008/09	Traditional Owners and members of local communities	Project briefings and ongoing communication regarding project activities.	Aurukun (weekly), Napranum, Mapoon	The issues most frequently raised by Wik and Wik Way Traditional Owners and broader groups of Traditional Owners who are signatories to the WCCCA and EBMPA have included: • Impact of the Project, in particular proposed dams on Norman Creek and Ward River, on the environment and areas of cultural significance; • Identification and protection of significant cultural heritage sites, including development of Communities, Heritage and Environment Management Plans; • Potential impact on cultural heritage sites within the Project infrastructure footprint; • Specific Project cultural awareness training for RTA and contractor workforces; • Increased buffer zones for specific areas; • Proposed rehabilitation practices and mine lease relinquishment for the Project; • Land access for Traditional Owners to outstations and areas used for camping and traditional practices; • Access and transport from Aurukun to the Project area to increase employment and business opportunities and allow people to continue to live in Aurukun and work at the mine; • Permit systems for access to the area by the general public; • Employment and training opportunities for local Aboriginal people during both construction and operations; • Coastal management and protection, including development of land and sea management plans and Indigenous land and sea ranger programs for the area; • Environmental impacts on rivers, creeks, wetlands and coastal areas, including flora and fauna e.g. crocodiles and turtles; • Environmental impacts due to extreme weather events, including cyclones and floods;
21 June 2008	WCCCC	Project EIS and feasibility study announcement.	Weipa	
16 July 2008	Wik Way Traditional Owners	Project Briefing.	False Pera Head, "Amban"	
10/11 September 2008	Wik Projects (Cultural Heritage Body) and Wik Way Traditional Owners	Two, half-day SIA consultation workshops.	Three Rivers Tavern, Aurukun	
22 October 2008	WCCCC	Special meeting held to discuss the establishment of SoE Project Sub-committee.	Boyd Bay	
12 December 2008	WCCCC	Project update and questions. Nomination of WCCCC members to the SoE Project S-C.	Western Cape Centre, Weipa	
4 March 2009	SoE Project Sub-committee	First meeting to establish Charter, consult, review and provide advice and recommendations to WCCCC in relation to the Project.	RTA Weipa Community Relations Building, Weipa	
31 March 2009	WCCCC	Project update and questions, consider recommendations from SoE Sub-committee.	Western Cape Centre, Weipa	
7 April 2009	EBPMA CC (Ely)	Project update and questions.	Weipa Fishing Lodge, Weipa	
3 June 2009	SoE Project Sub-committee	Consult, review and provide advice and recommendations to WCCCC in relation to the Project.	Western Cape Centre, Weipa	
22 June 2009	WCCCA Indigenous Directors	Project update and questions, role of SoE Sub-committee.	WTA, Conference Room, Weipa	
23 June 2009	WCCCC	Project update and questions, consider recommendations from SoE Sub-committee.	Western Cape Centre, Weipa	

Date	Stakeholder	Purpose	Location	Issues Most Frequently Raised
1 July 2009	Wik Way Traditional Owners	SIA workshop to discuss Project water supply strategy, including proposed dam infrastructure.	Aurukun Church	• Impact of dredging on sea grass, oysters and inshore reefs; • Potential of shared infrastructure opportunities with the Aurukun Bauxite Project to minimise environmental impacts; • Ongoing consultation and engagement processes between RTA and Traditional Owners (via WCCCA), including the establishment of an RTA office in Aurukun. The feedback from the August 2010 Aurukun meeting indicated recent consultation in Aurukun was inadequate and additional direct consultation was required; • Indigenous economic and business development opportunities; • Learning from the negative impacts of mining north of the Embley River; • Weed control, and • Protection and ongoing management of plane crash site located south of the Embley River. • Request from Traditional Owners for RTA to establish a mutually agreed process for working collaboratively with Traditional Owners to implement RTA's EIS commitments.
9 July 2009	Wik Way Traditional Owners	Field trip to Ely Dam and workshop to discuss potential impacts of dams and Project concerns.	Ely Dam, Weipa	
27 August 2009	Families of the victims of light plane crash in 1993	Field trip to plane crash site with family representatives for the first time since the incident.	On mining lease, adjacent to Norman Creek area	
2 September 2009	SoE Project Sub-committee	Consult, review and provide advice and recommendations to WCCCC in relation to Project.	Western Cape Centre, Weipa	
22 September 2009	WCCCC	Project update and questions, consider recommendations from SoE Sub-committee — including review and endorsement of the Stage 1 WCCCA independent review of the Project draft EIS Chapters.	Western Cape Centre, Weipa	
29 September 2009	Families of the victims of light plane crash in 1993	Meeting held in Aurukun with family representatives to discuss their suggestions for the ongoing protection and management of the plane crash site.	Community Church, Aurukun	
24 and 25 October 2009	SoE Project Sub-committee	Consult review and provide advice and recommendations to WCCCC in relation to Project. Two-day workshop focussed primarily on Stage 2 and 3 WCCCA independent review of the Project draft EIS Chapters.	Western Cape Centre, Weipa	
8 December 2009	WCCCC	Project update and questions, consider recommendations from SoE Sub-committee — including review and endorsement of the Stage 2 and 3 WCCCA independent review of the Project draft EIS Chapters.	Western Cape Centre, Weipa	
2 March 2010	Aurukun Community Meeting	Present RTA response and position in relation to key issues raised by Traditional Owners during WCCCA consultation conducted in January.	Rec Hall, Aurukun	
3 March 2010	SoE Project Sub-committee	Consult review and provide advice and recommendations to WCCCC in relation to Project. Confirmation of key messages and RTA position on	Western Cape Centre, Weipa	

Date	Stakeholder	Purpose	Location	Issues Most Frequently Raised
		issues discussed at Aurukun community meeting the day prior.		
30 March 2010	WCCCC	Project update and questions, consider recommendations from SoE Sub-committee — including review.	Western Cape Centre, Weipa	
1 June 2010	SoE Project Sub-committee	Consult, review and provide advice and recommendations to WCCCC in relation to Project.	Western Cape Centre, Weipa	
9 July 2010	Cultural Heritage Survey (Ward River Pump and Pipeline Corridor) De-brief	Debrief findings for cultural heritage surveys of Ward River pump station site and pipeline corridor.	RTA Community Relations Building, Weipa	
13 July 2010	SoE Project Sub-committee	Consult, review and provide advice and recommendations to WCCCC in relation to Project.	Western Cape Centre, Weipa	
31 August 2010	Aurukun Community Meeting	Present Project update and RTA response and position in relation to key issues raised by Traditional Owners. Obtain feedback from Traditional Owners.	Rec Hall, Aurukun	
1 September 2010	SoE Project Sub-committee	Consult, review and provide advice and recommendations to WCCCC in relation to Project.	Western Cape Centre, Weipa	
September to Mid-December 2010	Weekly Aurukun Community visits conducted by RTA Community Relations personnel	Ongoing engagement with Traditional Owners and residents of the Aurukun community in relation to Project.	Aurukun	
29 September 2010	Traditional Owner Field Trip to Hey River Ferry/Barge terminal proposed location	Traditional Owner engagement and consultation regarding the proposed infrastructure at Hey River location.	Hey River, Weipa	
30 November & 1 December 2010	Aurukun Community Visit & SoE Field Trip	Traditional Owner engagement and consultation regarding SoE Project infrastructure at port location.	Boyd Bay and Pera Head	
21 February 2011	Presentation to Napranum Community as part of WCCCA	SoE Project status report provided to Traditional Owners	Community Hall, Napranum	

Date	Stakeholder	Purpose	Location	Issues Most Frequently Raised
	Community Visit			
22 February 2011	Presentation to Mapoon Community as part of WCCCA Community Visit	SoE Project status report provided to Traditional Owners	Sport and Rec Hall, Mapoon	
23 February 2011	Presentation to Aurukun Community as part of WCCCA Community Visit	SoE Project status report provided to Traditional Owners	Bauxite Project Office, Aurukun	
9 March 2011	SoE Project Sub-Committee	Consult, review and provide advice and recommendations to WCCCC in relation to Project.	Western Cape Centre. Weipa	
5 April 2011	WCCCC	Project update and questions, consider recommendations from SoE Sub-committee	WTA Council Chambers, Weipa	

Plate 15-2 Traditional Owners and WCCCA Staff Members Visiting Ely Dam

15.2.5 Recreational and Professional Fishing Groups

Northern Prawn Fishery Industries Pty Ltd and the Gulf of Carpentaria Commercial Fishermen Association (GCCFA), via Queensland Seafood Industry Association, were consulted regarding the potential impacts of the Project on commercial fishing activities conducted in the Western Cape region (**Table 15-6**).

Table 15 - 6 Fishing Groups Consultation and Issues Raised

Timing	Stakeholder	Format	Issues Raised
20 August 2008	Weipa Charter Fishing Guides	Group meeting	The issues most commonly raised through this consultation included: • Dredging and location of spoil dumping ground; • Damage to prawn nursery areas; • Potential loss of fishing group resulting from ship anchorage areas off Boyd Point; • Weather damage to ships while tied up at loading facilities due to openness of the loading area to the weather; • Potential loss of safe anchorage for fishing boats in SE winds if access restrictions were applied to Boyd Bay; • Concern about fuel storage areas; • Potential discharge of contaminants and water ; • Impact on heritage sites, including scarred trees, artefacts and story places in the footprint area of the dams; • Environmental impacts on downstream wetlands and other areas frequently used by Traditional Owners for hunting; • Cumulative impacts of dams proposed by RTA and Chalco
September 2008 – June 2009 (various)	Gulf of Carpentaria Commercial Fishermen Association	Email Telephone	
September 2008 – January 2009	Northern Prawn Fishery Industry Pty Ltd	Face-to-Face Meeting Email	

Timing	Stakeholder	Format	Issues Raised
September 2008, July 2009	Weipa Sportfishing Club	Group meeting	on the Ward River; • Impacts on the migration of fish upstream and downstream of the proposed dam sites; • Control of unauthorised public access to the area; • Presence of dangerous metals brought to the surface during construction, and • Rehabilitation process for dams during mine closure.

RTA also conducted face-to-face meetings with the Weipa Sportsfishing Club, and a representative group of charter fishing guides. These meetings were held as part of the initial consultations held in 2008, and were followed up in July 2009 with new information on the proposed water supply strategy and additional detail about proposed dredged spoil disposal.

Both commercial fishing group representative bodies were provided with Project newsletters, information on the EIS process, the IAS, spoil ground location maps and the EPBC Act Referral.

15.2.6 Industry, Local Businesses and Service Providers

RTA has engaged with industry, local businesses and services provider stakeholders from across the Western Cape region through public information sessions, face-to-face meetings and presentations to representative bodies, such as the Weipa Chamber of Commerce. During the Weipa Chamber of Commerce consultation, RTA invited local business and service providers to contact RTA directly to discuss the Project further.

Updates on the Project were provided to members of the Weipa Chamber of Commerce on a regular basis throughout the period of the EIS through RTA's representation at this forum.

Details of the meetings held and the range of frequently raised issues are summarised in **Table 15-7**.

Table 15 - 7 Business and Service Provider Consultation and Issues Raised

Timing	Stakeholder	Format	Issues Raised
5 August 2008	Weipa Chamber of Commerce, including representatives of Weipa-based businesses and service providers	Face-to-face meeting	The issues most commonly raised through this consultation included: • Ensuring opportunities for local business and service providers in the region to tender for work associated with the construction and operation phases; • Interest in future potential employment and emerging business opportunities; • Management of traffic and transport on proposed new access road from Boyd Bay to Hey Point; • Social and behavioural issues associated with construction workforce; • Ongoing community consultation and engagement; • Access to sea and land; • Impacts on marine flora and fauna, and • Law and order issues.
5 August 2008	Three Rivers Tavern	Face-to-face meeting	
18 August 2008	Wik Media	Face-to-face meeting	
19 August 2008	Carpentaria Contracting	Face-to-face meeting	
19 August 2008	Weipa Campground	Face-to-face meeting	
20 August 2008	Local Charter Fishing Guides Spotless Weipa Air Bowyer Transport	Face-to-face meetings/ teleconference	
10 September 2008	Wik Projects/Aurukun Earthmoving	Face-to-face meeting	
2009 & 2010	Western Cape Chamber of Commerce – RTA Weipa Monthly Update provided by General Manager, Weipa Operations	Face-to-face meeting	
3 November 2010	Western Cape Chamber of Commerce	SoE Project Presentation, Face-to-face meeting	

15.2.7 General Public and Residents of Local Communities

Consultation and engagement with the general public and residents of the communities within the Western Cape has occurred primarily through the conduct of information sessions and public displays.

In addition to the meetings outlined in **Table 15-8**, RTA has conducted annual information sessions with all site employees. These sessions included an update on the Project and an opportunity to raise concerns and discuss the Project. These sessions have been an effective way to communicate to the workforce, which makes up a large proportion of the Weipa community.

Table 15-8 provides a summary of these sessions. The topics most frequently raised are summarised in **Table 15-10**.

Table 15 - 8 Public Information Meeting Schedule and Issues Raised

Date	Stakeholder	Location	Issues Raised
15 September 2008	Information Session/Display – Napranum	Napranum Aboriginal Council	The issues most commonly raised through this consultation included: • Interest in future potential employment and emerging business opportunities; • Impact of traffic and transport; • Social and behavioural issues associated with construction workforce; • Management of traffic and transport on proposed new access road; • Impact on and protection of Indigenous and non-Indigenous heritages sites; • Environmental impacts on downstream wetlands; • Cumulative impacts of dams proposed by RTA and Aurukun Bauxite Project on the Ward River; • Construction timeframes; • Rehabilitation process and success rates; • Ongoing community consultation, and • Land and sea access.
16 September 2008	Information Session/Display – Mapoon	Mapoon Aboriginal Council	
17 September 2008	Information Session/Display – Aurukun	Aurukun General Store	
17 September 2008	Information Session – Weipa	Weipa Council Chambers	
Weekly (Tuesday) since 16 June 2009	Public Display – Aurukun	Foyer of Aurukun Church	
1 September to 31 December 2009	Permanent Public Display – Weipa	RTA Weipa Community Relations Building	

15.2.8 Regional Landholders

Regional landholders of pastoral properties were briefed on the Project and participated in SIA consultations via telephone calls and face-to-face meetings. The issues raised are summarised in **Table 15-9.**

Table 15 - 9 Regional Landholders Meeting Schedule and Issues Raised

Timing	Stakeholder	Format	Issues Raised
22 May 2008	Bertiehaugh/Steve Irwin Wildlife Reserve (Australia Zoo)	Face-to-face meeting	The issues most commonly raised through this consultation included: • Ensuring the live cattle export facilities at Humbug Wharf can continue to be utilised in the future; • Increased traffic along the road to Aurukun, potentially resulting in increasing unauthorised access by the general public; • Effective fire management in areas adjacent to pastoral leases; • Potential employment and training opportunities for regional landholders and their families during the wet season, including business development opportunities e.g. hire of machinery; • Potential social impacts of the construction and operational workforces, including anti-social behaviour, and increased off-road driving and hunting activities, and • Increasing frequency of alcohol being transported into local communities governed by alcohol management plans.
9 September 2008	Merluna and Watson River Stations	Face-to-face meeting	
12 September 2008	Batavia Downs Station	Face-to-face meeting	
12 September 2008	York Downs Station	Face-to-face meeting	

15.3 Results

Feedback from all consultation sessions have been analysed by Sustainable Solutions and the Project team. The most frequently raised issues from the range of stakeholders are summarised in **Table 15-10**. Full details on these key issues, and proposed mitigation strategies, are described in **Section 16 Social Impact Assessment**.

Across all stakeholder groups, the issues and opportunities of greatest significance were:

- traffic/transport on the proposed new access road to the Project infrastructure (refer Section 16.3.1);
- land and sea management **(refer Section 16.3.2)**;
- community consultation and engagement **(refer Section 16.3.3)**;
- employment, training and educational opportunities **(refer Section 16.3.4)**;
- breakdown in community cohesion associated with increases in alcohol and substance abuse, and escalating law and order problems **(refer Section 16.3.5)**;
- water supply dam construction, operational and closure impacts **(refer Section 16.3.6)**;
- opportunities for business development **(refer Section 16.3.7)**, and
- workforce arrangements **(refer Section 16.3.8)**.

15.4 Ongoing Community Consultation

The EIS consultation and engagement program would continue throughout the EIS process. The public comment period is an important opportunity for stakeholders to provide formal input into the EIS process.

There would continue to be a range of opportunities for the community to access information about the Project and the EIS throughout the public comment period, including public meetings and displays which would be held in Mapoon, Napranum, Weipa and Aurukun. A dedicated section of the RTA website would continue to be available throughout this period, along with the freecall information telephone line and an EIS email address.

The ongoing consultation and engagement process would also continue to actively involve Traditional Owners in a range of activities to:

- increase knowledge and awareness of the mining processes;
- provide accurate, timely and relevant information on the Project;
- identify any concerns or potential issues Traditional Owners may have with the Project;
- explore areas of the Project with the potential to have a positive impact on communities, and
- develop and pursue appropriate strategies to mitigate any issues and concerns during the EIS process and during the construction and operational phases.

The WCCCC and the WCCCC SoE Sub-committee would continue to provide the primary consultative mechanism for the coordination of these activities.

A program of consultation would be undertaken by RTA to address community issues as the Project progresses. Interaction with stakeholders who have already been consulted as part of the Project planning phase would continue over the remainder of the EIS process and throughout the construction and operational phases.

Rio Tinto Alcan

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Environmental Impact Statement for South of Embley Project

This Environmental Impact Statement has been prepared to meet the assessment requirements for the Project under the *State Development and Public Works Organisation Act 1971* (Qld) and the *Environment Protection and Biodiversity Conservation Act 1999* (Cth).

Volume 3

16. Social Impact Assessment
17. Economics
18. Health and Safety
19. Hazard and Risk
20. Cumulative Impacts
21. Environmental Management Plan
22. EPBC Assessment Report

RTA Weipa Pty Ltd

Rio Tinto Alcan

Environmental Impact Statement for South of Embley Project

Volume 3

16. Social Impact Assessment
17. Economics
18. Health and Safety
19. Hazard and Risk
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RTA Weipa Pty Ltd

Rio Tinto Alcan

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Environmental Impact Statement

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Section 16

Social Impact Assessment

16 SOCIAL IMPACT ASSESSMENT

16.1 Social Context of the Region

For the purposes of this Social Impact Assessment (SIA) the local community area of the Western Cape region includes the Aurukun, Mapoon, Napranum and Weipa communities and all lands between Aurukun in the south and Mapoon in the north, extending from the coastline to the eastern boundaries of the Deed of Grant in Trust (DOGIT) and Aurukun Shire lands. The local community area was identified through consultation with the DLGP Social Impact Unit as described in **Table 15-2**.

There is no comprehensive published history of the Western Cape region, but there are many published sources relating to Cape York Peninsula that include some coverage of the Western Cape. The main historical phases of the region may be described as: the Indigenous pre-contact era; the European contact (exploration) era from 1606 to 1880; the frontier settlement era from 1880 to the early 1900s; the mission era from 1891 to the late 1950s and the post-mission community and mining era from the 1960s to present.

The lifestyles of Indigenous people of the region were severely affected and changed by European exploration and settlement of their lands, however the lands within the proposed Project area were never settled by pastoralists, rather they were proclaimed as government reserve lands in the early 1900s. The imposition by the Queensland Government through legislation controlling Aboriginal reserves and mission communities and the influence of mission settlements at Aurukun and Weipa were the main factors affecting the Traditional Owners of the Project area during the first half on the 20th century.

The discovery of bauxite in the 1950s and development of mining operations in the 1960s coincided with the gradual withdrawal of church missionary organisations that were replaced by State Government-managed communities. Despite moves over the last 30 years towards self-determination and more control of their lands by Indigenous communities and Traditional Owners through changes in government policy and recognition of native title, the Indigenous people of Queensland and the proposed Project area do not have the power of veto over mining development projects, as the State of Queensland retains the rights to all minerals.

This lack of control by Indigenous people of the region was recognised by RTA (formerly Comalco) and the Queensland Government in the compensation package accepted by Traditional Owners and Indigenous communities as parties to the Western Cape Communities Co-existence Agreement (WCCCA). In 2001 RTA signed the WCCCA with the 11 Traditional Owner groups associated with the ML 7024 and ML 6024 lease areas. Refer to **Figure 16-1** for the names and distribution of the Traditional Owner groups.

The lease to the east of RTA's on the north side of the Mission River, ML 7031, formerly was held by Alcan South Pacific or Alspac. In 1997, Alspac signed the Ely Bauxite Mining Project Agreement (EBMPA) with the Dulhunty (Atambaya and Angkamuthi) Peoples, the Taepithiggi People, the Thanakwith People, the Tjungundji People, the Warrangku People and the Yupungathi People, the Napranum Aboriginal Community Council (now the Napranum Aboriginal Shire Council), the Marpuna Community Aboriginal Corporation (now the Mapoon Aboriginal Shire Council), the New Mapoon Aboriginal Council (now the New Mapoon Aboriginal Shire Council) and the Cape York Land Council Aboriginal Corporation.

In 1998, Alspac and Comalco partnered under an agreement called the Bauxite Mining and Exchange Agreement (BMEA) to mine the Ely area of ML 7031 on Alspac's behalf. The EBMPA was amended in 1999 to recognise the changes brought about by the BMEA. In 2006, Comalco began mining the Ely area southwest of ML 7031. In October 2007 Rio Tinto acquired Alcan and the new aluminium company became known as Rio Tinto Alcan was in control of both mining leases.

Figure 16-1 Western Cape York Peninsula Regional Map of Indigenous Groups

The area of land south of the Embley River is recognised as the traditional lands of the Wik and Wik Way people. The Wik and Wik Way people, by birthright, are the Traditional Owners of the lands which occupy a large area along the coastal floodplains lying between Pormpuraaw and Weipa and inland to the middle reaches of rivers such as the Archer, Kendall and Holroyd Rivers (O'Faircheallaigh 1996). There are probably more than 50 clan estates and many language groups. The Wik estate occupies more than 72,000 hectares.

The Aurukun community is comprised of approximately 1,200 people, many of which represent the Wik and Wik Way Traditional Owners of the area. While Aurukun is the central location for many people living in the area, there are also a number of "outstations" stretching over 125km from Pera Head south to the Kendell River. There are also a number of Wik and Wik Way Traditional Owners who have relocated and now live in other communities across Cape York.

Throughout history, the Wik and Wik Way people have demonstrated a strong commitment to their rights as the Traditional Owners and native title holders for their traditional lands. The most historic example of this commitment was the Wik and Wik Way native title case in which the High Court found in 1996 that the grant of a non-exclusive pastoral lease did not necessarily extinguish native title and that native title rights could co-exist with the rights of a lessee.

In July 2009, the Federal Court determined by consent (FCA 789) the native title rights of the Wik and Wik Way Native Title Claim Group. The court held that native title did exist in relation to the determined area that includes the area of RTA's mining lease (ML 7024) located south of the Embley River. This consent determination was the first over a mining lease in Queensland. The Wik and Wik Way people were the first Traditional Owner signatory group under the WCCCA to have native title recognised by the Federal Court under the *Native Title Act 1993 (Cwlth)*.

16.2 Description of Social Values

Information presented in this section is based on the *Weipa Community Baseline Study (April 2008)* commissioned by RTA and carried out by SGS Economics and Planning (SGS). The data used in the SGS report was largely sourced from the 2001 and 2006 Australian Bureau of Statistics Census of Population and Housing (2006 Census). The data was extracted from a series of ABS Census Collection Districts that have been combined to represent the study areas of Weipa, Napranum, Aurukun and Mapoon. It should be noted that the data collected for Indigenous communities can be limited due to the nature of the communities and their organisational structure, however it is also important to note that the ABS takes comprehensive measures to ensure the data is as accurate as possible for these communities. The data contained in this section is complemented with recently published ABS data on population, housing and employment and other socio-economic indicators from other sources such as the (former) Department of Employment and Workplace Relations, the Queensland Government's Planning Information and Forecasting Unit (PIFU) and information available from published information on the operations, Weipa and the Cape York Region.

The Socio-Economic Index of Disadvantage, which was produced by the ABS in 2006, is a summary measure of social and economic conditions by geographic area focussing on low-income earners, relatively lower education attainment, high unemployment and dwellings without motor-vehicles. **Table 16-1** shows the percentage of the population in each quintile (one-fifth or 20% of the population). By definition, Queensland has 20% of the population in each quintile. In comparison, 100% of the Aurukun population was in the most disadvantaged quintile, while 0% of the population of Weipa was in the most disadvantaged quintile.

Table 16-1 Socio-Economic Index of Disadvantage

Local Government Area	Quintile 1 (most disadvantaged)	Quintile 2	Quintile 3	Quintile 4	Quintile 5 (least disadvantaged)
Aurukun Shire Council	100.0	0.0	0.0	0.0	0.0
Weipa Town Area	0.0	0.0	32.8	67.2	0.0
Queensland	20	20	20	20	20

Source: ABS (2006)

16.2.1 Population and Demographics

Population

At the time of the 2006 Census, the total population of the four communities in the Western Cape region was 5,191 people. Weipa accounted for most of the region's population with 3,089 people, followed by Aurukun (1,039 people), Napranum (829 people) and Mapoon (234 people).

Population growth occurred in all study communities between 2001 and 2006. Weipa increased by almost 4% per annum, Aurukun increased by 0.3% per annum, Napranum increased by 2.3% per annum and Mapoon increased by 3.5% per annum (refer **Table 16-2**).

Table 16-2 Change in Population, 2001 to 2006

	2001 Population	2006 Population	Average Annual Change
Weipa	2,580	3,089	3.67%
Aurukun	1,024	1,039	0.29%
Napranum	740	829	2.30%
Mapoon	197	234	3.50%

Source: ABS Census of Population & Housing, 2001 and 2006

Population Projections

The workforce for RTA's current operations predominantly resides in Weipa. Aurukun and Mapoon are too distant for daily work commutes and the majority of Indigenous employees tend to base themselves in Weipa rather than Napranum. Population estimates for Weipa have been made using the population multiplier determined from the relationship between population at the time of the 2006 Census and RTA's overall workforce numbers. RTA is by far the dominant local employer and the size of the mine-related workforce is the key driver of the residential population. At the time of the 2006 Census, the population of Weipa (3,089) amounted to 3.5 people for every RTA employee (777) and contractor (107). **Table 16-3** shows Weipa population estimates in relation to historic and forecast workforce numbers using a resident-to-workforce multiplier of 3.5.

The population estimates assume that the Project commences at a production rate of 15Mdptpa. Production would also continue at Andoom simultaneously until those bauxite reserves are depleted. The population projections indicate that under this scenario Weipa would have a marginally smaller population than in 2007-2008. Future demands on infrastructure and government services are expected to be no higher than in recent years.

Under the 30Mdptpa production scenario, when Andoom production is likely to have ceased, the overall operational workforce would decrease as the Project has thicker bauxite reserves and shorter average haul distances and hence higher labour productivity than Andoom. The Weipa population is projected to return to levels that are slightly higher than what they were in 2006.

Table 16-3 Population Projections for Weipa.

Year	Average Mining Workforce			Projected Population
	Employee	Contractor	Total	Weipa
2006	777	107	884	3,089 (Census)
2007	825	345	1,170	4,098
2008	912	245	1,157	4,052
2009	826	85	911	3,191
SoE 15Mdptpa and Andoom	800	200	1,000	3,502
SoE 30Mdptpa	760	190	950	3,327
SoE 50Mdptpa	1,020	255	1,275	4,465

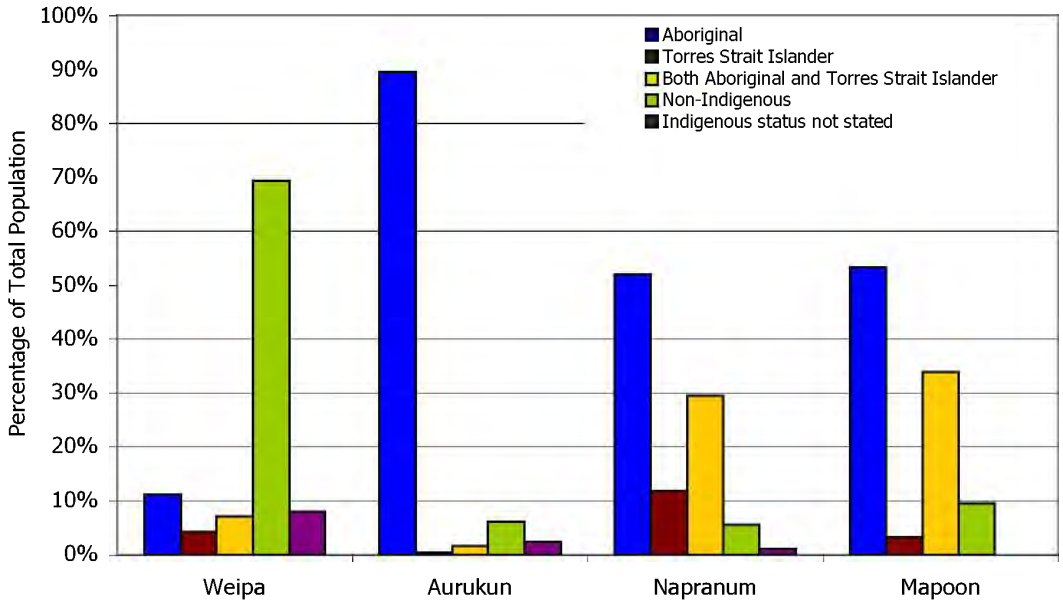
Source: RTA, based on actual workforce numbers 2006-2009

At 50Mdptpa, the population of Weipa is projected rise to approximately 400 above the peak of 2007-2008. Such a population rise would require development of more residential land and housing, and provision of expanded government services. It is not possible to predict when market conditions would enable a production increase above 30Mdptpa. The Golf Links II residential estate of 65 lots is available for development in Weipa when, and if, required. There is adequate suitable land for additional development to meet demand. While this land is currently outside the Weipa town boundary, the boundary can be extended, as has been done in the past.

The Office of Economic and Statistical Research (OESR) population projections for Aurukun Shire for the years 2011, 2016, 2021 and 2026 are 1,170, 1,203, 1,233 and 1,264 respectively (OESR 2009), assuming an average growth rate scenario of 0.6% per annum. The ORSR has not made projections for Mapoon and Napranum due to lack of data. If a 0.6% growth rate is applied to the 2006 population, the Mapoon population would rise to 241 in 2011, 248 on 2016, 265 in 2021 and 264 in 2026. Likewise, the Napranum population would rise to 854 in 2011, 907 in 2021 and 934 in 2026.

Indigenous Population Profile

The Indigenous population, as counted in the 2006 Census, refers to Indigenous people living in the geographic area concerned. Weipa has a lower proportion of Indigenous people than the other Western Cape communities with a total of 702 Indigenous persons, or 23% of the total population (refer **Figure 16-2**). In Aurukun, there were 955 people who reported being of Indigenous origin accounting for 92% of the population. In Napranum there were 782 Indigenous people or 90% of the local population. Mapoon's population consisted of 219 indigenous people, or 90% of its population. All four communities show a high proportion of Indigenous residents compared to the Queensland average of 3.2%.



Source: ABS Custom Indigenous Population Profile, 2006

Figure 16-2 Indigenous Populations, Weipa, Aurukun, Napranum and Mapoon, 2006

The Indigenous and non-Indigenous population of the four local communities (local community area), in terms of absolute numbers, is presented in **Table 16-4.** The total population figures presented in this table differ marginally to those in **Table 16-2** showing the total population for each of the communities of interest. This is a common occurrence when comparing totals or sub-totals drawn from different ABS data sets.

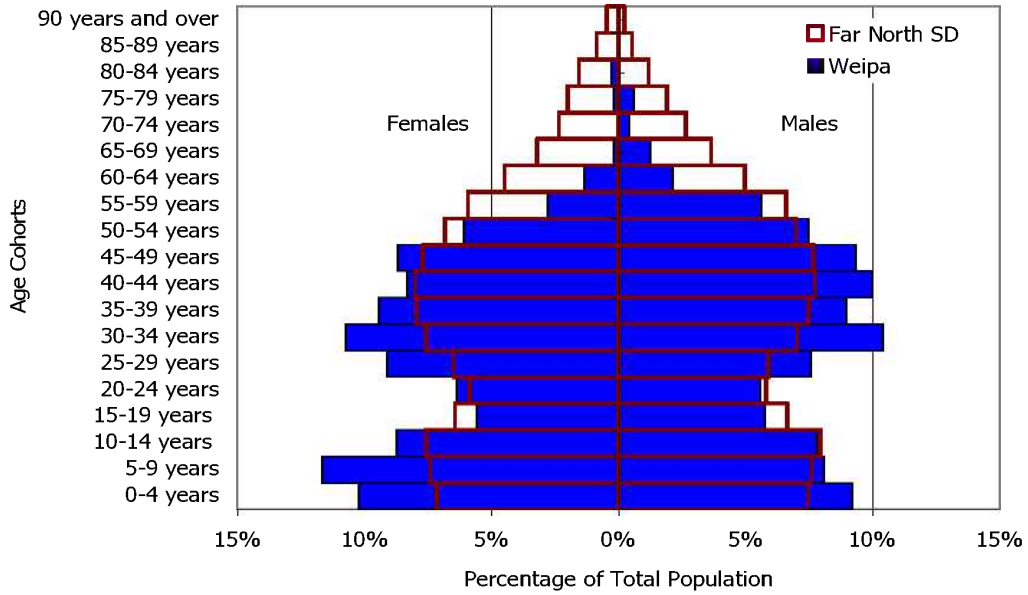
Table 16-4 Indigenous and Non-Indigenous Population, 2006

	Weipa	Aurukun	Napranum	Mapoon
Aboriginal	347	934	436	129
Torres Strait Islander	133	4	99	8
Both Aboriginal and Torres Strait Islander	222	17	247	82
Total Indigenous	**702**	**955**	**782**	**219**
Non-Indigenous	**2,145**	**64**	**47**	**23**
Indigenous status not stated	249	25	9	0
Total population	**3,096**	**1,044**	**838**	**242**

Source: ABS Custom Indigenous Population Profile, 2006

Weipa

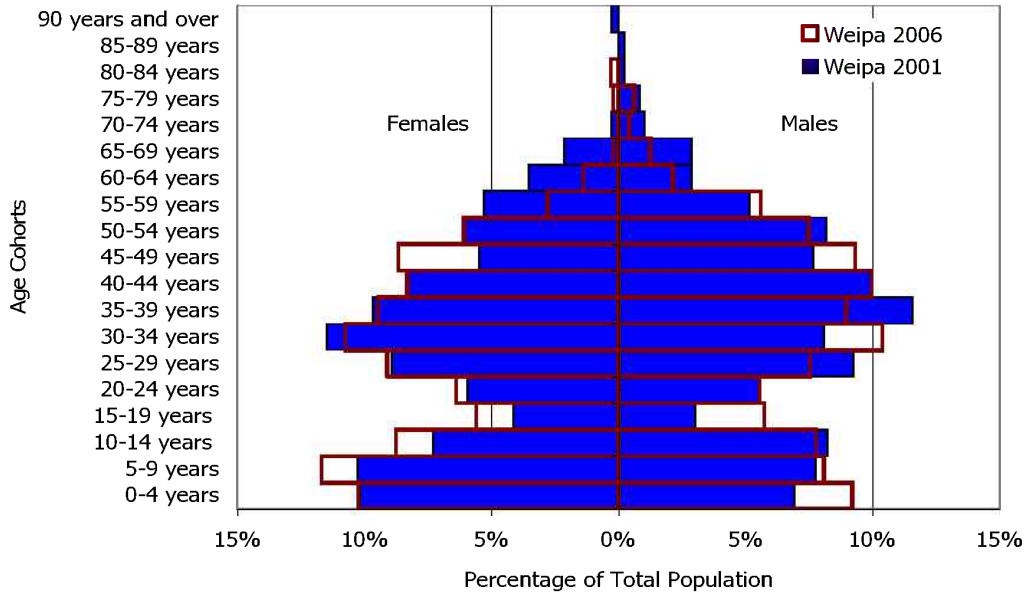
Weipa has a large proportion of young to middle aged residents, of both sexes, predominantly between the ages of 25 and 45, the age range coinciding with the majority of the mining occupational workforce. Weipa's median age is 31, younger than the Far North Queensland (FNQ) Statistical Division (SD) population median age of 36 years. **Figure 16-3** highlights there are relatively fewer persons aged between 15 and 25 in Weipa when compared to the age cohorts surrounding them. This is most likely the result of high school-aged students attending boarding schools located elsewhere and young adults moving to larger centres for employment.



Source: ABS Census of Population & Housing, 2006

Figure 16-3 Age/Sex Structure, Weipa and FNQ SD, 2006

When comparing the difference in age-sex structure in Weipa between 2001 and 2006, a significant increase in the proportions of population aged between 55 and 69 is evident along with an increase in the proportion of people aged between 45 and 49 years of age (refer **Figure 16-4**). This reflects the national trend of an ageing population. Those aged below 20 years of age also increased in the overall population share between 2001 and 2006.



Source: ABS Census of Population & Housing, 2001 and 2006

Figure 16-4 Age/Sex Structure, Weipa, 2001 and 2006

Aurukun

Aurukun's population grew an average of 0.3% per annum between 2001 and 2006. Compared to the FNQ SD and Weipa, Aurukun has higher proportions of people aged between 0 and 39 years (refer **Figure 16-5**). In total, 75% of males and 76% of females responded as being younger than 40 years of age. Compared to Weipa, Aurukun has a larger proportion of people aged 40 years and under. Aurukun's relatively young population has potential implications for the demand for social services and the provision of recreational and leisure facilities for young families. The population structure also has significant implications for employment and training which are discussed in **Section 17**. It must be noted that there is no data to compare Aurukun, Napranum or Mapoon age profiles with 2001 figures.

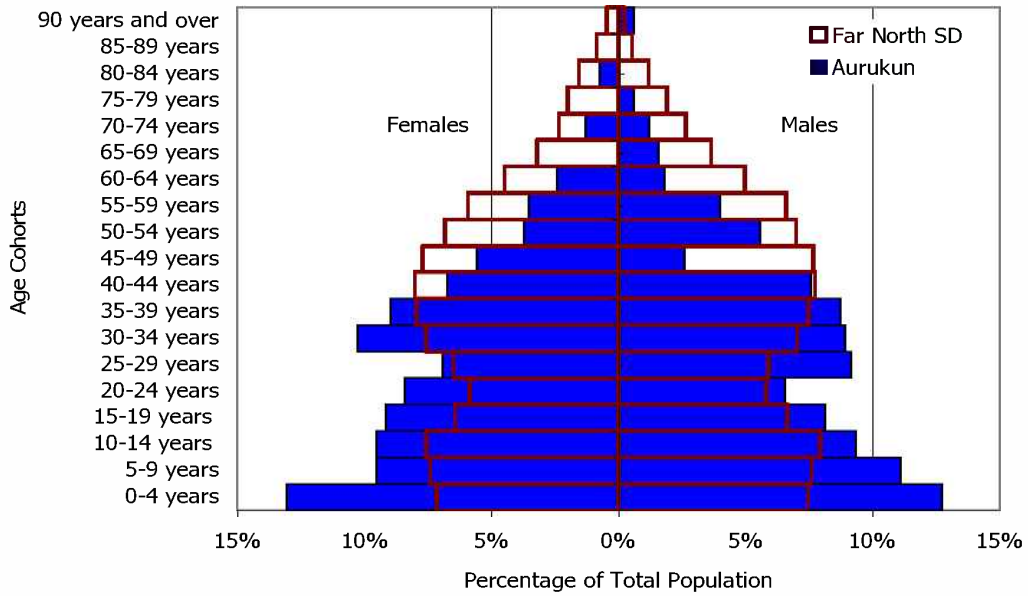
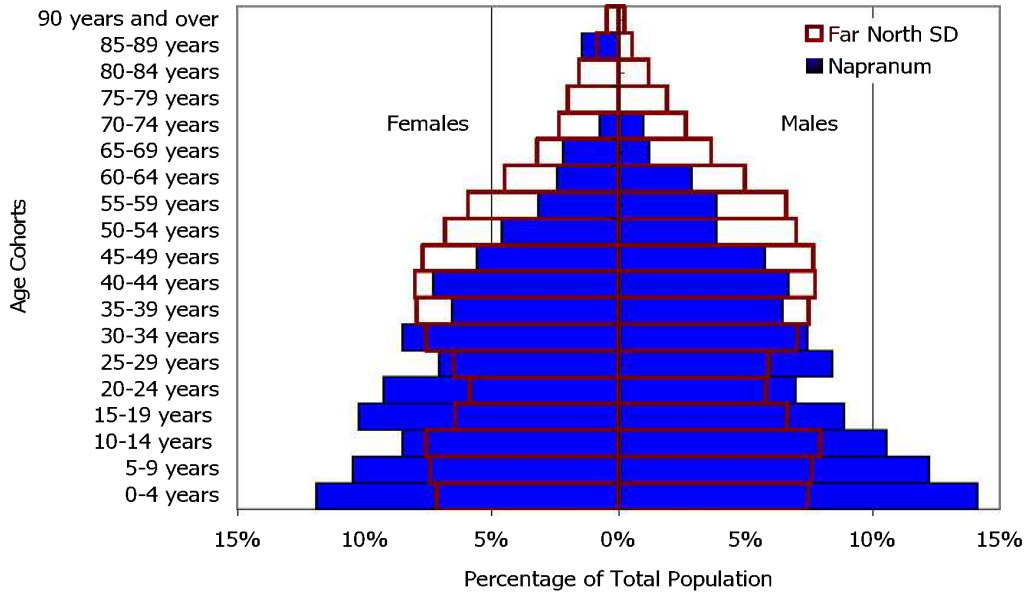


Figure 16-5 Age/Sex Structure, Aurukun and FNQ SD, 2006

Napranum

Napranum has a higher proportion of youth and children compared to Weipa. Napranum also has a higher proportion of people aged 60 years and over compared to Weipa (refer **Figure 16-6**). This could perhaps be partly explained by the high proportion of working age people living in Weipa who are there because they work in mining-related industries including RTA. There is a higher proportion of younger people in Napranum, as well as fewer older people, when compared to the FNQ SD.

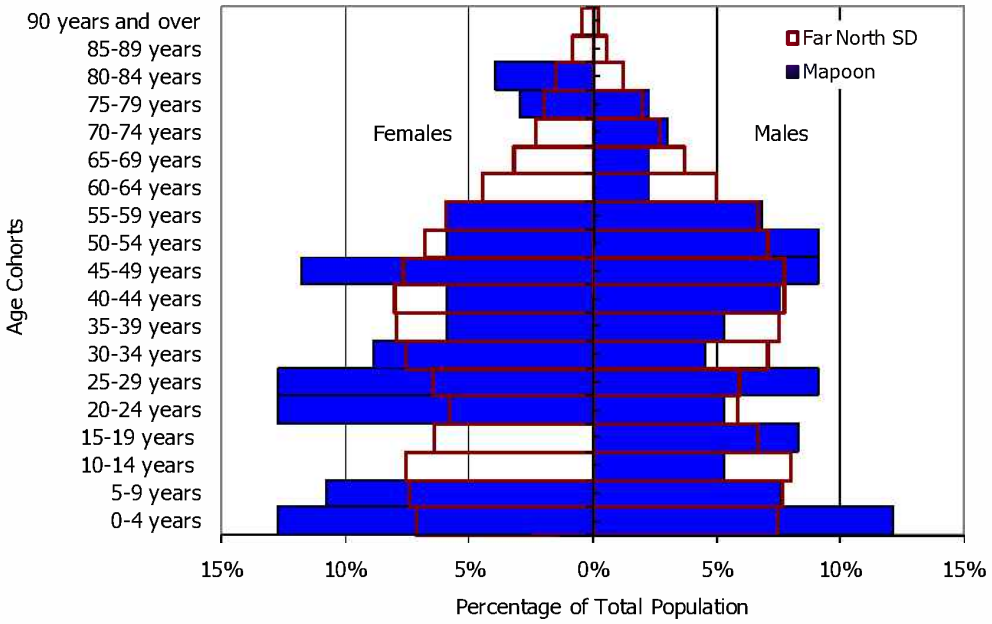


Source: ABS Census of Population & Housing, 2006

Figure 16-6 Age/Sex Structure, Napranum and FNQ SD, 2006

Mapoon

The absence of females in the 10-19 and 60-74 age cohorts in the chart below is likely to be an artefact of the low population (234) and other factors associated with the timing of the 2006 Census (refer **Figure 16-7**). Whilst Mapoon has a small population, the figure shows that there is a significantly high proportion of children aged ten years and under when compared with other communities in the Western Cape region as well as the FNQ SD. Recent data indicates that the population of Mapoon is gradually increasing as extended family members are migrating to the area from New Mapoon, Cairns and other areas of Cape York (SGS 2008).

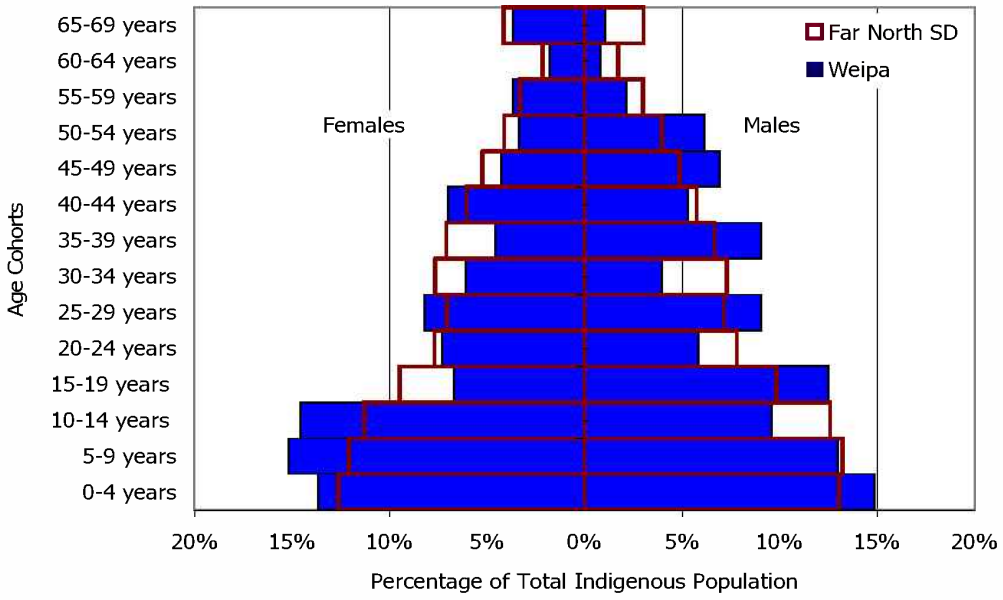


Source: ABS Census of Population & Housing, 2006

Figure 16-7 Age/Sex Structure, Mapoon and FNQ SD, 2006

Indigenous Age/Sex Profile

According to the 2006 Census, there is a high proportion of Indigenous people aged nine years and under living in Weipa. In 2006, the median age of Indigenous people living in Weipa was between 15-19 years which compares to 20–24 years in the FNQ SD (refer **Figure 16-8**).



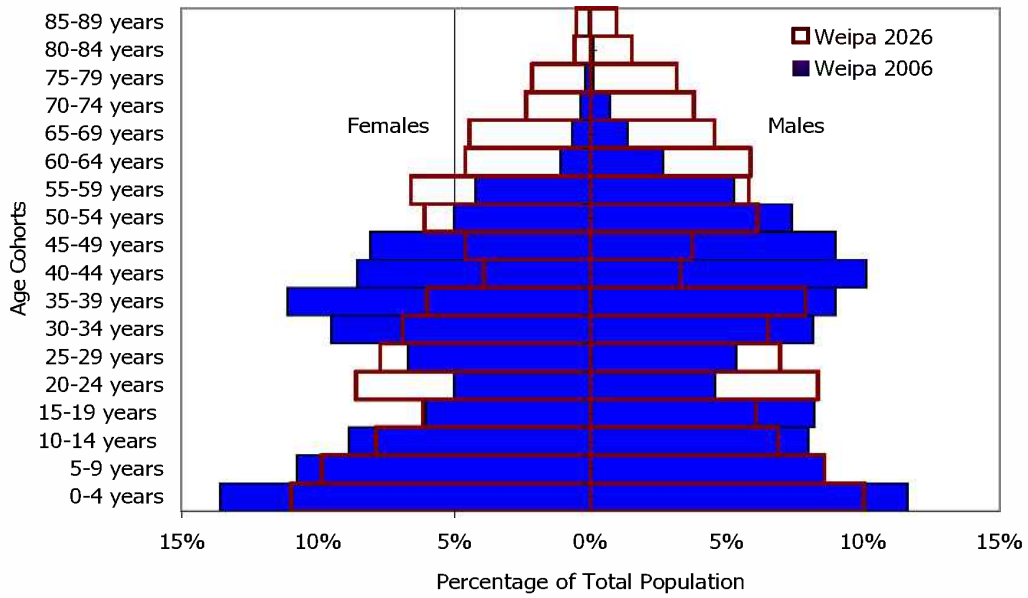
Source: ABS Census of Population & Housing, 2006

Figure 16-8 Indigenous Age/Sex Structure, Weipa and FNQ SD, 2006

Weipa Population Projections by Age/Sex

The age/sex profile of Weipa in 2006 compared to Weipa's forecast age/sex profile for the year 2026 is shown in **Figure 16-9**. The data is taken from PIFU projections. PIFU makes certain assumptions concerning the main components of population change, being fertility, mortality and migration, to generate their population forecasts. Importantly, PIFU notes that they cannot model changes in the main components of population change, other than the ones assumed, and therefore cannot account for influences such as the establishment of a mine or an industrial project.

The PIFU projections show an expected increase in the proportion of the population aged 55 years and over as well as an increase in the proportion of the local population aged between 20 and 29 years. The expected ageing of the population is evident in the chart with a significant increase in the proportion of the population aged 65 years and over between 2006 and 2026 as well as a fall in the proportion of the population aged 19 years and under over the next 20 years. It must be noted that population projections were not available for Napranum, Aurukun and Mapoon.



Source: Queensland Government, Planning Information & Forecasting Unit (PIFU), Population Projections, 2006

Figure 16-9 Population Projections by Age/Sex, Weipa, 2006 and 2026

Mortality, Morbidity and Causes

According to *Health Determinants Queensland 2004* (Queensland Health 2004), the major causes of death in the Western Cape region include coronary heart disease, stroke, chronic obstructive pulmonary disease, depression and lung cancer. Health determinants of significant impact in this population include harmful alcohol consumption, smoking, excess weight and obesity, poor nutrition, physical inactivity and risk and protective factors for mental health. Specific death and illness data was not available for each of Weipa, Aurukun, Napranum and Mapoon, only for the Western Cape region as a whole.

Marital Status

At the time of the 2006 Census, 45% of Weipa residents were married (down from 57% in 2001) and 43% have 'never married' (increased from 33% in 2001) which is high when compared to the 38% in the FNQ SD. Proportions of divorced people were, however, lower in Weipa than in the FNQ SD (8% compared to 10%).

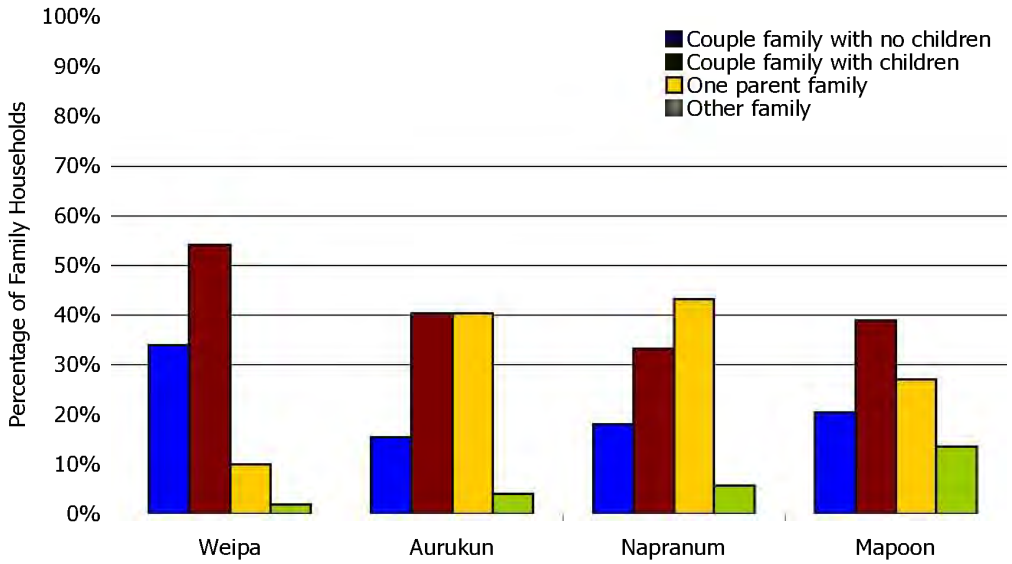
In contrast, the communities of Aurukun, Mapoon and Napranum have a predominantly high proportion of people who have never married (87%, 65% and 80% respectively). Analysis by SGS (2008) suggests that this could be attributable to the large proportion of young people in these communities.

During the Community Baseline Assessment process, Centrelink and other community organisations (such as Weipa Community Care) were interviewed (SGS 2008). According to those interviewed at the time, anecdotal evidence suggests there is a high incidence of separation and relationship breakdowns among Weipa residents. However, this has not been confirmed by any quantifiable data source as none is available.

Family Type

The 2006 Census indicates that the most common family type in Weipa is couples with children, accounting for 54% of total family groups. This is higher than any other Western Cape community with Aurukun at 40%, Napranum at 33% and Mapoon at 39%. Couples with no children were the second highest family type in Weipa at 34%. Single parent families accounted for 10% of all family households in Weipa; however, this figure was significantly higher in the other communities at 40% in Aurukun, 43% in Napranum and 27% in Mapoon. The percentage of each family type in each community is shown in **Figure 16-10.**

The 'other family' category makes up a small proportion of the family types in each community and is defined by the ABS as households of related individuals who can not be classified as belonging to a couple or single parent family. This can include, for instance, two sisters living together where neither have a partner or are a parent or a child of someone living in the house.



Source: ABS Census of Population & Housing, 2006

Figure 16-10 Family Type, 2006

Table 16-5 shows the average annual change in the number of each family type between 2001 and 2006. This data provides an indication of the change in the number of family household types rather than a proportion of total family households. Weipa was the only community to experience increases in the numbers of all family types between 2001 and 2006. The number of couple families (without children) in Aurukun decreased by 4.5%, other family types decreased in Napranum by 4.7% and single parent families decreased by 1.2% in

Mapoon. According to Centrelink, single parent families often struggle to meet the high cost of living and child care in Weipa as single parent benefit payments are just sufficient to cover basic living expenses but not the costs of child care.

Table 16-5 Annual Change in Family Type, 2001-2006

	Weipa	Aurukun	Napranum	Mapoon
Couple family with no children	7.4%	-4.5%	3.8%	8.4%
Couple family with children	4.9%	3.7%	-0.3%	13.9%
One parent family	7.7%	1.4%	8.8%	-1.2%
Other family	36.1%	5.2%	-4.7%	-

Source: ABS Census of Population & Housing, 2006

Ancestry/Ethnicity

While there is strong proportion of Weipa residents with Indigenous ancestry (23%) compared with Queensland (3.2%), Weipa has a high proportion of people of non-Indigenous and north western European ancestry compared with the other study communities. This is attributable to the skilled workers who migrate to Weipa for work from outside of the Western Cape region. The remaining communities all contained populations that were well over 50% Indigenous. Indigenous people made up 91% of the population in Aurukun, 93% in Napranum and 90% in Mapoon. This is particularly important, as RTA is committed to providing local Aboriginal people with employment in line with its company philosophy and corporate culture and as part of its WCCCA commitments. According to RTA records, Indigenous employees accounted for 19% of RTA employees and local Aboriginal employees accounted for 14% of employees in 2008.

Disability/Disadvantage

The total number of disability service users in the local community area was 25 in 2008. Details of the types of disabilities are shown in **Table 16-6**. Locations have been grouped by post code and disability counts of one or two have been rounded up to three to protect the privacy of individuals.

This represents approximately 0.47% of the population which is slightly lower than the Queensland state average of 0.49%.

Table 16-6 Disability Service Users, 2008

Primary Disabilities	Weipa Napranum Mapoon	Aurukun	Queensland
Intellectual	4	6	8,146
Specific learning/ADD	-	-	130
Autism	-	-	2,192
Physical	6	-	3,730
Acquired Brain Injury	3	-	936
Neurological	-	3	1,501
Deaf blind	-	-	39
Vision	-	-	351
Hearing	3	-	150
Speech	3	-	56
Psychiatric	3	-	2,112

Primary Disabilities	Weipa Napranum Mapoon	Aurukun	Queensland
Developmental Delay	-	-	765
Not Stated/Unknown	-	-	792
Total Population (2006)	4,212	1,138	4,290,000

Source: Qld Department of Communities – Population by Age and Sex, Australian States and Territories, June 2008

16.2.2 Community Infrastructure and Services

Child Care/Kindergarten Facilities

There are childcare facilities in Weipa, Napranum and Aurukun. All centres currently operate at full capacity.

The Crèche & Kindergarten Association of Queensland (C&K) currently operates the Cape Kids Childcare Centre in Weipa which is currently licensed to provide day care services for a maximum of 28 places for children aged 6 weeks to school age. Weipa Community Care Association operates a Family Day Care Scheme through the Weipa Community Centre. This caters for children up to the age of twelve years of age. There is also a kindergarten and Pre-prep operated by the C&K.

Aurukun has a childcare centre which is operating at full capacity. The Napranum Childcare Centre also has a shortage of places for children. Mapoon does not have a childcare centre at this time and plans are underway for the development of an early childhood centre through the local Indigenous partnership initiative under the auspice of the Queensland Government.

In recent years a shortage in childcare places has been identified as one of the priority concerns facing Weipa and its surrounding communities (SGS 2008). This shortage has often resulted in lengthy waitlists at many of these facilities. In July 2009, Cape Kids had a waitlist of 157 families and the waiting time was approximately two years. The Centre was unable to provide for additional childcare places as the number of licensed places was dictated by the physical size of the Centre. Similarly Weipa Family Day Care experienced similar shortages. In 2009, the Australian Government announced funding of approximately $2.1 million to refurbish and expand the existing Cape Kids Childcare facility in Weipa. This will provide up to 75 places when it is opened. C&K will operate the new facility using land provided by RTA.

None of the childcare facilities provide before and after school care and vacation care. However the Napranum Police Citizens Youth Club offers a children's activity club which offers a related service.

Weipa Community Care

The Weipa Community Care Association is a not-for-profit organisation operating as a community centre for individuals and families living in Weipa. The Association is funded by the Department of Communities and provides social services and support including: support and referral for people in crisis situations; counselling to women and children experiencing family or domestic violence in the communities of Weipa, Napranum and Mapoon; assistance to newcomers to Weipa who require local information; support for community groups and organisations to run local events; and local functions that raise awareness of, and fundraising for, the Association and other not for-profit organisations. In addition, it manages a community café, second-hand clothing store and family day care.

According to Weipa Community Care Association, 2006 data showed that one woman was taken out of the community service provision area every month due to incidents of domestic violence. (At the time of writing, a breakdown of incidents by each community was not available owing to confidentiality issues in small populations). In the period July-September 2008, Weipa Community Care recorded that 36 clients were provided with personal support, including counselling services, for incidents of domestic violence. Weipa Community Care also provides

services to Napranum, including a healing service, and management of a women's shelter in Weipa to support domestic violence victims.

Aged Care

The new Weipa Integrated Health Service (WIHS) was opened in February 2009 and provides ten aged care beds. The Home and Community Care (HACC) services is a State and Commonwealth-funded service aimed at providing basic maintenance and support services for older people and young people with disabilities. HACC services are currently provided at Napranum, Mapoon and Aurukun and include community nursing, social support, personal care, centre-based respite, transport, information and advocacy and home maintenance.

Given the absence of a dedicated aged care centre in Weipa, as well as the growing numbers of RTA employees and others retiring in the region, there will be a continuing demand for aged care facilities and services to cater for the needs of the ageing population. There is also a need for facilities and services supporting people with disabilities and mental illness.

Electricity, Telecommunications, Water and Waste

The electricity supply to Weipa and Napranum is provided by a power station built and operated by RTA. The plant currently adequately meets the electricity requirements of Weipa, Napranum, and the RTA mining operations. RTA distributes electricity to private consumers under a licence from the Queensland Department of Employment, Economic Development and Innovation (DEEDI) (formerly Department of Mines and Energy). All households and businesses are billed for their electricity based on the regulated price set annually by the Queensland Government for other small and rural communities in Queensland. All RTA employees have their electricity subsidised.

Telstra provides a range of telecommunication services to the communities across the Western Cape including the availability of a landline for residents, Next G mobile phone coverage and internet services that includes broadband connections.

Drinking water in Weipa is sourced from a series of shallow aquifer bores which are then held in a holding dam and elevated reservoir that allows the water to be gravity fed to dwellings. Due to the low pH levels, lime and chlorine are added to the drinking water to adhere to national water standards. Weekly testing is undertaken to monitor bacteria levels and quarterly testing to determine levels of mineral, hardness and pH variations. At the time of consultation, there was no metering system in place for Weipa Town Authority (WTA) to charge for residential and commercial use of water.

The Awonga Point Sewage Treatment Plant (STP) which services the entire Weipa town area involves a combination of gravity and pump systems and is managed and operated by the WTA. The Lorim Point STP services the Napranum town area and is managed and operated by RTA. The treated effluent enters a series of retention ponds. The treated effluent from the Awonga Point STP is eventually released into the Mission River and the treated effluent from the Lorim Point STP is released into the Embley River. The garbage collection service for Weipa is provided by the WTA through an external contractor. The waste disposal landfill is located within the mining lease however it falls outside of the Weipa town boundary. Garbage collection and waste removal for Mapoon, Napranum and Aurukun communities are all managed by their respective Shire Councils. Each of the Shire Councils also operates their respective waste disposal facilities.

Transport Infrastructure

The major road infrastructure in Weipa is supported by the Peninsula Development Road (PDR). The road stretches approximately 800km from Cairns and is the only link, by road, to the other areas of Far North Queensland. The PDR is maintained by RTA within the lease boundary (ML 7024), which is approximately 30km out of Weipa. This road is a vital piece of infrastructure that supports and facilitates economic development for the Western Cape region. The maintenance of local Weipa roads is managed by WTA. Roads within communities of Napranum, Mapoon and Aurukun are maintained by their respective Shire Councils.

The existing road network in the vicinity of the Project area, together with details of the proposed traffic routes and infrastructure have been described in **Section 14**.

Air passenger transport in Weipa is available through QantasLink services. QantasLink operates up to three daily flights from Cairns. The Weipa Airport is owned by RTA and is within the town of Weipa. According to the WTA and Weipa Chamber of Commerce, improving the aesthetics of the Airport is one of the key priorities for supporting tourism and business activities in Weipa.

Skytrans operates air passenger services to Aurukun from Cairns. In addition to Skytrans there are also a number of private air charter companies based in Cairns and Weipa who provide charters between Weipa, Mapoon and Aurukun.

Australian Customs operates aerial surveillance, with aircraft from the Coastwatch fleet based and operating out of the Weipa airport. The Royal Flying Doctor Service (RFDS) aircraft are able to land at airstrips located at Aurukun, Weipa and Mapoon in the case of emergencies.

The Port of Weipa is managed by the North Queensland Bulk Ports Corporation Limited (NQBP). The Port of Weipa handles approximately 350 vessels per year (2008 data). The Port of Weipa has wharves at Lorim Point, which is used for the export of bauxite; at Humbug Point, which handles general cargo and heavy equipment; and at Evans Landing, which is used for petroleum products, naval purposes and commercial fishing activities.

16.2.3 Health and Emergency Services

Health

The Western Cape region is serviced by the Queensland Government through the WIHS Unit which provides 12 acute beds, 10 residential aged care beds, primary health care, dental, physiotherapy, and District Office administration. Primary health care centres are located in Aurukun, Napranum and Mapoon. These facilities are operated by Queensland Health (QH).

In addition the communities across the region are serviced through a number of other service providers, including RFDS, various outreach primary health care teams and HACC. A summary of the all health services provided across the region listed in **Tables 16-7** to **16-9**.

Table 16-7 Medical Services in the Weipa Catchment Area

Type of Medical Practitioner	Type of Service	Local or Visiting	Base	Frequency/ Availability
General Practice	Far North Queensland Rural Division of General Practice (FNQRDGP) Private GP	Local	WIHS	5½ days a week & chargeable after hours call service
General Practice	(Queensland Health) outpatients/ inpatients	Local	WIHS	Eight hours per day five days a week
Medical Emergency	(Queensland Health)	Local	WIHS	Medical Officer on call
General Practice	(Queensland Health) outpatients	Visiting to	WIHS	GP service four mornings a week

Type of Medical Practitioner	Type of Service	Local or Visiting	Base	Frequency/ Availability
		Napranum		for three to four hours
General Practice	(Queensland Health) outpatients	Visiting to Mapoon	WIHS	GP service one day per week equivalent to five hours
General Practice	(RFDS contracted to Queensland Health) Primary health care	Visiting to Aurukun	RFDS	19hr/week
General Practice	(RFDS contracted to Queensland Health) Primary health care	Visiting to Coen	RFDS	6hr/week
General Practice	(RFDS contracted to Queensland Health) Primary health care	Visiting to Pormpuraaw	RFDS	10hr/week
General Practice	(RFDS contracted to Queensland Health) Primary health care	Visiting to Kowanyama	RFDS	6 ½ day coverage, after hours call arrangements with RFDS call centre

Source: Department of Community Services, Qld Health

Table 16-8 Allied Health and Community Health Services Provided in Weipa Area

Service type	Name of provider	Local or visiting	Base/ location	Frequency/ availability
Pharmacy	S. McCahon		Weipa (shopping centre)	5½ days a week
Ambulance	Queensland Ambulance Service/Queensland Health MOU	Local	WIHS	On call
Acute care	Queensland Health	Local	WIHS	12 beds
Allied health				
Dietetics & diabetes education	FNQDGP	Visiting WIHS	Cairns	12 visits per year
Physiotherapy	(private contractor to Queensland Health)	Local	WIHS	24-hrs public
Occupational therapy	Queensland Health	Visiting WIHS	Cairns	4 visits per year
Oral health	Queensland Health	Visiting WIHS	Cairns	4 visits per year
Podiatry	FNQDGP	Visiting	Cairns	9 times year
Dentist	(currently vacant)	Visiting	Cairns	Fortnightly
Social work	Queensland Health	Local	Weipa	Weekly
Nutritionist	Queensland Health	Local	Weipa	Weekly
Maternal and child health	Queensland Health	Local	Weipa	Daily

Service type	Name of provider	Local or visiting	Base/ location	Frequency/ availability
Domestic violence	Queensland Health	Visiting WIHS	Cairns	4 visits per year
Sexual assault services	Queensland Health	Visiting WIHS	Cairns	4 visits per year
Mental health				
Psychology	Queensland Health	Visiting WIHS	Cairns	Fortnightly
Adult MH	Queensland Health	Local	Weipa	Weekly
C&Y MH	Queensland Health	Visiting WIHS	Cairns	6 visits per year
Alcohol and Drugs Service				
Early identification and intervention service	Queensland Health	Local	Weipa	Weekly
Aged Care Assessment Team	Queensland Health	Visiting WIHS	Cairns	2 visits per year
Palliative care support service	Queensland Health	Local	Weipa	As required
Continence Program/advisor	Queensland Health	Visiting WIHS	Cairns	12 visits per year
Falls Prevention Program/educator	Queensland Health	Visiting WIHS	Cairns	12 visits per year
HACC Services				
– community nursing	Queensland Health	Local	Weipa	As required
– domestic assistance	HACC	Local	Napranum	As required
– social support	HACC	Local	Napranum	As required
– personal care	HACC	Local	Napranum	As required
– centre based respite	HACC	Local	Napranum	As required
– home maintenance	Council	Local	Napranum	As required
– home modification	Council	Local	Napranum	As required
– transport	HACC	Local	Napranum	As required
– information & advocacy	HACC	Local	Napranum	As required
– social support	HACC	Local	Mapoon	As required
– personal care	HACC	Local	Mapoon	As required
– domestic assistance	HACC	Local	Mapoon	As required
– transport	HACC	Local	Mapoon	As required

Service type	Name of provider	Local or visiting	Base/ location	Frequency/ availability
– centre based respite	HACC	Local	Mapoon	As required
– home maintenance	Council	Local	Mapoon	As required
Aged accommodation				
Residential Aged Care	Queensland Health	Local	WIHS	10 beds
Hostel Napranum	Council	Local	Napranum	As required
Carer support programs	HACC	Local	Napranum	As required

Source: Department of Community Services, Queensland Health

Table 16-9 Other Health and Aged Care Services Provided in Weipa Area

Organisation	Hospital/Health Service	Services provided	Frequency /Availability
Queensland Health	WIHS 12 acute care beds	Medical Superintendent & Senior Medical Officer	24/7 emergency
Queensland Health	Outreach primary health care teams (as listed) Nurse and Health workers, Women's health Sexual Health Mental Health Nutrition Renal/Diabetes Prevention Alcohol Tobacco and other Drugs	All teams run clinics at WIHS in their specialties, offer training to staff, taking referrals for individual patients or groups. However their main role is providing outreach services to whole of Cape York Health Service District PHC Centres.	Provide periodic Nurse & Health worker based services on the WIHS campus (e.g. Women's and Sexual health clinic every second Friday)
Queensland Health Napranum Primary Health Care Centre (PHCC)	Primary health care and chronic disease management	3 x Registered Nurses, 5 x Indigenous Health workers	Monday to Friday. After hours care is provided at WIHS
Queensland Health Mapoon PHCC	Primary health care and chronic disease management	2 x Registered Nurse and 2 x Indigenous Health Workers	Monday to Friday. After hours care is provided at WIHS
Queensland Health Aurukun PHCC	Primary health care and chronic disease management	6 x Registered Nurses, 6 x Indigenous Health workers	Seven days per week

Source: Department of Community Services, Qld Health

RTA operates an Occupational Health Centre on-site for all employees to utilise for any health issues or concerns. Services offered include specialist physiotherapy, wellness assessments, optometry and general health checks. Counselling services for all RTA employees are provided by Assure Programmes through their Employee Assistance Programme. This includes fortnightly visits to Weipa by counsellors.

There are a number of key social and health issues that have been reported as key barriers to achieving positive health outcomes and which also affect employment. These have been highlighted in both the *Weipa Community Baseline Assessment* (SGS 2008) and in the Aboriginal and Torres Strait Islander Partnership (ATSIP) *Quarterly Reports on Key Indicators in Queensland's Discrete Indigenous Communities* (Queensland Government 2008). The issues highlighted include alcohol and drug use, alcohol related harm, poor diet and hygiene, and family relationship breakdowns. Alcohol and drug related illnesses are common to both Indigenous and non-Indigenous populations in the Western Cape region. RTA has adopted a

strict alcohol and drug policy to ensure that RTA employees and contractors operate and fulfil their duties in a safe work environment.

Alcohol Management Plans (AMPs), a Queensland Government initiative, are currently implemented across a number of Cape York communities, including Aurukun, Napranum and Mapoon. AMPs contain a set of recommendations on reducing alcohol related crime and violence via restrictions in the sale and consumption of alcohol. The regulations apply to all people in the restricted area, whether they are a resident, visitor or tourist passing through. Weipa does not have an AMP which, at times, has resulted in people from neighbouring communities driving to Weipa to purchase and consume alcohol. The Queensland Police Service notes that incidents of drink driving are considered to be high amongst the people travelling to and from the restricted communities.

ATSIP notes that Aurukun is one of four communities working with the Queensland and Australian governments to address the impacts of alcohol abuse (Queensland Government 2008). The aim of the Alcohol Reform Program, which is part of the broader Welfare Reform Program that commenced in 2007, is to improve service delivery to Aurukun residents. This includes the provision of alcohol and drug treatment services and enhanced community and sport and recreation activities that form a key component of alcohol demand reduction strategies.

One of the key components of the program is the formation of Family and Responsibilities Commission (FRC) that has membership from the Aurukun community. The role of FRC is to refer those individuals and families in difficulties to the relevant services and program provided by various government agencies and service providers. The Commission's inaugural meeting was held in June 2008 and the Aurukun Commissioners have been active in the community since that time.

A community wellbeing centre that provides drug and alcohol, family violence, gambling and general counselling support has operated in Aurukun since December 2008. The Aurukun Well-Being Centre is designed to improve the availability of health services. It provides a community-based approach to treating addiction and related mental health issues, addressing family violence, reinforcing social norms and facilitating pathways out of treatment to employment and education. The services offered by the Well-Being Centre include assessments, counselling, support, case co-ordination and referrals to other services. The Centre is being managed under the auspices of the Royal Flying Doctor Services (RFDS). Well-Being Centres are also being established in other Cape York communities, including Coen, Hope Vale and Mossman.

Emergency Services and Response

RTA's Weipa fire and rescue services team comprises ten fire and rescue officers and a fire and rescue crew leader. Fire and rescue officers are based at both Lorim Point and Andoom stations. The stations are manned 24 hours a day, seven days a week.

The primary role of the fire and rescue team is to provide emergency (fire and first aid) response to the Weipa operations, deliver training on-site and issue permits (e.g. confined space, hot work). In specific prescribed circumstances the fire and rescue team may be requested to support the local Queensland Ambulance Service in responding to community incidents.

An ambulance service is provided through the WHIS to the Weipa local area, including Napranum and is on call 24 hours a day, seven days a week. There are State Emergency Service units in Weipa and Aurukun. The Weipa unit services Napranum and Mapoon.

RTA's Weipa operations maintain, and implement as required, a detailed Business Resilience and Recovery (BRR) Plan (otherwise known as an "Emergency Management Plan").

The current BRR Plan is written to allow for management and development of an appropriate response to any type of emergency situation. However the plan includes specific procedural guidance for appropriate response to a wide range of threats that have been identified as a potential risk at the Weipa operations. It includes, but is not limited, to:

- aircraft incident;
- major fire/explosion;
- fatality/fatalities;
- natural disaster (including cyclone);
- vehicle incident;
- loss of communications / information technology;
- workplace violence;
- widespread illness (including influenza pandemic);
- loss of utilities; and
- loss or potential for loss of structural integrity of tailings storage facility.

The implementation of the BRR Plan during construction and operational phases of the Project is detailed in **Section 19.3**.

16.2.4 Educational Facilities and Services

Pre-prep to Year 12

The Western Cape College (WCC) is the main education service provider in the Western Cape region. The College currently services the schooling needs of Weipa, Mapoon, Napranum and Aurukun communities. In 2009, the WCC had enrolled approximately 1,200 students across the three campuses of Mapoon, Aurukun and Weipa. According to the WCC, the enrolment of Aboriginal students has increased in the last seven years. The average attendance rate for all students in 2007 was 81%. The Weipa campus caters for approximately 960 students from Pre-prep to senior (Year 12). The Aurukun campus offers classes from years 1 - 10, and had a total enrolment of 253 in 2008, whilst the Mapoon campus provides classes from pre-prep to year 6 with an enrolment of 28 in 2008. The Napranum campus of the WCC was closed in 2005 with Napranum students now attending the Weipa campus, travelling by bus each day.

In 2008, the WCC Special Education Unit had 47 students enrolled from pre-prep to year 12 across campuses in Aurukun, Mapoon and Weipa (refer **Table 16-10**). The facilities for the Special Education Unit in Weipa and Aurukun are both new.

Table 16-10 Special Education Unit Demographics (2008)

	Pre-prep to Year 12		
	Aurukun	**Weipa**	**Mapoon**
Indigenous	20	16	1
Non Indigenous	0	10	0
Total	20	26	1

A new resource centre (library) was completed in 2008 at the Weipa campus and a new performing arts complex, administration building, and multi-purpose facility was completed in 2009. In 2010, a new science and technology centre was constructed at the Weipa campus. The WCC also maintains a strong partnership with the Weipa Youth Hostel which provides living away from home boarding facilities for Indigenous students from neighbouring communities.

The WCC is committed to the Senior Education and Training Plan Service Guarantee for Cape and Torres Strait Schools. This ensures that all high school students upon graduation receive either an Overall Position (OP) score (an eligible OP score is required for school leavers to enter into Queensland tertiary education providers such as universities), complete a school-based apprenticeship or traineeship, be on a clearly articulated vocational and technical education

pathway or gain employment. The outcomes for year 12 students completing their schooling in 2008 are reflected in **Table 16-11**.

Table 16-11 Outcomes for Year 12 Students (2008)

Outcomes	Number / %
Total number of Senior Certificates awarded	29
Percentage of Overall Position (OP)-eligible students with OP 1 - 15	67%
Percentage of students awarded Senior Certificates and awarded a Vocational Education and training (VET) qualification	76%
Percentage of students awarded Senior Certificates with OP-eligibility or awarded a VET qualification	79%
Percentage of Queensland Tertiary Admissions Centre (QTAC) applicants receiving an offer	100%

Vocational and Technical Education Program

The Tropical North Institute of TAFE has a regional campus located in Weipa that also services the communities across the Western Cape region. Post-secondary education and training programs are delivered in Weipa for specific courses. Another role of the TAFE campus in Weipa is to link employers and employment service providers with qualified trainees and apprentices. The campus currently delivers the following training programs:

- 4x4 Vehicle Training
- Driver Training
- Vocational Literacy and Numeracy
- Certificate II – IV Business and Business Administration
- Certificate III & IV Visual Arts and Contemporary Craft
- Certificate III & IV Aboriginal and Torres Strait Islander Cultural Arts.

A number of other programs are delivered by distance learning through the main campus in Cairns with local support provided by the Weipa campus.

Available traineeships in the region are filled largely by local Aboriginal people (LAP). Trainees are generally placed into roles at RTA, with State Government agencies or local businesses.

As at the end of December 2009, RTA employed 24 trainees (approximately 1/3 female and 2/3 male) across a range of areas including plant operators, mine operators, laboratory assistant, administration, rail maintenance, electrical maintenance, childcare, warehousing, environment, hospitality, engineering and local law/animal control. Recent years have seen the retention rate for trainees increase with the introduction of a range of support programs by RTA.

Since the commencement of the RTA Local Aboriginal Traineeship Program in 2002 there have been over 160 participants in the program. The number of trainees who have now transitioned into full time employment is 39. This includes trainees who have progressed to an apprenticeship.

RTA also currently hosts 37 apprentices (including 11 Indigenous apprentices) who are employed by Cairns Regional Group Training. Apprenticeships are offered across site in a range of areas including diesel fitting, electrical, fitting and turning, civil construction and boiler making.

Education and training has a direct impact on recruitment of local people by RTA. The company supports education and training programs in the community and various initiatives have been established with RTA's support and as partnerships with key stakeholders to increase education and employment outcomes of Indigenous non-Indigenous people in the Western Cape region. Some examples of these include:

- university scholarships for Western Cape College graduating students;

- RTA sponsored academic awards for English, Science and Mathematics;
- vacation work opportunities for students attending university who come from Cape communities;
- support through RTA Donations Program for the Foot In The Door Program, University Tours and various school groups attending regional and state academic programs such as Tournament of the Minds; and
- career education, including site visits and work experience for local students attending boarding school.

Tertiary Education

Weipa has a higher proportion of residents with post-secondary education qualifications compared to Aurukun, Napranum and Mapoon. Those residents with university degrees are also concentrated in Weipa. Holders of Certificate qualifications (either Certificate I, II, III or IV) accounted for 26% of people aged 15 years and over in Weipa compared to 2% in Aurukun, 10% in Napranum and 20% in Mapoon. The percentage of Certificate holders in Weipa (26%) and Mapoon (20%) is greater than the Queensland state average of 18% while the percentages in Aurukun (2%) and Napranum (10%) are lower. Between 2001 and 2006 people aged 15 and over who possessed a Certificate qualification rose 1% in Weipa. However, this group decreased by 0.9% in Aurukun, 8% in Napranum and 10% in Mapoon (SGS 2008).

16.2.5 Employment and Economic Profile

The 2006 labour force numbers and participation rates in the four communities of the Western Cape region are presented in **Table 16-12** [note: Community Development Employment Project (CDEP) program participants are counted by the ABS as employed persons]. Weipa has the region's highest labour force participation rate of 79% followed by Mapoon (66%), Napranum (48%), and Aurukun (47%). The Weipa and Mapoon labour force participation rate is higher than that for the FNQ SD and Queensland (63% and 62% respectively). The Napranum and Aurukun labour force participation rates are significantly lower. The labour force participation rate refers to the number of people who are either employed or actively seeking work, as a percentage of the total population aged 15 years and over.

Table 16-12 Labour Force Participation, 2006

	Total labour force		Population aged 15 years and older		Labour force participation rate		Percentage change
	2001	2006	2001	2006	2001	2006	
Weipa	1,481	1,751	1,989	2,235	74.5%	79.1%	4.7%
Aurukun	430	334	717	704	60.0%	47.4%	-12.5%
Napranum	299	261	466	546	64.2%	47.8%	-16.4%
Mapoon	83	113	131	172	63.4%	65.7%	2.3%

Source: ABS Census of Population & Housing, 2006

The employment rates in the local area community in the 2006 Census data have been strongly influenced by the inclusion of CDEP participants in employment statistics. The CDEP is a Commonwealth Government-funded initiative. The program operates in remote areas and provides work-readiness training and work experience. It also supports community development projects and aims to build the capacity of Indigenous organisations and communities.

The CDEP program continues to operate in communities where there are limited economic opportunities, including Aurukun, Napranum and Mapoon. The program ceased in areas with established economies on 1 July 2009.

In the Western Cape communities of Aurukun, Mapoon and Napranum, the CDEP is administered by Community Enterprise Australia (CEA), which manages a number of CDEP funded enterprises.

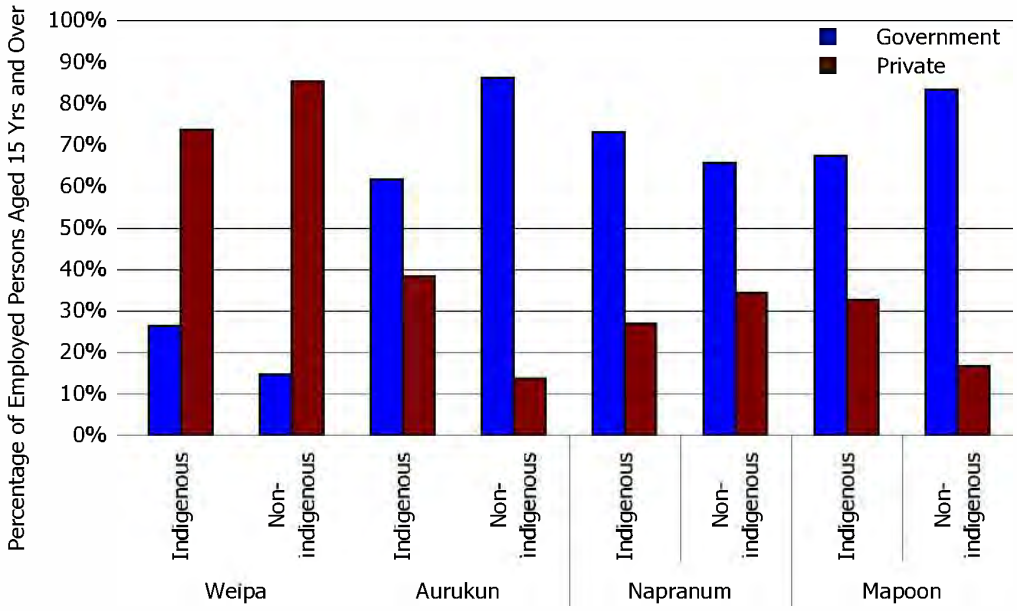
The latest available data on CDEP participant numbers in the Western Cape region is available from the 2006 Census. Because CDEP payments are classified as a wage, the ABS counts CDEP participants as 'employed' in the Census. However, the participation in CDEP projects fluctuates regularly and the CDEP employment can be extremely variable in terms of the nature of activities undertaken and the degree to which those activities could be considered 'gainful employment'.

The CDEP payment is equivalent in monetary terms to an unemployment benefit payment. According to CEA, the perception of 'employment' generated by the ABS data on CDEP fails to identify some important qualifications. Perhaps the most important of these is that, while CDEP is classified as a wage, many of the participants have expressed the opinion that they "don't want to participate in CDEP work but are told that they have to". For CEA's part, this presents challenges administering and managing the CDEP. These challenges are compounded by fluctuating participation (i.e. participants failing to show up for work on a regular basis, participants not willing to work more than a few days a week, etc.) and the on-going challenge of funding operations such as the machinery and equipment required for the various CDEP enterprises run by CEA in the region.

If, as the ABS defines it, CDEP is considered 'real' employment, then it can be considered to provide for a significant share of employed persons in Weipa and the Western Cape (as at 2006). However, if CDEP is not considered as 'real' employment, unemployment rates amongst the Aboriginal communities in the region can be considered to be much higher than otherwise stated. This would also reduce the labour force participation rate so long as those people were not considered to be actively seeking work, that is, those registered as unemployed.

Employment by Sector

Figure 16-11 shows the number of jobs available in each of the four communities based on the sector of employment and Indigenous status of the employees. Private sector employment is relatively high in Weipa for both Indigenous and non-Indigenous people in comparison to that of the other communities, where government employment is dominant. Weipa's high proportion of Indigenous and non-Indigenous private sector employment is largely attributable to employees and contractors engaged in RTA's operations. Employee and contractor workforce numbers for 2006-2008 are presented in **Table 16-3** along with projections for the staged development of the Project. The local, regional and State-wide direct and indirect employment generated by the Project is discussed in **Section 17.4.**



Source: ABS Census of Population & Housing Working Population Profiles, 2006

Figure 16-11 Employment by Industry Sector (Government and Private), 2006

Unemployment

The unemployment rate at the time of the 2006 Census was 1.4% for Weipa, significantly lower than FNQ SD (4.4%) and Queensland (4.7%) (refer **Table 16-13**). However, the unemployment rates were higher than both the State and the region in Aurukun (8.1%) and Napranum (5.7%).

Table 16-13 Employment in Weipa, Aurukun, Napranum and Mapoon, 2006

	Employed persons	Unemployed persons	Labour force	Unemployment rate 2001	Unemployment rate 2006
Weipa	1,729	22	1,751	2.6%	1.4%
Aurukun	307	27	334	3.5%	8.1%
Napranum	246	15	261	4.3%	5.7%
Mapoon	110	3	113	3.6%	2.7%
FNQ SD	107,468	4,991	112,459	7.0%	4.4%
Queensland	1,824,997	90,950	1,915,947	8.2%	4.7%

Source: ABS Census of Population & Housing, 2006

As identified above, if CDEP is not considered as 'real' employment, the numbers of unemployed people in the Aboriginal communities of the Western Cape are significantly higher than those figures shown in **Table 16-13**.

In Weipa, according to the 2006 Census data, CDEP participation is minor with a total of 63 Indigenous workers and three non-Indigenous workers involved in the program during 2006.

Nevertheless, according to the 2006 data, this constituted 4% of total employment, 22% of Indigenous employment and 0.2% of non-Indigenous employment. Whilst these figures may

appear to be small, given the smaller proportion of Indigenous people in Weipa, it has a significant impact on their unemployment rate.

If the CDEP is considered employment, the Indigenous unemployment rate in 2006 was 3%. If CDEP is considered to be unemployment, then the rate of Indigenous unemployment in 2006 was significantly higher at 24%. Non-Indigenous unemployment averaged 1% in both cases (refer **Table 16-14**).

Table 16-14 Indigenous and Non-Indigenous Employment, Weipa, 2006

	If CDEP was classified as employment		If CDEP was classified as unemployment	
	Indigenous	**Non-Indigenous**	**Indigenous**	**Non-Indigenous**
Employed: CDEP	63	3	0	0
Employed: Other	225	1,438	225	1,438
Total Employed	288	1,441	225	1,438
Unemployed	9	13	72	16
Total Labour Force	297	1,454	297	1,454
Not in the labour force	99	169	99	169
Not stated	24	11	24	11
Total Population (15 years and over)	**420**	**1,634**	**420**	**1,634**
Unemployment rate	3.0%	0.9%	24.2%	1.1%
Proportions of employment due to the CDEP	21.9%	0.2%	0.0%	0.0%

Source: ABS Census Indigenous Population Profile, 2006

In 2006, 21% of Indigenous employment present in Weipa was directly attributable to CDEP, which is low when compared to the other Western Cape communities with 81% in Aurukun, 71% in Napranum and 66% in Mapoon.

In summary the employment classification of CDEP workers significantly affects the unemployment statistics of Aboriginal communities of the Western Cape.

Indigenous Employment and Training Initiatives

RTA Weipa operations have increased the representation of local Indigenous and overall Indigenous people in their workforce steadily since 2004 (refer **Table 16-15**). Under the WCCCA, local Indigenous employees are defined as people with direct links to one of the 11 Traditional Owner groups who are signatories to the Agreement. This includes any Indigenous people connected to the Traditional Owner group by marriage or adoption or a person recognised as a local Indigenous person by the WCCCC.

Table 16-15 Indigenous Employment, Weipa Operations

Employee Category	Year				
	2004	2005	2006	2007	2008
Total Employees	688	723	777	825	912
Local Indigenous Employees	53 (9.4%)	90 (12.4%)	101 (13.3%)	109 (13.0%)	128 (14.0%)
Total Indigenous Employees	90 (13.0%)	118 (16.3%)	136 (18.0%)	156 (19.0%)	181 (19.8%)

During 2009, market conditions were significantly affected by the Global Financial Crisis resulting in lower demand for Weipa bauxite. RTA's Weipa operations reduced production to 16.8Mdpt. As a consequence, RTA undertook a series of initiatives to reduce labour whilst minimising reductions in employee numbers. Overall, RTA reduced approximately 90 employee roles and significantly restructured the Weipa operations. During this period, local Indigenous employment rates were maintained at between 13.8 – 15.2% of the total workforce throughout the year and the total Indigenous representation was approximately 21%.

RTA recognises that the employment of local Indigenous persons offers the opportunity for the business to increase retention rates. The retention rate for local Indigenous employees has typically been close to the site average and during the second half of 2009 trended higher than the site average. At the Weipa operations, Indigenous employees have proportionally higher numbers in semi-skilled/operator and administrative roles, however there is currently under-representation in professional and leadership roles.

Whilst RTA has continued to increase representation of local Indigenous and other Indigenous persons in its workforce, it is recognised that a number of significant social barriers continue to affect the work-readiness levels of people living in Western Cape communities. This has required RTA to take a long term approach to employment and training and implement strategies targeting specific communities, rather than adopt a one-size-fits-all approach.

An example of this has been the implementation of a pilot program specifically for Aurukun known as the RTA Destinations Program. The program has recently completed its second year of the pilot program and provides a staged approach to employment for people moving from CDEP to full time employment in RTA's operations. The program involves a structured recruitment and selection process that includes site visits to the mining operations in Weipa and extensive community and stakeholder engagement. Stage 1 provides a 13-week focus on work readiness and life-skills development conducted by Myuma Pty Ltd at its facilities near Camooweal in north-west Queensland. Participants successfully completing this stage progress to Stage 2, a 4-month work sampling placement at RTA Weipa operations. The final stage is a 4-month fixed-term contract at RTA's operations. All participants who successfully complete three stages are guaranteed a full-time position with RTA at the end of the program. The pilot program has provided the opportunity to identify a number of aspects of the program that need to be addressed to increase the success rate of participants moving through each stage. A formal review of the program is now planned, in collaboration with Traditional Owners and the WCCCC in order to identify and implement improvements to the program.

Programs such as the Local Aboriginal Traineeship Program and the RTA Destinations Program have highlighted the significant barriers that still exist for many Aboriginal people looking to pursue a career in the mining industry. The most significant of these are; low levels of literacy and numeracy, high levels of dependence on other people to assist with day-to-day tasks (e.g. banking, transport arrangements, financial management), lack of a driver's licence, family-related issues (e.g. multi-family households, family obligations, caring for family members, homesickness, living away from children, inter-family disputes), poor ability to self-manage alcohol and drug consumption, and health concerns (including cardio-vascular disease and diabetes).

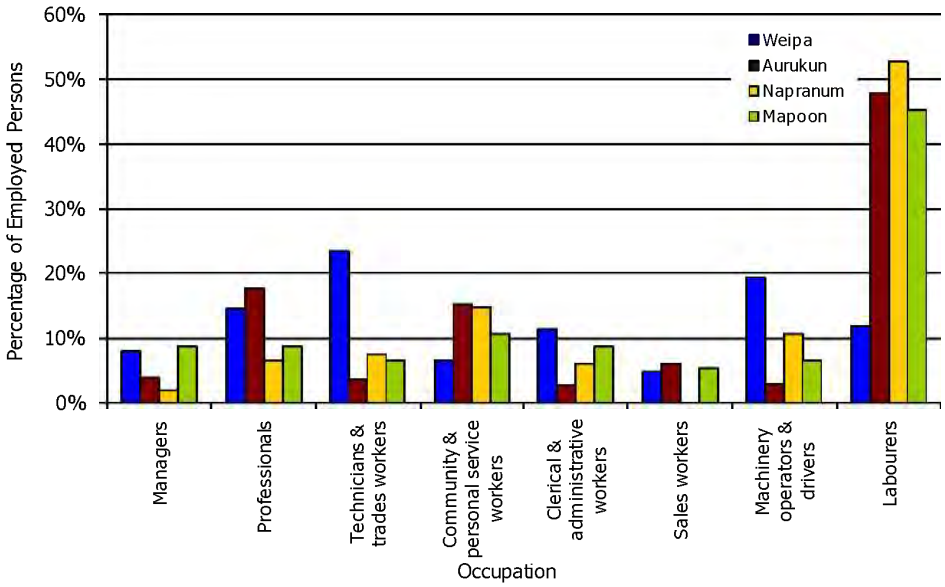
As part of an organisational restructure conducted at RTA's operations in 2009, the Human Resources and Training department, incorporating Indigenous Training and Development and

Employee Support Teams was established. The new department oversees the development and implementation of Indigenous employment, training and development initiatives including coaching and mentoring, employee support, school-to-work pathways, local Indigenous traineeships, career pathway development, stakeholder engagement (including working collaboratively with job network providers, local/state/federal government agencies and community organisations) and engagement with Traditional Owners through the structure and processes established through the Employment and Training Sub-Committee, under the WCCCA.

Employment by Occupation

The occupations of employed persons in the study area at the time of the 2006 Census are shown in **Figure 16-12.** The majority of employed residents from Weipa are technicians and trade workers (23.3%), followed by machinery operators and drivers (18.7%), and professionals (13.5%). In the three communities of Aurukun, Napranum and Mapoon, working residents are mostly employed as labourers (46.6% of residents in Aurukun, 48.2% in Napranum and 49.5% in Mapoon). These occupations reflect the occupations of mining and related industries.

There are also a significant number of community and personal service workers in these communities, and Aurukun also has a relatively high proportion of professionals.



Source: ABS Census of Population and Housing, 2006

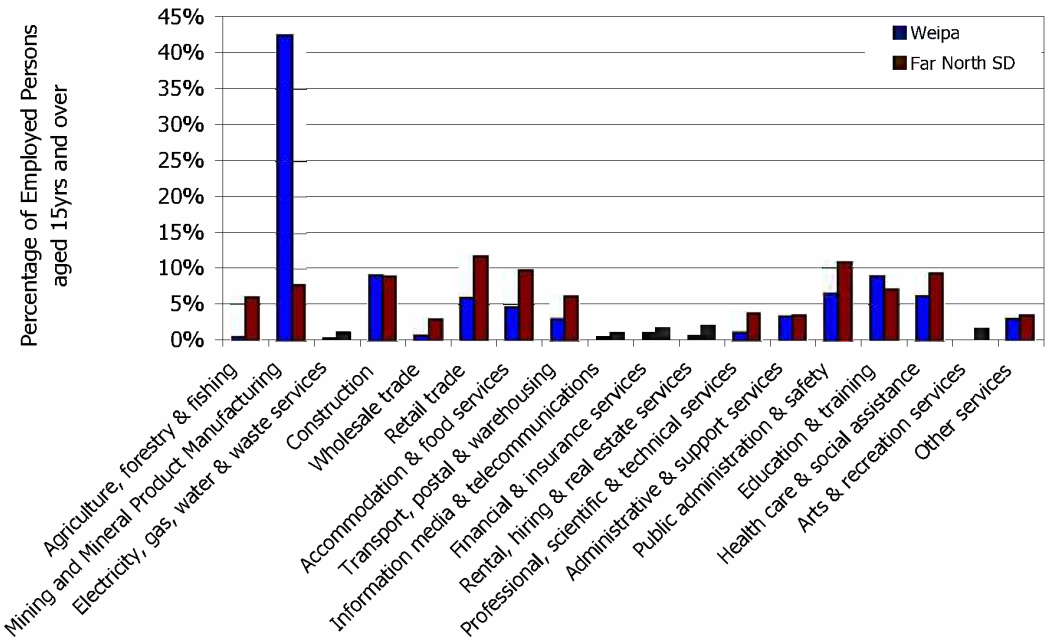
Figure 16-12 Occupational Profile, 2006

Employment by Industry

The proportional representation of employment by Australia and New Zealand Standard Industrial Classification (ANZSIC) in Weipa compared to the FNQ SD is presented in **Figure 16-13**. There is no data available for Aurukun, Napranum and Mapoon. Mining and Mineral Product Manufacturing was clearly the largest employer, accounting for 43% of resident jobs in Weipa followed by Education and Training (9%), Public Administration and Safety (9%), Healthcare and Social Assistance (6%) and Retail Trade (6%). By way of comparison, RTA data shows 884 persons were engaged by RTA in 2006 as direct employees or contractors. The 2006 Census data shows a total employed workforce of 1,729 in Weipa. Assuming the mine

workforce was all based in Weipa, the mine-related workforce would have constituted 51% of total employment at that time. However, if it is assumed that the mine-related workforce constituted 43% of total Weipa employment (as per 2006 Census data) this would imply that about 58 members (6.6%) of RTA's 2006 workforce were residing outside Weipa, predominantly in Napranum.

The industry breakdown clearly shows the integral nature of the mining industry to the Weipa community.

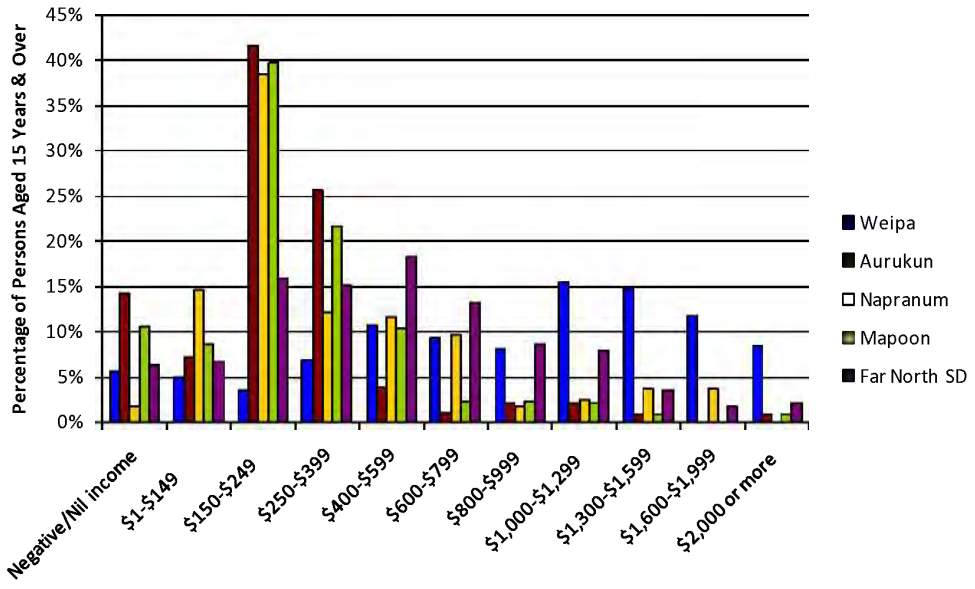


Source: ABS Census of Population & Housing, 2006

Figure 16-13 Employment by Industry: Weipa and FNQ SD, 2006

Income

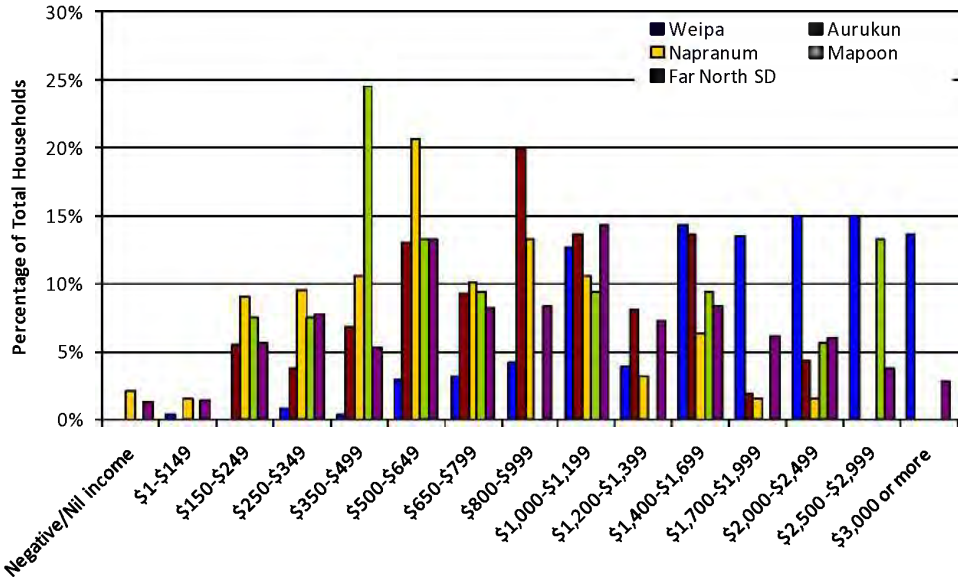
The 2006 gross individual income distribution (for people aged 15 years and over) in FNQ SD and the four communities of Weipa, Aurukun, Napranum, and Mapoon are shown in **Figure 16-14**. Gross individual income in Weipa was predominantly in the higher income brackets, with over 50% of employed residents earning $1000 or more a week, reflecting the large proportion of the workforce engaged in the mining industry. Incomes in Weipa were generally higher than those for FNQ SD. Individual incomes for Aurukun, Napranum and Mapoon residents were much lower than for Weipa residents, and also lower when compared with the FNQ SD as a whole. Between 55% and 60% of residents in Aurukun, Napranum and Mapoon earned less than $249 a week. This would largely reflect the lack of employment opportunities in these areas and a higher dependency on income support.



Source: ABS Census of Population & Housing, 2006

Figure 16-14 Gross Individual Income, 2006

The weekly household income in the four communities for 2006 is presented in **Figure 16-15**, and compared with the FNQ SD. Household income was largely in the higher income ranges for the Weipa area whilst for the Aurukun, Napranum and Weipa communities, household income was lower. Weipa performed better than the FNQ SD with regard to household income, having over 50% of households with weekly income in the top four income ranges. The other three communities were lower than the FNQ SD as a whole, with over 50% of households for both Napranum and Mapoon with a household income of between $1 and $649.

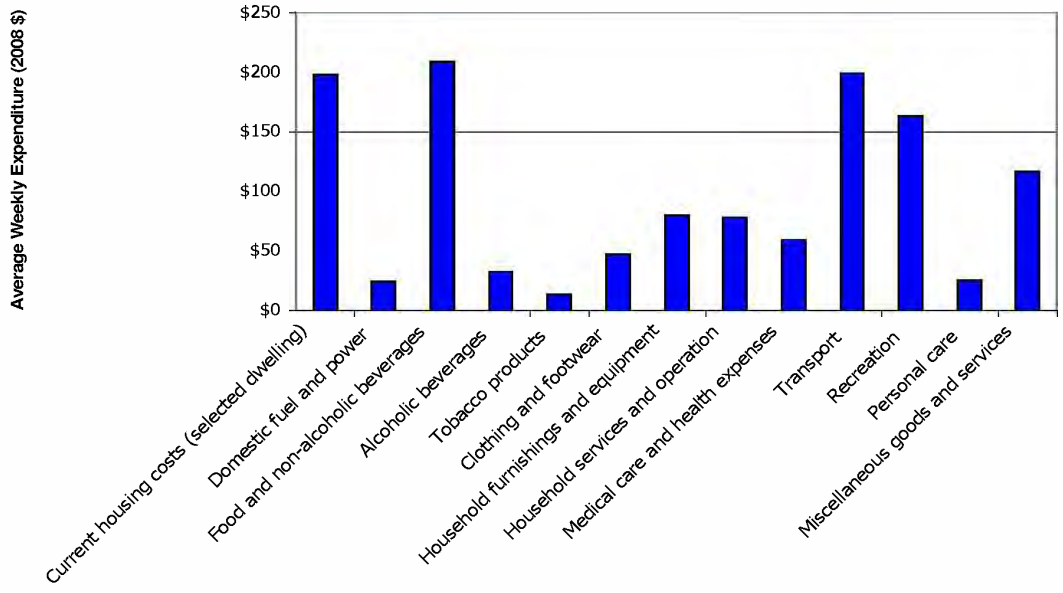


Source: ABS Census of Population & Housing, 2006

Figure 16-15 Household Income, 2006

Weipa Household Expenditure Patterns

The *Queensland Household Expenditure Survey* published by the ABS for 2003-2004 provides a basis to estimate the average household expenditure on goods and services by Weipa residents in 2008 (refer **Figure 16-16**). No data was available for Aurukun, Napranum and Mapoon. The data was extracted based on a trending of the expenditure items by the income profile of the Weipa study area (extracted from 2006 Census data), with all figures expressed in 2008 dollars. The major expenditure items for households in Weipa are currently housing costs (rent and mortgage), food and beverage costs and transport, with approximately $200 a week spent on each.



Source: ABS Household Expenditure Survey, 2003-2004 and ABS Census of Population and Housing, 2006 (calculations by SGS Economics and Planning)

Figure 16-16 Average Weekly Household Expenditure, Weipa

Business Profile

A breakdown of the businesses in Weipa by industry category is shown in **Table 16-16**. The majority of the businesses are based in retail trade (around 30%) with a significant number in accommodation, cafes and restaurants (20%). These businesses largely service the retail needs of mining workers and their families. There is also a small tourism industry in Weipa (refer **Section 16.2.7**) which is serviced by these retail businesses and cultural and recreational businesses (10%). Other industries of note are construction and property, and business services, both of which comprise 6% of businesses.

Table 16-16 Business Counts by Industry, Weipa, 2009

Industry	Businesses	% of Total
Mining	5	7.5 %
Manufacturing	1	1.5 %
Construction	4	6 %
Wholesale Trade	2	3 %
Retail Trade	18	26.8 %

Industry	Businesses	% of Total
Accommodation, Cafes & Rest.	15	22.4 %
Transport & Storage	8	11.9 %
Finance & Insurance	1	1.5 %
Property & Business Services	4	6 %
Health & Community Services	3	4.5%
Cultural & Recreational Services	6	8.9 %
Total	**67**	**100 %**

Source: Weipa Biz, 2009; localbusinessguide.com.au, 2009

The number of businesses in Napranum, Aurukun and Mapoon is low and it is not possible to break them into a percentage of industry type (refer **Table 16-17**).

Table 16-17 Local Businesses in Aurukun, Napranum and Mapoon, 2009

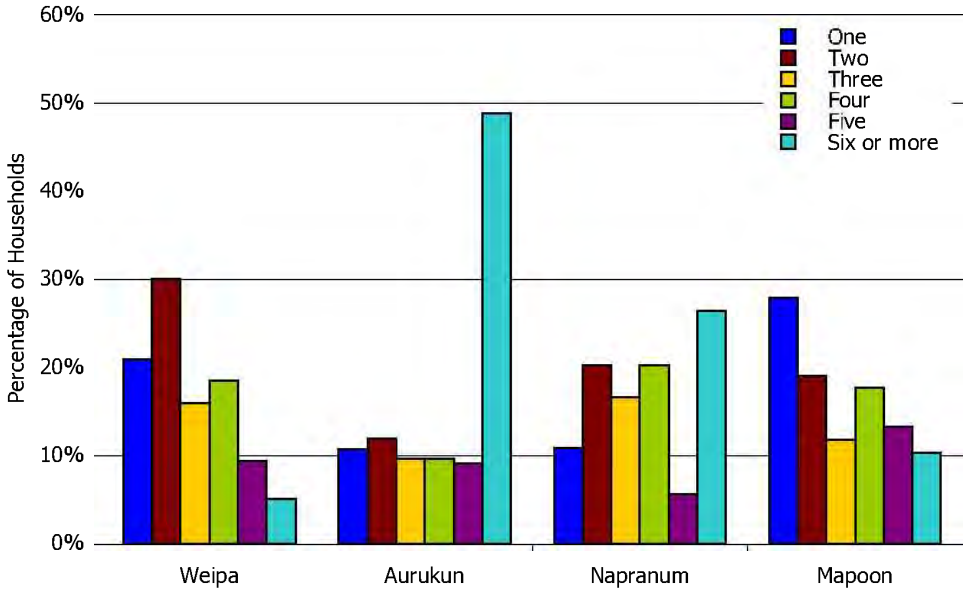
Business	Address
Aurukun General Store	Aurukun
Aurukun Wetland Charters	Aurukun
Aurukun Earthmoving	Aurukun / Cairns
Wik Projects	Aurukun / Cairns
Wik Media	Aurukun
Aurukun Arts and Craft Centre	Aurukun
Cape York Turtle Rescue/Camp Chivaree	Mapoon
Mapoon Seafoods	Mapoon
Mapoon Store	Mapoon
Napranum Takeaway Shop	Napranum
Nanum Tawap	Napranum
Napranum Farm	Napranum
Athelpen & Puuch	Aurukun

Source: Weipa Biz, 2009 and information provided by RTA, August 2009.

16.2.6 Housing and Accommodation

Household Size

The 2006 Census found that in Weipa the most common household sizes were two people per dwelling (30%) and single person households (21%). The average Weipa household size was 2.7 people, marginally above the Queensland average of 2.6. The most common household size in Aurukun and Napranum was six or more (49% and 26% respectively). The average Aurukun household size was 5.7 people, which indicates a high degree of overcrowding. The most common household size in Mapoon was single person occupancy (28%, or 14 of 60 households surveyed). These households probably represent relatively short term residents involved in support services for the community. Household sizes are shown in **Figure 16-17**.

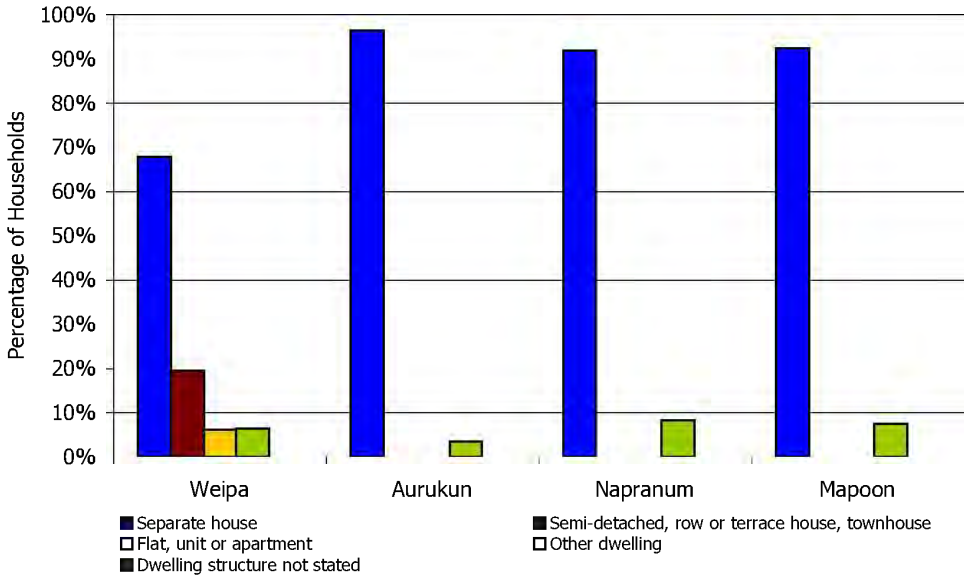


Source: ABS Census of Population & Housing, 2006

Figure 16-17 Household Size, 2006

Housing Type

The 2006 Census found separate houses comprised the large majority of housing stock in all four communities, with only Weipa containing semi-detached houses and unit type dwellings. Each community had a small proportion of "other dwellings", defined by the ABS as improvised homes, tents, sleep outs and caravans. Housing types are shown in **Figure 16-18.**

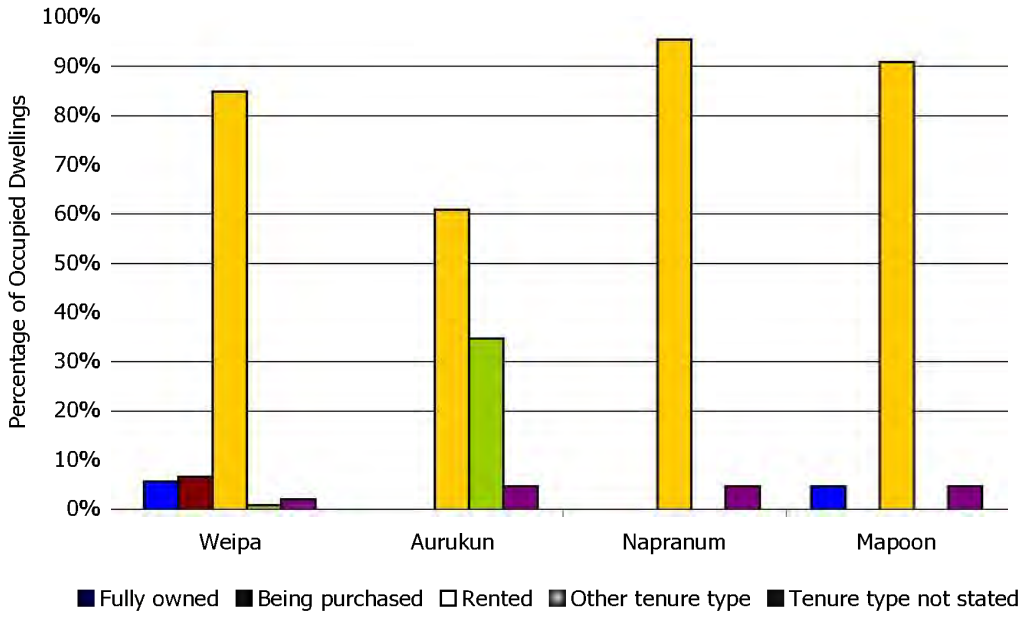


Source: ABS Census of Population & Housing, 2006

Figure 16-18 Household Type, 2006

Housing Tenure

The housing tenure profile of the four communities is presented in **Figure 16-19**. According to the 2006 Census, fully owned dwellings accounted for 6% of all dwellings in Weipa, whilst 85% of dwellings were rented. This data is now outdated due to the sale of houses by RTA to employees. Rental accommodation is the most prominent tenure type in Aurukun (61%), Napranum (95%) and Mapoon (91%). The housing in Napranum is owned by the Council, with the exception of State housing and one church house which is not the same as "private ownership" in the mainstream sense. Aurukun reported 35% "other tenure types", a category which includes households which are occupied under arrangements other than by renting, owning or under the process of purchase. The likely reason that this tenure classification is so prevalent in Aurukun is because almost all of the housing stock is owned by the Aurukun Shire Council.



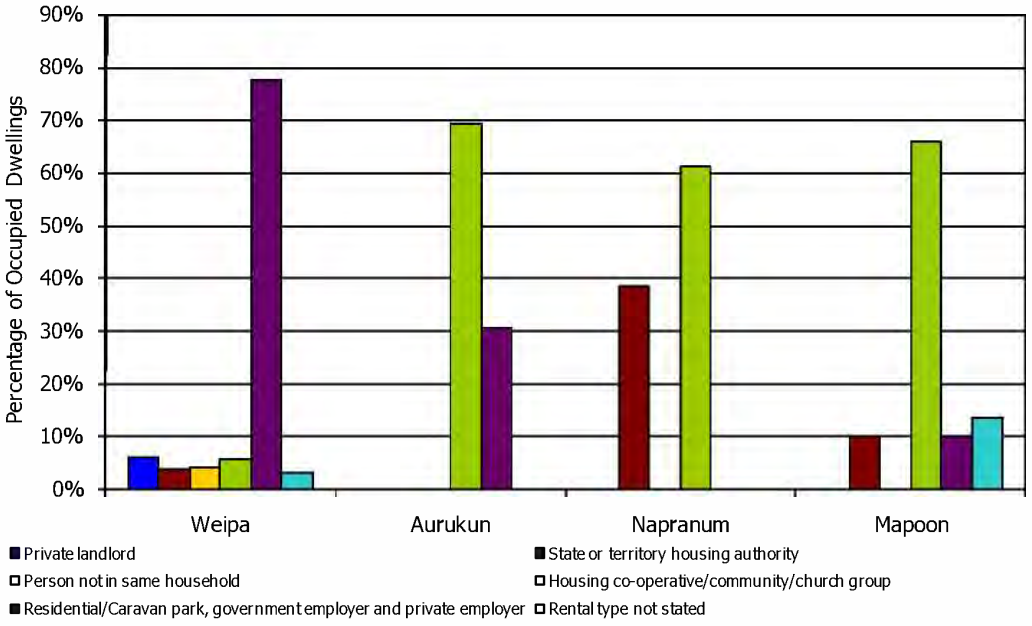
Source: ABS Census of Population & Housing, 2006

Figure 16-19 Tenure Type, 2006

According to 2006 Census data, housing cooperative/community/church groups provided 70% of all rental accommodation in Aurukun, 61% in Napranum and 66% in Mapoon. The State provided 39% of rental households in Napranum.

In Weipa, 77% of rental properties were categorised as a residential/caravan park, government employer and private employer. In 2006, RTA as a private employer would have dominated this category. This data is now outdated due to the sale of houses to RTA employees.

Details of rental accommodation types are presented in **Figure 16-20**.

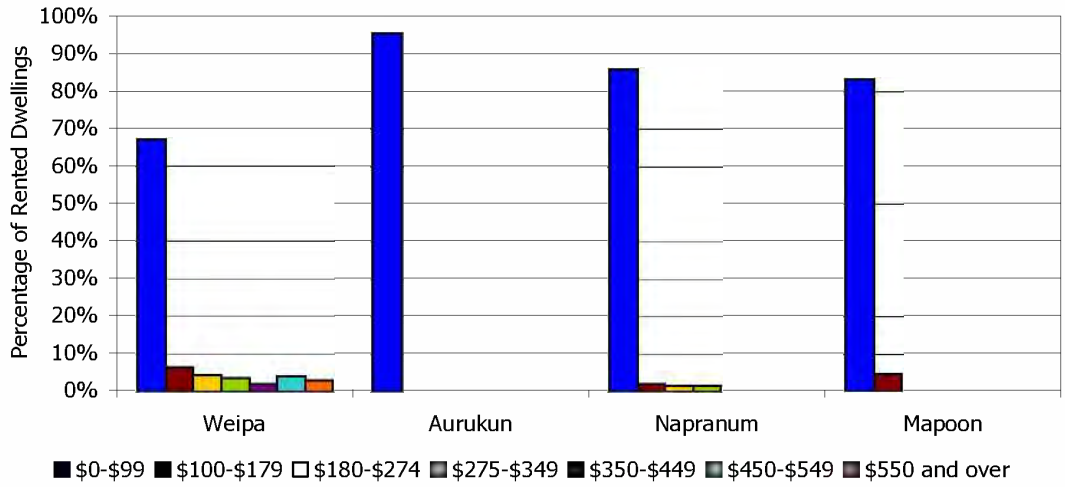


Source: ABS Census of Population & Housing, 2006

Figure 16-20 Rent Type, 2006

Rental Costs and Availability

Weekly rental costs in Weipa, Aurukun, Napranum and Mapoon based on the 2006 Census are presented in **Figure 16-21**. The high proportion of low rental costs in Weipa in 2006 reflected the high proportion of RTA supplied rental accommodation at the time. The vast majority of rental properties in Aurukun, Napranum and Mapoon rented for less than $100 per week in 2006. In September 2009, Weipa Real Estate listed 10 dwellings (houses, units, duplex) for rent. Three bedroom house rents ranged from $440 to $650 per week. This compares to typical weekly rentals of $250 to $350 for three bedroom houses in Cairns. The cost differential is typical of remote area rents when compared to large east coast urban centres.



Source: ABS Census of Population & Housing, 2006

Figure 16-21 Weekly Rental Cost, 2006

House and Land Availability

Housing vacancy was not recorded in the 2006 Census. However, consultations with a wide range of local stakeholders indicated that there was a shortage of all types of housing stock in Weipa in 2007 (SGS 2008). Concerns were expressed that a shortage hampered the attraction of prospective employees to the mine and to State and Federal agencies. SGS (2008) stated that anecdotal evidence from 2007 suggested vacancy rates were very low for all rental properties and that additional housing stock would be required if Weipa is to fulfil its role as a regional hub to deliver government, economic and educational services and facilities for the communities of the Western Cape region.

In September 2009, Weipa Real Estate listed 11 houses for sale and 16 units or duplexes/triplexes for sale.

The WTA 2007/08 Annual Report states that there were more than 1200 houses, duplexes and flats in Weipa. Approximately 25% were owned by RTA, with the remainder owned privately and by Government agencies. Private ownership has increased in recent years as RTA has sold houses to its employees. In 2006, 334 houses were purchased by employees, followed by 133 in 2007 and 141 in 2008.

House prices in Weipa are currently comparable to those in the Cairns Local Government Area. The median house price for existing three bedroom properties in Weipa is approximately $370,000, compared to about $340,000 for Cairns. Vacant residential land available at the time of writing included 16 vacant lots owned by RTA, nine vacant privately-owned lots in the Stage I Golf Links Estate, and two vacant privately owned lots in the suburb of Nanum. Housing lot prices average $135,000 while multi-unit lots ranged from $155,000 to $500,000. The WTA has indicated that housing construction costs are approximately 25% higher than in Cairns.

Stage II of the Golf Links Estate is approved but not yet developed and will provide an additional 65 residential lots in Weipa.

16.2.7 Tourism Industry

While Weipa's principal industry is mining, which accounts for nearly half of all employment and around three-quarters of Weipa's total economic output, up to 30,000 tourists visit Weipa each year. Most tourists who visit to the Western Cape region do so primarily to take part in camping and recreational fishing activities. Tourism providers offer services in beach, deep-water and

estuary fishing, in camping and bird watching. Visitors to Weipa generally stay for greater than three days.

The most prominent and available form of tourist accommodation in the region is caravan and camping facilities. These facilities are targeted towards budget travellers. Hotels, motels, retreat and backpacker accommodation is also available in Weipa. The caravan and camping grounds are a base for most of the tourist activities in the area and a number of tours and recreational activities are run from the caravan and camping grounds.

Based on 2007 consultations for the Weipa Community Baseline Survey, SGC (2008) concluded that tourist accommodation was at full capacity, particularly during the dry season. It was concluded that government employees and contractors unable to find long-term accommodation utilise camping grounds and hotels, crowding out tourists. While this is beneficial for operators of accommodation and food businesses, these government employees and contractors are less likely to utilise tour and recreational services than tourists.

A 60-70 bed motel is proposed for the Stage I Golf Links Estate, which would increase the supply of short-term accommodation for tourists and other visitors.

Operators of charter fishing tours have the most direct involvement with the Project area, taking tours that visit the coastline and estuaries along the Gulf of Carpentaria (refer **Section 6.6.3**). The feedback from consultation with these operators in presented in **Section 16.3.2**.

16.2.8 Primary Industries

Cattle grazing has historically been the dominant rural industry on Cape York. This industry progressed after the introduction of Brahman cattle which responded more favourably to the tropical conditions of the region. The industry expanded through the 1950s and 1960s as a result of demand for Australian beef from the United States and extensive investment from the US in several large cattle stations. However, following a significant drop in cattle prices in 1974, and the introduction of the Brucellosis and Tuberculosis Eradication Programme (BTEC) in the early 1980s, the pastoral industry of Cape York experienced a significant decline. The industry as a whole also suffered during the Asian Economic Crisis of 1998, resulting in export markets drying up with a reduction in demand for Australian beef.

In the 1980s and 1990s, RTA managed a cattle property (Sudley Station) which provided pastoral work for local Aboriginal people and fresh meat for the region. However, due to the loss of the market for fresh meat in Weipa and a downturn in the live export trade for cattle during the Asian Economic Crisis, Sudley Station was eventually sold to a private owner in 2004.

The Port of Weipa provides a live cattle export facility. However, there are numerous constraints on the viability of live cattle exports. Primarily, individual Cape York producers do not generally sell cattle in quantities sufficient to fill a livestock transport ship and hence make an economically viable shipment. Furthermore, buyers in the live cattle market tend to have cattle quality standards which local producers find hard to meet, limiting the appeal of locally produced stock. Nevertheless, in August 2009, the first shipment of live cattle since 2003 was exported from Weipa.

The Department of Primary Industries and Fisheries has identified the Weipa region as having potential to grow the high value timber species, sandalwood. Potential also exists to incorporate Indigenous training facilities and employment opportunities within such an industry.

Nanum Tawap Ltd is an Indigenous-owned enterprise incorporated in 2003 which specialises in selective timber harvesting and sawmilling, and the production of cement blocks and pavers. Nanum Tawap harvests Darwin Stringybark and Melville Island Bloodwood. The wood is milled and primarily used for the local construction, floorboards and furniture. A large portion of the workforce is sourced locally from Napranum providing training and long term employment for local residents.

Timber harvesting takes place on current mining areas north of the Embley River under a set of operating conditions enabling mining and selective harvesting to occur safely in adjacent areas as follows:

- the formal hand over of identified mining areas to selected timber harvester for a specified period of time;
- the harvester removes selected trees, leaving stumps of at least 1.2m;
- access to areas is via public roads, no access is provided to active mining areas unless the contractor is fully compliant with RTA mine operating rules and standards; and
- once timber salvage activities are completed, areas are returned to RTA for vegetation clearing, raking, burning and mining.

There have been a number of studies undertaken to assess the economic sustainability of a timber harvesting operation for the area of the mining lease located south of the Embley River, including *Visions and Realities for a Wik Forestry Industry on Cape York Peninsula, Australia"* undertaken by the University of Queensland School of Economics (Venn 2004). RTA supports the establishment of a timber harvest operation south of the Embley River that would harvest timber on areas of the mining lease proposed to be mined or cleared for development of Project infrastructure (refer **Section 16.3.7**).

The Gulf of Carpentaria hosts a number of commercial fisheries. The Northern Prawn Fishery is described in **Section 6.7.1** and the Inshore Finfish Fishery and the Commercial Line Fishery are both described in **Section 6.7.2.**

16.2.9 Sporting Facilities and Recreation Activities

There is a range of recreational facilities available to the Weipa community including public parks, a gymnasium, a squash centre, a network of pedestrian and cycling pathways and a new 25m, eight-lane swimming pool opened in 2009. The swimming pool is the first phase of a two-phase project undertaken by the WTA. The second phase involves the proposed development of an indoor sports facility.

There is also a range of sporting and recreational clubs with facilities to support rugby league, sportsfishing, tennis, netball, gymnastics, golf, lawn and indoor bowls, and a dance academy. Other social clubs present in Weipa include the pottery club and various mothers' groups. Public boat ramps are situated adjacent to Evans Landing Wharf and at Rocky Point.

Formal sport and recreation activities are more limited in the communities of Aurukun, Napranum and Mapoon. A Police Citizens Youth Club (PCYC) has been established in Napranum to cater for children and adults. Programs are structured and age appropriate with qualified supervisors in attendance. Activities include basketball, volleyball, cricket, swimming lessons and recreational time, healthy cooking classes, dance programs, breakfast programs, youth empowerment programs, scouts, AFL Kickstart, team building camps and a range of arts and crafts activities.

The Queensland government is examining the feasibility of extending the PCYC initiative to the communities of Aurukun and Mapoon in the future. The Queensland government provides funding support for youth services, a sport and recreation officer and school holiday activities. The Aurukun swimming pool was also recommissioned in April 2008.

The Aurukun Arts and Craft Centre opened in 2001 to provide a work place for the artists of the community. Aurukun has a long tradition of ceremonial sculptures and has attracted the attention of avid collectors and major art galleries and museums. There is also a strong tradition of women's fibre work in the form of dilly bags, baskets, fish nets and other pieces made from dyed plant material.

The Western Cape region is also well known for its fishing and camping and continues to be one of the most popular reasons for people visiting the area. Located in Nanum, the Weipa Campground provides a range of facilities for camping, including powered and unpowered sites, and cabins. The Weipa Campground also has a laundry, swimming pool and during the dry season conducts mine tours for visiting tourists.

The operators of charter fishing tours utilise the coastline in the Project area as do individuals from Weipa who use the area for camping, fishing, pig hunting and recreational quad bike use

(refer **Section 16.3.2** for detailed discussion). The Project area is also used by Traditional Owners for fishing and hunting.

16.2.10 Cultural Heritage

The Indigenous and non-Indigenous cultural heritage values of the Project area are described in **Section 11.1** and **Section 11.2** respectively. Archaeological, anthropological and historic places are discussed, along with landscape features and aspects of the natural environment that have cultural significance.

16.2.11 Local Community Values, Characteristics and Lifestyles

2003 Regional Issues Assessment

In order to better understand the issues facing the region, RTA invited a number of community leaders from across the Western Cape to participate in an interview as part of a *Western Cape Regional Issues Assessment*. This information is included here as it provides a context about the relative importance of issues and how they evolve. RTA employees conducted the interviews with community leaders. Employees were also asked to give their opinion by way of a written survey. A total of 60 community leaders were interviewed and 369 employees returned survey forms. Three focus groups were also held, one each in Mapoon and Aurukun and one with RTA apprentices.

The feedback from consultation was that drug and alcohol abuse was rated as the most significant issue facing the region. Respondents said that drug and alcohol abuse was tied closely to unemployment, lack of youth activities, and an increase in petty crime. The second most significant issue nominated was health. In particular, participants nominated the lack of access to basic medical and emergency services (i.e. long waiting times for doctors) and a need to improve existing services. Respondents' comments demonstrated a perception that even basic health care needs were not being adequately met by existing facilities.

Employment was rated as the third most important issue in the region. The provision of valuable training leading to genuine employment opportunities for young people was considered essential. Respondents said employment could help ensure the region's youth stayed in the area and would have the added effect of reducing juvenile crime. A shortage of accommodation was also mentioned as a significant deterrent in attracting skilled workers to the region. The respondents rated youth activities as the fourth most important issue of concern. The community leaders expressed concern that there were few opportunities for youth in the region, particularly those in the 13-18 year old age group. The responses indicated that most activities rely on volunteer help and there is little funding available. Education was rated by respondents as the fifth most significant issue. There were concerns about the standard of education available to students, the experience level of teachers, and the range of subjects and vocational courses on offer.

Weipa Community Baseline Study - Community Survey

As part of the *Weipa Community Baseline Study* (SGS 2008), a community survey of Weipa residents was conducted in June 2007. A total of 100 respondents (3.2% of the 2006 population) were asked in a telephone survey "what are the priority issues facing the future of the Weipa community?"

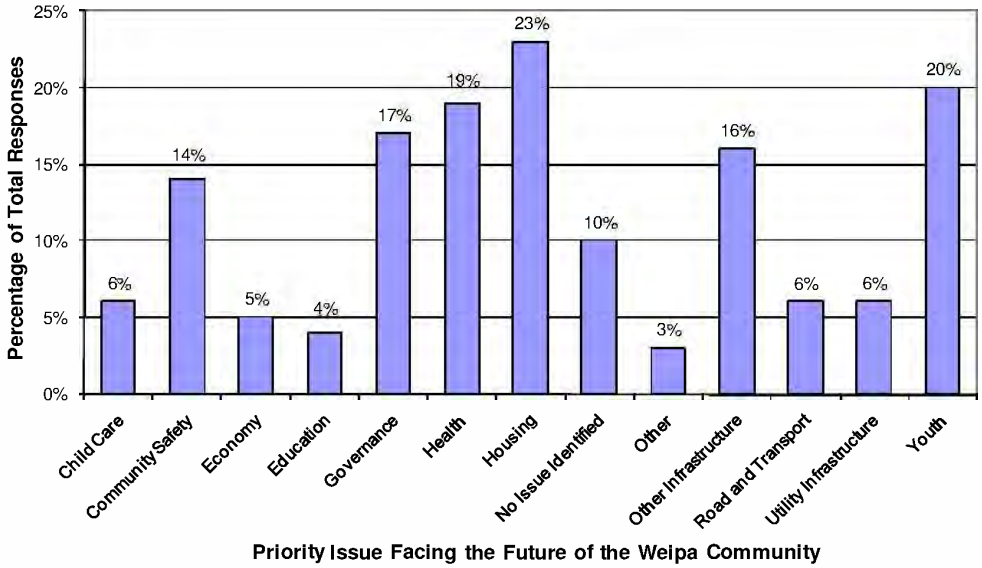
The community survey revealed similar issues to the 2003 consultations. The notable difference was the respondents' concern about the lack of available and affordable housing in Weipa, accounting for 23% of the responses.

Youth and health issues were the second and third most common responses, with 20% and 19% of respondents respectively. Health was reported as a major concern by 20% of respondents, with approximately half noting the need for the new hospital (since built) and half noting concerns about the retention of medical staff. From the survey, 19% of respondents mentioned youth and indicated a need for diversionary activities to alleviate boredom and associated anti-social behaviours.

Governance was cited as a priority issue facing Weipa (17%). The majority of comments related to the normalisation of the town and respondents' preference for an independent local council. Weipa is managed by the WTA which comprises four elected representatives, two RTA-appointed representatives and one appointed Traditional Owner representative. The respondents believed RTA largely controlled the WTA and that an independent local council would be able to better access government funding to address various issues in Weipa. Local governance matters have since been clarified by the adoption of a management protocol agreed between the WTA and RTA (WTA 2008).

Other infrastructure, such as sport and recreation facilities, and community facilities and services, were identified as a priority issue for 16% of respondents. Suggestions included the need for a new assembly hall, upgrading and repairs to the Weipa Community Centre, upgrading the swimming pool, tennis court and the basketball court, and constructing disabled access at the swimming pool. Other infrastructure also included infrastructure and development to assist small businesses in planning for the future of Weipa beyond mining.

A summary of the priority issues identified in the 2007 community survey is shown in **Figure 16-22**.



Source: Weipa Community Survey, 2007

Figure 16-22 Priority Issues Facing the Future of the Weipa Community (2007)

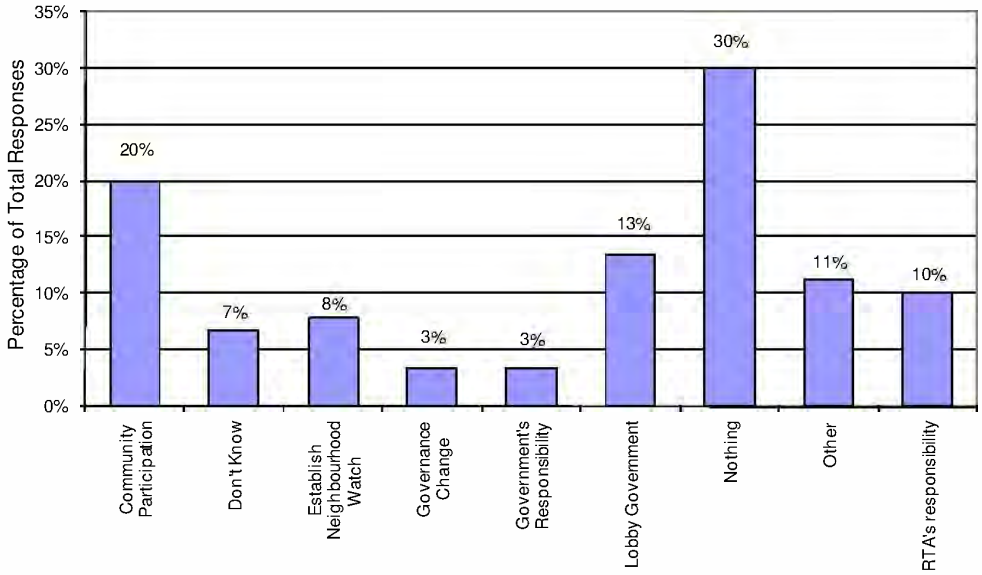
Proposed Community Response to Priority Issues

The respondents were also asked what they could do to address the priority issues mentioned above. The suggestions are summarised in **Figure 16-23**. From the survey, 30% indicated that there was nothing residents could do as they did not have the necessary means to facilitate any change, 20% of respondents reported that community participation could be of some benefit and a further 13% indicated that lobbying the Government could be a possible solution to addressing the priority issues in Weipa. Other responses included the following:

- the need for more entertainment for young people;
- the need for independent childcare due to limited availability of childcare places currently available;

- concerns regarding the non-competitive environment for businesses which resulted in high prices for groceries and other consumable items;
- the need for greater security including security cameras and people locking their doors; and
- the need to have more people in town - tourists, residents and businesses.

RTA's responses to these community issues are managed in collaboration with relevant community stakeholders, including Weipa Town Authority, Western Cape Chamber of Commerce, and relevant Government agencies. There are a number of projects proposed to address these issues, including expansion and refurbishment of the Cape Kids Childcare Centre and the construction of a skate park in 2011.

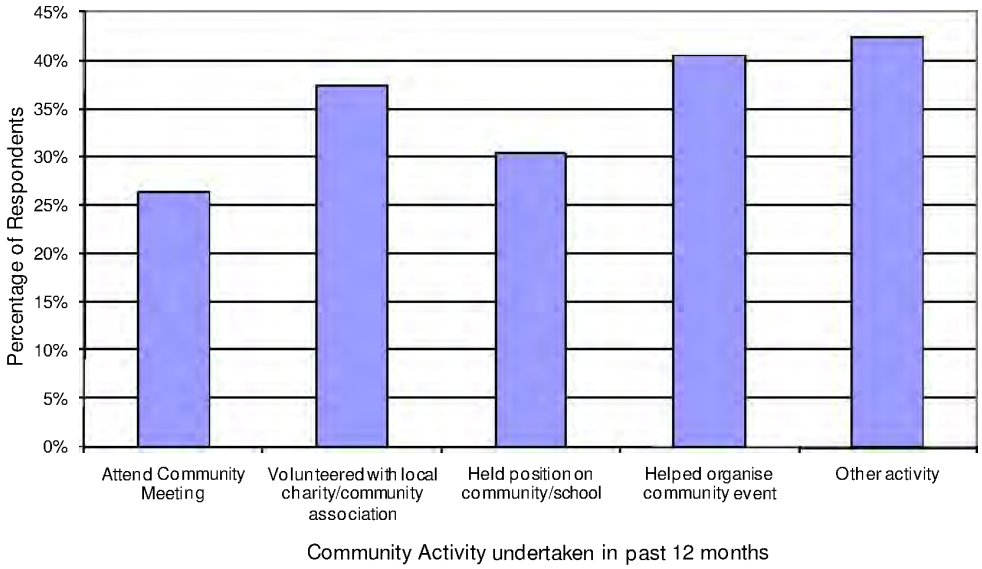


Source: Weipa Community Survey, 2007

Figure 16-23 Proposed Responses to Address Priority Issues

Participation in Community Activities

A total of 99 respondents (99%) indicated that they had been involved in at least one community activity in the past 12 months, with many indicating they had been involved in more than one activity (refer **Figure 16-24**). Out of the total number of respondents, 40% indicated that they had helped organise a local event and 37% indicated that they had volunteered with a local charity or community organisation. A further 30% had held a position on a community or school committee. Volunteering was perceived as being common amongst those who were affiliated to Western Cape College, either as a parent or as a teacher.



Source: Weipa Community Survey, 2007

Figure 16-24 Participation in Community Activities

Community Commitment to Weipa

Survey respondents were asked whether they planned to stay in for the next five years. From the survey, 71% of respondents indicated that they planned to stay in Weipa for the next five years while 20% of respondents indicated that they would move elsewhere (refer **Table 16-18**). Respondents aged 46-60 were the largest proportion planning on living in the Weipa area for the next five years (76%). These figures support the findings of the consultation which indicate that there are increasing numbers of people wanting to retire in Weipa.

Table 16-18 Plans to Stay in Weipa for Next Five Years by Age Group

		18-30 yrs	31-45 yrs	46-60 yrs	61 yrs +	Total
Plan on living in Weipa in next five years	Count	14	27	28	2	71
	%	67%	69%	76%	67%	71%
Do not plan on living in Weipa in next five years	Count	6	5	8	1	20
	%	29%	13%	22%	33%	20%
Do not know/Unsure	Count	1	7	1	0	9
	%	5%	18%	3%	0%	9%
Total	Count	21	39	37	3	100
	%	100%	100%	100%	100%	100%

The reasons for remaining in Weipa are presented in **Table 16-19**. Of those who planned on living in Weipa in the next five years, 59% of the respondents were staying for the lifestyle. In particular, comments were made in relation to: "the quiet", "the relaxed lifestyle", "the good fishing and camping" and the weather. Also of significance were the 24% of respondents who indicated that the reason for remaining in Weipa was because of employment. Many of these respondents also reported their appreciation for the lifestyle.

Table 16-19 Reasons for Staying in Weipa

Reason	Frequency	Percentage of Responses
Employment	17	24%
Financial	1	1%
Home	4	5%
Lifestyle	42	59%
Location	4	5%
Other	4	5%
Total	71	100%

Source: Weipa Community Survey, 2007

2008 Regional Leaders Forum

In February 2008, a forum of community, government and business leaders from Weipa, Aurukun, Mapoon and Napranum was co-ordinated by RTA to promote collaboration on issues relating to the long-term future of Weipa and the Western Cape region. The Forum was the third annual meeting of its type and was designed to ensure that RTA business plans and activities in the region are aligned with evolving local views and expectations. The 2008 Forum identified the following priority areas:

- sustainable communities;
- enterprise and business;
- education;
- law and order; and
- land.

The discussions on sustainability focused on Weipa and building on existing advantages that include a deep water port, airport, a secure mining industry, proximity to Asia and freehold land. Plans for the future included progressing the second stage of a new sporting complex, new childcare centre, and the building of a trade technical college. Enterprise and business initiatives indentified for the future included building the membership of the Western Cape Chamber of Commerce to increase the income base of the Chamber, apply for grants to help deliver strategic projects, and secure funding to appoint a regional economic development officer. Discussion of education initiatives included the building of a new hostel to accommodate 120 students from the region at Western Cape College and youth re-engagement in the education system. Law and order discussions focused on the need for a 24 hour Police Station in Weipa staffed with a complement of 18. The view of the Forum was that more land was needed to support the future growth of Weipa. Other issues discussed included assessing the need for land and sea centres in regional communities, a plan for rehabilitation and returning 'mined-out' land to Traditional Owners, and cooperation from RTA in supporting Traditional Owner aspirations and activities in 'caring for country'.

The initiatives that have progressed since the 2008 Forum include:

- progression of a new childcare centre in Weipa;

- the securing of two regional economic development officers for the Western Cape Chamber of Commerce;
- the commencement of the construction phase for the new hostel accommodating children attending school in Weipa from other Indigenous communities; and
- development of a productive working relationship between RTA, Western Cape Communities Trust (WCCT) and Traditional Owners focused on caring for country aspirations through a cooperative approach.

16.3 Potential Impacts and Mitigation Measures

The stakeholder issues identified during the SIA consultation are described in **Section 15** and summarised in **Table 15-10**. These issues have been examined considering the following criteria:

- the number of stakeholder groups who raised the issue;
- the significance of the stakeholder group in terms of being directly or indirectly affected by the Project; and
- the level of importance as expressed by stakeholders during the consultation meetings.

Subsequently all issues were grouped into eight broad categories for which mitigation and management strategies were developed. The proposed mitigation and management measures have taken into consideration stakeholder suggestions and were developed as a result of consultation between the social impact assessment consultant and RTA. The eight categories of issues are:

- traffic and transport;
- land and sea management;
- community consultation and engagement;
- employment, training and education;
- community cohesion (law and order, alcohol and substance abuse);
- dams;
- business development; and
- workforce.

In addition, there are a number of other issues which, while not key issues for local stakeholder groups as identified during the consultation meetings, are issues of importance to indirectly affected stakeholders such as State and Commonwealth government departments and agencies. These other issues of relevance to government stakeholders are categorised as follows.

- Demographic changes.
- Economic impacts on the local economy.
- Housing and property values.
- Cumulative impacts.

The potential impacts and RTA's proposed mitigation and management measures are described in **Sections 16.3.1** to **16.3.12**. These sections are summarised in tabular form at the end of **Section 16.3** in a Social Impact Management Plan (refer **Table 16-22**). The Social Impact Management Plan refers to matters over which RTA has some control and does not refer to matters that are the responsibility of Government or other parties.

16.3.1 Traffic and Transport

Mine Access Road and Barge/Ferry Access and Usage

Potential Impacts and Suggested Mitigation Strategies

The most significant concerns expressed were regarding the Mine Access Road (Hey River barge/ferry terminal to the Boyd infrastructure area) and the location of the barge/ferry terminal on the Hey River. The majority of stakeholder groups consulted (refer **Table 15-10**) stated that while it would be useful for the public to be able to use the Mine Access Road to go fishing and hunting, or to travel from Aurukun to Weipa, issues of safety and protection of the environment were of greater importance. Examples of disadvantages of public access included the potential for road accidents, interaction with active mining operations and the general public and unauthorised access to areas of the mining lease and traditional lands south of the Embley River. Other reasons given for restricting access to mine use only included the increased potential for illegal alcohol transportation between Weipa, Napranum and Aurukun, the potential for further damage to turtle nests on the beaches caused by increased access to those with quad bikes and four wheel drives vehicles, and increased rubbish from tourists and weekend visitors from Weipa.

Concern was also expressed that allowing public access to the road would greatly increase the potential for the deliberate starting of fires and the inadvertent transport of harmful weeds. On the other hand, the view was also expressed that it would be difficult to control access to the area south of the Embley River due to the extensive network of informal tracks. The majority of those consulted felt that controlling access would be difficult and stated that RTA had a duty of care to protect people from harm on the lease and keep the Mine Access Road restricted to mine access only. The passenger ferry and barge terminal facilities were recognised as the logical control point to prevent access from the northern end of the mining lease.

The location and operations of the barge/ferry terminals was a concern raised by numerous Traditional Owners consulted in Napranum, including members of the Napranum Aboriginal Shire Council and the Community Justice Group. The view was expressed that the barge/ferry terminal on the Hey River may increase the frequency of illegal transportation of alcohol (grog running) through the lease area and into local communities. This concern relates to the possible use of the terminal as a distribution point. There were also concerns raised regarding noise and lights associated with barge/ferry operations, and the impact of this on the local community.

RTA Mitigation Strategies

RTA proposes to restrict access to the barge/ferry terminals and Mine Access Road to people and vehicles entering the Project area for the purpose of authorised mine-related business. The control points would be at the Humbug barge terminal, Hornibrook ferry terminal and Hey River barge/ferry terminal. Access would also be provided for emergency response vehicles and personnel. Security measures would be implemented at each terminal and signage installed to ensure that the public is informed about the restricted usage of the terminals, controls on alcohol, and the restricted access to the Mine Access Road. Signage would be installed along access tracks on the eastern boundary of the mining lease restricting access to active mining areas to authorised Project personnel and restricting access to other on-lease areas to people with appropriate permits. RTA would continue to manage access for Traditional Owners to specific areas in accordance with the obligations outlined in the WCCCA. Land access matters are more fully described in **Section 16.3.2.** With regards to the impact of noise from barge and ferry operations on the Napranum community, noise modelling has predicted that noise objectives and criteria would be met at Napranum (refer **Section 10.5**). RTA would implement a noise monitoring campaign, including attended monitoring at Napranum, after operation commences to validate the noise model. Where it is determined that actual noise levels exceed applicable noise limits, action would be taken to reduce noise levels. The current community feedback mechanism would be used to address concerns that arise, in collaboration with the local community.

Access between Aurukun and the Project Area

Potential Impacts and Suggested Mitigation Strategies

Daily access and transport from Aurukun to the Project area by road, boat and/or air was raised as an opportunity to improve employment and business opportunities for residents of Aurukun.

RTA Mitigation Strategies

Access to the Project area is currently via a system of unsealed roads from the Amban turnoff (approximately 45km north-east of Aurukun) on the Aurukun Road. These roads have restricted access during the wet season. RTA investigated a number of different access options for employees to travel to and from Aurukun to the Project area on a daily basis, including a 70km long all-weather road. The investigation concluded that the provision of access between Aurukun and the Project area must be considered as part of a broader employment, training and economic development package.

RTA is committed to facilitate the provision of access and transport for Traditional Owners living in Aurukun and working in the mine. The measures that that RTA proposes to take in relation to training and employment opportunities for local Indigenous people are discussed in **Section 16.3.4**.

Weipa Airport

Potential Impacts and Suggested Mitigation Strategies

The Weipa airport was a key consideration of some stakeholder groups. According to consultation results from the WTA and the Western Cape Chamber of Commerce, improving the aesthetics of the airport is one of the key priorities for supporting tourism and local business activities. The view was also expressed by some members of these groups that the existing facility could not handle the increased traffic brought by Fly-In Fly-Out (FIFO) arrangements for the construction phase of the Project and an airport upgrade would be required to accommodate FIFO activity. This view includes the belief that lengthening the runway to accommodate larger aircraft would be required.

RTA Mitigation Strategies

The increase in air services during both construction and operational phases would be within the capacity of the existing airport infrastructure (refer **Section 14.3**). It is unlikely that, during the construction phase, more than one additional air service per day using existing aircraft types would be required, on average. RTA would arrange additional flights during construction as required, as per previous arrangements during the recent construction of facilities for existing operations (the NeWeipa Project).

The population projections for the various stages of the Project are described in **Section 16.2.1**. Significant population increases are not projected to occur until production increases to between 30Mdptpa and 50Mdptpa. Assuming flights increase with population, the number of flights to and from Weipa would increase by approximately three per week under the 50Mdptpa scenario and this would not require changes to airport infrastructure (refer **Section 14.3**).

Security

Potential Impacts and Suggested Mitigation Strategies

The consultation feedback suggested that the mine employee car park at the Hornibrook ferry terminal would need to be secured to prevent vandalism and theft. A number of stakeholders held the view that there is potential for an increase in the incidence of youth crime related to this terminal.

RTA Mitigation Strategies

RTA would provide secure parking facilities adjacent to the Hornibrook ferry terminal. This would include a fenced compound with appropriate security systems.

Emergency Services/Emergency Response

Potential Impacts and Suggested Mitigation Strategies

Issues related to emergency services, accident response and emergency transport were expressed as a key concern from a wide range of stakeholders. The QPS, WTA, and some government representatives (e.g. Queensland Health, Department of Communities) felt that a helipad should be built south of the Embley River to facilitate the transport of seriously injured personnel directly to Weipa. It was felt by Queensland Health and the Aurukun Health Clinic that this might provide a faster response than the Cairns-based RFDS. Queensland Health, the RFDS representative and the QPS said that RTA should consider designating part of the bitumen Mine Access Road as a landing strip for the RFDS (with appropriate permanent landing lights to accommodate night flights).

The QPS raised the point that the mine extension would inevitably bring an increase in sea traffic and, with this, an increase in the numbers of people who may require emergency assistance due to mechanical failure or weather conditions. A suggestion was made that RTA should consider the purchase of a volunteer marine rescue vessel or jointly purchase one with another organisation operating in the area and base it at the proposed port. This could provide a partnership activity with the Queensland Marine Rescue Association which would supply and train the rescue workers. At a minimum, stakeholders felt that a 24 hour occupational health and safety facility and personnel would be required at the Project site.

RTA Mitigation Strategies

RTA currently has a comprehensive emergency response system in place supported by qualified personnel. Existing emergency response plans would be extended to cover the Project area.

Designated first aid and emergency rescue facilities and equipment would be available on-site during the construction and operation phases. A paramedic and ambulance would be based at the Boyd infrastructure area (on shift). A nearby two kilometre section of the Mine Access Road would be designed to accommodate RFDS aircraft landings and take-offs and provision for temporary night-time lighting would be made. Helicopters would be able to land on this portion of road as well.

Details of the proposed emergency management plans for the Project are presented in **Section 19.3**.

16.3.2 Land and Sea Management

Access to areas on mining leases ML 7024 and ML 6024 with cultural heritage and recreational significance, the protection of coastal and riparian landscapes, and management of land and sea areas were raised by the majority of stakeholders and were considered a high priority. Stakeholders in the communities of Weipa, Napranum and Aurukun expressed views about the management of the coast and issues such as dredging, dredged spoil disposal, buffer zones and rehabilitation of the landscape after mining.

Land and Sea Access

Potential Impacts and Suggested Mitigation Strategies

Traditional Owners

The Wik and Wik Way Traditional Owners of the lands located south of the Embley River expressed strong concerns over the access and management of culturally important areas and landscapes and, in particular, the management of the significant coastal areas.

One of the most frequently raised issues was expressed as '*the abuse of the land*' to describe the damage to the coastline and to turtle nests through the use of quad bikes and vehicles operated by the general public on beaches. Traditional Owners stated that the tyres on the quad bikes dig up the beach and destroy the turtle nests and that people from Weipa and elsewhere use the area without permission from the Wik and Wik Way Traditional Owners. Examples of both Indigenous and non-Indigenous people accessing the area without permission were provided throughout the consultation period. Individuals described examples of incidents

where people gained unauthorised access to the area, consumed alcohol, left rubbish, caused damage to animals and plants and used firearms. The Traditional Owners expressed concern that people continue to use the area as their "own personal playground".

The Wik and Wik Way Traditional Owners also expressed the need for a robust permitting system. The current permit system operated by the Aurukun Shire Council is not thought by many Traditional Owner families to be effective and they propose that this system be reviewed, with the view to increase involvement of Traditional Owners with support from WCCT, RTA and other agencies. The Wik and Wik Way families consulted felt strongly that a permit system with varying degrees of access rights should be developed, put into place and most importantly, enforced. It was suggested that permit access categories could include (a) "Recreational permit" for areas used for camping, fishing and other recreational activities (including allowing construction workers to access certain areas during non-work periods (possibly accompanied by Traditional Owners, e.g. guided tours); and (b) "Professional/commercial permit" for business access for groups such as charter fishing guides. One of the significant benefits identified by establishing such a permit system well before the actual construction phase commences, is that potential impacts from construction workers and other people behaving inappropriately can be greatly reduced.

Tourism (Charter) Fishing Business Owners

The charter fishers felt strongly that mining south of the Embley River was going to have significant negative impact on their businesses. They indicated that at least 60% of their business was based on tourists who wished to walk on a pristine beach in an area "untouched" by industrialisation and that a new port would intrude on that experience. The charter fishing groups who felt that they would suffer the most impact from the Project include fly fishermen.

The use of quad bikes on beaches by pig shooters, pig hunters and other people from Weipa who drive quads "*up and down the beach for fun*" was said to disrupt low-impact tourism activities, as well as to cause extensive damage to beaches. The charter fishing operators stressed these activities don't affect fishing *per se*, but they do have a tremendous negative impact on the birds, the turtles, safety and visual amenity owing to the tyre tracks everywhere. Once they arrive at their destinations, the shooters and others often then turn inland and create more damage to sensitive areas. The charter operators expressed the view that extending the mine south of the Embley River would potentially bring more shooters, hunters, "*Weipa weekend warriors*" and others who drive up and down the beach and who would further damage the coastline. This concern also included construction workers who would want to access the beach on their time off shift.

In the view of this stakeholder group, these factors, combined with a port and associated operation located near the coastline, and the dredging and the dumping of spoil, are likely to have a negative impact on charter fishing businesses.

The charter operators felt that one way to lessen the impact would be through the implementation and enforcement of a permit system for tourists and the general public who access the area for recreational purposes. They also clearly supported the management of such a system by the Traditional Owners but considered that RTA should provide support for the establishment of an effective system and any other associated activities. It was felt that quad bikes should be banned from the beach, as should pig shooting and other forms of pig hunting inland from the coast. It was noted that the use of firearms on a mining lease is prohibited. The comment was also made that RTA should support this and other forms of coastal management as a positive outcome from the mine extension.

Recreational Access for Local Residents

A concern was expressed by the Weipa Sportfishing Club, representatives from the Weipa Campground, and many Weipa residents and tourists with an interest in fishing, that access to popular recreational fishing areas, particularly around Pera Head, Boyd Bay and Norman Creek may be severely restricted by mining activity south of the Embley River. This view was expressed particularly within the context of individuals stating that they like living in Weipa for the lifestyle the region affords them.

Recreational fishers wanted to know if recreational boats would be able to pass under the wharf instead of travelling out to sea during rough conditions when passing near the proposed port. This was viewed as both a safety concern as well as a recreational fishing concern.

A number of individual stakeholders consulted in Weipa, including various Weipa Chamber of Commerce members and other stakeholder interests, held the view that the unique outdoors lifestyle and recreational opportunities available in Weipa and the Western Cape, including the area south of the Embley River, attracts people to the region. People often remain in Weipa for employment but also because of the pristine fishing and camping locations. The view was expressed that it if there are too many restrictions on enjoying access to recreational opportunities, Weipa would fail to attract employees to the mine and elsewhere and current residents may consider leaving.

RTA Mitigation Strategies

RTA would continue to manage access for Traditional Owners to specific areas, including the three outstations in the Project area at Amban (False Pera Head), Waterfall (near Ina Creek) and Six Ti-Tree (just south of Waterfall). Amban, Waterfall and Six Ti-Tree are generally utilised in the dry season for varying periods. Access would be managed in accordance with RTA's obligations outlined within the WCCCA. This would be monitored on a regular basis in line with the mine plan development, safety requirements during construction and operational phases, and the needs of Traditional Owners of the Project area. RTA would work collaboratively with Traditional Owners and the relevant WCCCA sub-committee to develop a land access strategy aimed at causing as little disturbance as possible to Traditional Owner access. The strategy would aim to provide access for Traditional Owners both during active and non-active mining periods for areas including Hey Point, Boyd Bay, Pera Head, Amban/Norman Creek and Waterfall/Six Ti-Tree/Ina Creek.

RTA acknowledges that for many Traditional Owners the development of outstations is very important. RTA would continue to work collaboratively with the WCCCC and relevant sub-committees on future requests for outstation development in accordance with the WCCCA.

RTA would work with Traditional Owners and other relevant stakeholders to develop an effective permit system to protect significant cultural heritage sites and environmental values and allow controlled access for recreational purposes. The administration of such a system by Traditional Owners would be subject to discussions between Traditional Owners, RTA and other stakeholders.

RTA would designate a safe passage underneath the proposed jetty for small recreational and charter boat users to prevent the need to travel around the wharf and jetty (which would have a safety exclusion zone of 50m) and in accordance with any Maritime Safety Queensland requirements. Access to moorings at Boyd Bay would not be restricted. RTA would have limited need to use Boyd Bay during construction and operations. The proposed port would be visible from beaches between Pera Head and Boyd Point, but not from beaches further north or south.

The use of firearms on the mining leases would not be permitted.

Land and Coastal Management

Potential Impacts and Suggested Mitigation Strategies

Concerns regarding the management of land and the coast were raised primarily by Traditional Owners, WCCCC and the Shire Councils throughout the consultation process. Traditional Owners expressed a desire to play a more active role in the development and implementation of strategies to ensure protection of the coastline and effective management of the environment and cultural heritage on traditional lands affected by the Project. Traditional Owners indicated that they not only wanted to be consulted about management strategies, but also about the ongoing monitoring of impacts resulting from mining operations. This was an opportunity identified which would support employment and training for local Indigenous people in areas other than production and operator roles.

Traditional Owners frequently expressed concerns about the potential for weed species to spread from north of the Embley River into sensitive areas south of the Embley River by mine vehicles coming down from the north.

A range of coastal protection measures were suggested by Traditional Owners, Shire Councils and other community groups, such as Wik Projects, including removal of ghost nets and other marine debris, monitoring and protection of turtle nesting areas, monitoring and review of recreational fishing practices, and monitoring impacts of mining and the associated shipping. One of the key management aspects regarding coastal protection was identified as the difficulty in controlling access to the coastline. Traditional Owners identified that effective management of the coastline would involve opportunities for economic development and employment and training through the establishment of ranger programs, eco-tourism accommodation and camping grounds. A permit system that controlled visitors using the land and coastline for recreational purposes, including fishing, was suggested.

A common issue raised by a number of stakeholders, including fishing groups, Traditional Owners, WCCT, Councils and local residents was the concern about the number of feral pigs in the area. It was highlighted by Traditional Owners, in particular, that feral pigs were having a significant impact on turtle nesting and that a large number of the nests identified during surveys had been disturbed by pigs. Traditional Owners said a large number of people were gaining unauthorised access to the area for pig hunting and as a result there was considerable environmental damage due to the use of 4WD vehicles and quad bikes along beaches and through bush.

The identification of significant cultural heritage sites and the development of site protection plans for such areas were identified as one of the highest priorities for land and coastal management.

RTA Mitigation Strategies

RTA remains committed to the existing obligations under the WCCCA with regard to land and coastal management. In response to the issues raised by Traditional Owners, RTA recognises and supports the need for the joint development of a comprehensive Communities, Heritage and Environment Management Plan (CHEMP) for the area of the mining lease south of the Embley River. A CHEMP would provide the framework for RTA and Traditional Owners to work together to manage the community, heritage and environmental values of the area covered by the mining lease south of the Embley in the context of the WCCCA.

The CHEMP would aim to address, but not be limited to, the following:

- Traditional Owner consultation and engagement processes;
- land access strategies;
- weed management;
- environmental surveys and monitoring programs;
- environmental buffer establishment and management;
- fire management;
- feral animal management;
- port lighting;
- fish passage associated with Dam C;
- ballast water management;
- cultural heritage management plans for heritage site avoidance, heritage zone planning and site disturbance processes;
- site protection plans for Indigenous and non-Indigenous cultural heritage sites;
- signage; and

- broader land and coastal management programs.

The CHEMP would be developed in collaboration with Traditional Owners, with the WCCCA SoE Project Sub-Committee providing the primary consultation mechanism for this work. The final Plan would be endorsed by the WCCCC prior to implementation.

Details relating to cultural heritage management are included in **Section 11.1.**

As part of the CHEMP, RTA is committed to working collaboratively with Traditional Owners to jointly develop land and sea management plans for the Project. RTA is committed to working with Traditional Owners, WCCT and other key stakeholders to establish a program to support caring for land and sea, including assistance with the development and implementation of a ranger program and a permit system for the Project area.

Rehabilitation

Potential Impacts and Suggested Mitigation Strategies

Throughout the consultation process one of the most frequently raised concerns by both Traditional Owners and members of the general public was the post-mining rehabilitation process. The people who raised this concern saw the Project as an opportunity to learn from past practices north of the Embley River and implement best practice rehabilitation techniques.

RTA Mitigation Strategies

RTA and the WCCCC would adopt a collaborative approach in dealing with the environmental management of mining activities. Mine rehabilitation would be undertaken progressively during the life of the mine. Mined areas are likely to be rehabilitated to native woodland. However, the final land use options and standards would be developed and discussed with the Traditional Owners, as required under the WCCCA, and with relevant Government stakeholders. RTA, in consultation with Traditional Owners, would develop land use strategies for land relinquishment and economic development opportunities. RTA would continue to report annually to the WCCCC on rehabilitation programs, including an inventory of areas disturbed by mining, timeframes for rehabilitation and supporting reports pertaining to the monitoring of rehabilitated areas. RTA would continue to involve Traditional Owners in rehabilitation programs where practicable. The approach to mine rehabilitation is described in **Section 3.10**.

Buffer Zones

Potential Impacts and Suggested Mitigation Strategies

Traditional Owners have identified that the insects that pollinate the wetlands and coastal vine thickets live in the woodlands. If there is not a sufficient buffer around these woodland areas, it is believed that these insects would potentially disappear with clearing and mining. This may then lead to the decline or actual disappearance of these other vegetation types that contain important story places. The Wik and Wik Way Traditional Owners have requested large buffer zones at a number of locations such as Waterfall (Ina Creek), False Pera Head (Amban), Pera Head and Boyd Bay. Traditional Owners felt strongly that buffer zones also needed to include woodlands for biological reasons. The Traditional Owners acknowledged that the size of buffers for biological purposes requires more research and greater knowledge of the proposed mining plans.

The coastal vegetation types and, in particular, creeks, rivers and wetland areas are of significant cultural importance to Traditional Owners and should be protected. These areas are also considered to have economic development potential that could provide a valuable business opportunity for Traditional Owners.

In addition to these coastal locations, a number of stakeholders have raised the importance of also ensuring that a buffer zone is maintained around the 1993 plane crash site, where three Traditional Owners and a pilot tragically lost their lives.

RTA Mitigation Strategies

In collaboration with Traditional Owners, RTA would develop a Communities, Heritage and Environment Management Plan (CHEMP) that would provide details of buffer zones and land management strategies for the areas identified above. The cultural value of certain flora and fauna to Traditional Owners is discussed in **Section 11.1.4**. Building on the ethnobotanical work that has recently been completed north of the Embley River, RTA would work collaboratively with the relevant WCCCC sub-committee and Traditional Owners to develop a strategy that captures the cultural values of plants of significance. This work would be reflected in the Project CHEMP.

Surveys would be undertaken ahead of mine development with involvement of Traditional Owners to identify and clarify the significance of specific areas and to use this information to prioritise high risk sites. RTA, in consultation with Traditional Owners, would designate and enforce agreed buffers around these sites. The 1993 plane crash site would be included.

The disturbance of sensitive environmental areas by mining would be avoided by the development of an environmental buffer system. The system would comprise a methodology for determining set-back distances from sensitive vegetation types and the preclusion of mining from within the designated buffers. The sensitive vegetation to be buffered by Darwin Stringybark woodland would comprise the following vegetation types; riparian, wetland, estuarine, vine forest and coastal vegetation on sand. The environmental buffer system is described in **Section 7.9.2**.

Dredging, Spoil Disposal and Shipping

Potential Impacts and Suggested Mitigation Strategies

Dredging and the off-shore dumping of dredged spoil was an important issue for a number of stakeholders, including Traditional Owners and all commercial, tourism and recreational fishing groups. The concerns related to dredging at the Hey River barge/ferry terminal and at the proposed port. Members of the Weipa Sportsfishing Club requested that any dredging that may be required for the barge/ferry terminals should ensure that the spoil is removed and dumped outside of the estuary.

The location of the spoil grounds in relation to adjacent reefs was identified as possibly the most significant potential impact by the members of the Weipa Sportsfishing Club. This issue was also raised by the charter fishermen and Traditional Owners, as well as Weipa residents via the Western Cape Chamber of Commerce. It was suggested by the Weipa Sportsfishing Club that many people attribute the dirty water observed around Duyfken Point in windy conditions (and therefore the impact on fishing) to the dredging and dumping of spoil associated with the current Port of Weipa shipping channel. Members asked what options had been explored for the proposed spoil ground, including whether there was an option to pump the spoil onto the land. They asked whether consideration had been given by RTA to changes in tidal flow at different times of the year and the size of the area that would potentially be affected.

During the consultation process a number of key locations of interest were identified by local recreational fishermen. These included the shoals off Boyd Point (Three Mile), and the areas of reef located north of Boyd Point and around Pera Head. The group requested that RTA map popular recreational fishing areas (derived from GPS points provided by the group) and compare these areas to proposed shipping routes, anchorage areas and spoil grounds. The suggestion was made by sportsfishing and commercial fishing interests that an artificial reef should be considered to mitigate any potential impacts from the dumping of spoil, particularly in sensitive fishing spots such as the 'Nine Mile' area.

The group recognised that RTA would need to identify suitable routes for the safest berthing options and that these may affect some of these fishing areas.

In follow-up consultations with the Weipa Sportsfishing Club, the details of the proposed new spoil ground west of Boyd Point were provided on maps which also showed a range of previously identified popular recreational fishing locations. The proposed spoil ground is located

approximately 7km north-east of the reefs located at 'Nine Mile'. The members of the Club did not provide any negative feedback regarding the proposed spoil ground location.

Professional mackerel fishers had specific concerns around whether they would still be able to troll the area close to the coast between Pera Head and Boyd Bay.

The discharge of ballast water by bulk carriers was raised as a concern in consultations with various health representatives in Weipa. There was a view that studies need to be considered to examine the potential health impacts of ballast discharge into Gulf waters near the proposed port. There were also concerns raised about potential flora and fauna pest species coming into the area from foreign vessels. There were no specific species mentioned and it was stated that these types of studies needed to be undertaken by RTA to protect both the environment and residents of the area.

A Raptis & Sons, representing Northern Prawn Fishery Industries Pty Ltd, advised that Weipa is one of their main prawn catching areas and that they had concerns relating to the proposed berth and loading facilities near Boyd Point, including:

- dredging and the proposed spoil disposal area and the potential for major, irreversible damage to sea grass;
- potential damage to prawn nursery areas;
- potential loss of fishing ground resulting from the proposed shipping anchorage off Boyd Point
- potential damage to ships while tied up to loading facilities due to the openness of the loading area to the weather resulting in potential for fuel and ore spillage;
- the potential loss of a safe anchorage for the prawn fleet in south-east winds;
- increased risk of marine accidents due to ferries;
- damage to mangroves in construction phase;
- reduced flow from Norman Creek;
- areal extent of the proposed spoil ground;
- which code would be used for ballast water management;
- concern about fuel storage areas; and
- the wharf structure and its ability to withstand severe weather.

The Gulf of Carpentaria Commercial Fishermen Association indicated the whole Boyd Bay - Albatross Bay area was used intensively for three to five months a year by about 20 to 30 boats. The following issues were raised:

- potential discharge of contaminants and water;
- the effect of the Project on their traditional anchorage in Boyd Bay; and;
- the proposed wharf would go through the inner reef and the Spanish mackerel area.

In summary, dredging and spoil disposal were issues common to most of the stakeholder groups and these groups sought information regarding proposed exclusion zones, shipping routes, anchorage areas and proposed spoil grounds to assess the likely impact on their activities.

RTA Mitigation Strategies

Dredged spoil from the proposed port would be disposed of at a new spoil ground located approximately 17km west of Boyd Point. This location avoids reefs of significance to charter and recreational fishers and is remote from the nearest sensitive coastal habitats at Pera Head, Boyd Point and Boyd Bay. The proposed new off-shore dredged spoil disposal area would have a potential area of deposition of less than 1km radius from the centre of disposal.

The Albatross Bay spoil ground is currently used by NQBP. To avoid creating a separate spoil ground, the dredged material from barge/ferry terminals would be disposed of at the existing Albatross Bay spoil ground.

Turbidity plume modelling of port dredging and spoil disposal is described in **Section 6.9.2** and impacts and management measures in relation to marine water quality and marine habitat are described in **Section 6.9.2** and **Section 6.9.3**, respectively. Modelling included variations in tidal flow. Overall dredging activities are anticipated to have a low risk of adverse impact on fisheries.

Land disposal of dredged material was evaluated and was not considered feasible. Land disposal would require construction of a containment structure similar to a tailings storage facility in order to settle solids and decant seawater. The rehabilitation of saline marine sediments deposited on land is also difficult.

The protected anchorage at Boyd Bay would remain accessible to fishing vessels as the proposed bulk carrier mooring area is in much deeper water (refer **Figure 14.3**).

Ballast water would be managed in accordance with the Commonwealth Department of Agriculture, Fisheries and Forestry's *Australian Ballast Water Management Requirements*. These require vessels from non-Australian ports to exchange ballast water outside Australia's territorial waters (refer **Section 13.3.8**). Monitoring for marine pests would be undertaken at the proposed port (refer **Section 6.9.4.6**).

Despite the construction of the water supply dam (Dam C), the proportion of runoff water entering the Norman River estuary is estimated to be 84.9% (at 50Mdptpa) of the water entering without the dam. Environmental releases would occur from the dam (refer **Section 5.2.3**). It is not expected that there would be a significant impact on the downstream estuarine environment. More detail on the impact of the dam is presented in **Section 5** Water Resources and **Section 8** Aquatic Ecology.

There are no reefs or seagrass located in the proposed port dredging footprint. There is no seagrass present within the barge/ferry terminal dredging footprints. Prawn nurseries are generally associated with mangroves and seagrass, and these habitats are absent from the vicinity of proposed port. Mangroves are absent from the port area. A small area of mangroves would require removal to construct the Hey River barge/ferry terminal.

The proposed port and barge/ferry terminal structures have been designed in consideration of storm surge to a minimum of 1:100 ARI design level. The ship loader and conveyor have been designed to minimise the potential for ore spillage (refer **Section 14.4.7**). Fuel would not be stored at the proposed port.

Ferries would only operate on the Embley and Hey Rivers from Hornibrook ferry terminal to the Hey River barge/ferry terminal. The increase in vessel movement is anticipated to be a low risk in terms of marine accidents (refer **Section 14.4.6**).

16.3.3 Community Consultation and Engagement

Potential Impacts and Suggested Mitigation Strategies

A comprehensive stakeholder engagement program was undertaken during the preparation of the Project EIS (refer **Section 15**). However, almost all groups requested additional information and/or follow-up meetings and indicted the need for ongoing consultation by the Project team during studies and the construction phase.

RTA Mitigation Strategies

The EIS consultation and engagement program would continue throughout the EIS process as described in **Section 15.4**.

A comprehensive stakeholder engagement plan for ongoing consultation and engagement would be developed prior to the commencement of construction. This would ensure continuity of engagement with key stakeholders, including Traditional Owners and Western Cape communities, and provide mechanisms to seek further information, to provide feedback and to

raise concerns related to the Project. Regular employee communications covering updates on the Project would be continued. To improve the effectiveness of RTA's engagement with local communities, a Community Forum would be established in Weipa to facilitate two-way communication with the broader Weipa community. RTA would also work collaboratively with Aurukun Shire Council to establish a permanent office in Aurukun to coordinate RTA activities.

The WCCCC SoE Sub-Committee would continue to provide the primary consultative mechanism between RTA and Traditional Owners throughout the EIS process. At the conclusion of this period the WCCCC would decide whether there is a need to continue this forum, in addition to the existing Sub-Committees that operate for the current Weipa operations. Progress reports and forward looking plans on all activities associated with the Project, including heritage surveys and development of management plans, Traditional Owner consultation and engagement activities, drilling programs and ongoing environmental work, would be submitted for consideration at least quarterly to this Sub-Committee. Formal recommendations would be forwarded to the WCCCC for endorsement prior to implementation.

RTA would support Traditional Owner initiatives which provide greater recognition of traditional connections to the land south of the Embley River and would work collaboratively with the WCCT and Traditional Owners to develop and implement these initiatives. Examples of such initiatives from existing operations include the use of traditional names for key locations and mine blocks and the delivery of cultural awareness training for all employees and contractors working on the mining lease.

The existing RTA complaints procedure would be adopted for the Project, and includes:

- maintenance of a register of complaints held on-site;
- a process for receiving, handling and investigating complaints;
- providing expeditious investigation and a response as soon as practicable, and
- giving a non-compliance notification to any party whose actions have caused a complaint as a result of non-compliance with environmental requirements.

16.3.4 Employment, Training and Education

At the time of the 2006 Census, RTA employed 28.6% of Weipa's population. The local skills base in Weipa is characterised by a high number of technicians and trade workers and machinery operators (42% of resident workforce), as well as professionals (13.5%). This reflects the skills mix sought by RTA for its current mining operations. The make-up of the Project operational workforce would not differ significantly from that of the current operations. As the Project comes on line, RTA would continue to draw its operational workforce from local sources and from outside the region. The overall size of the operational workforce of employees and contractors would not increase above 2007-2008 levels until the Project reaches a production rate between 30Mdptpa and 50Mdptpa (refer **Section 16.2.1**).

Potential Impacts and Suggested Mitigation Strategies

Throughout the consultation process, employment and training was raised by almost all stakeholder groups as an opportunity for the people of the region arising from the Project.

Employment was a key consideration for Traditional Owners in particular, and this was demonstrated clearly through the consultation feedback. Traditional Owners indicated that they would like to see opportunities exist for local Aboriginal people to be employed during both construction and operational phases of the Project. This included the opportunity for Traditional Owners to be able to live in Aurukun and be employed in the Project. Representatives of Indigenous-owned and operated businesses throughout the region indicated that they would like to be given the opportunity to bid on tenders as they arise and, if equally able to deliver the work, that consideration be given to providing the tender to a local business owned and operated by local Aboriginal people.

Consultation feedback has demonstrated strong support for the RTA Destinations (work readiness) Program framework as a supportive pathway to employment (refer to **Section**

16.2.5 for details of the framework). Government agency representatives, the QPS, Traditional Owners and those Weipa residents familiar with the program expressed the view that they could see the potential for positive outcomes for Aurukun participants through the adoption of a staged approach to employment, however this work is ongoing and a collaborative approach is required to address the social issues that currently impact on the successful progression of participants through the program. It was requested that the program continue to be supported by RTA. It was also suggested that RTA consider reviewing the program at the conclusion of the pilot program to identify improvements to the model to ensure greater success with the transition from Aurukun to full time employment at the RTA operations. This would include support with the implementation of effective case management of individuals and employment pathways for participants into a variety of work areas by RTA and, potentially, other local businesses.

Numerous local Weipa businesses and the Western Cape College also supported RTA's consideration of exploring training models that support greater opportunities for "on the job" training. This would include opportunities on machinery and a broader range of employment areas, including opportunities for Traditional Owners to work on country in areas such as heritage management and environmental monitoring programs. A range of stakeholders also suggested and have indicated strong support for the development of a mining skills training centre incorporated into the construction camp.

It is common occurrence for the employees of local contractors to leave the employment of the contractor and join RTA (and would likely continue to do so), therefore it was requested that RTA works closely with local businesses and organisations such as the Weipa Chamber of Commerce to support the development of an economic development and employment strategy which benefits all local employers. This should cover diversification of employment opportunity, training, attraction and retention of skilled staff from outside the region to serve RTA and other local businesses and service providers. It was recognised that RTA maintains a close working relationship with local education and training providers including Western Cape College and TAFE and this will continue into the future.

Various State and Commonwealth Government agencies noted there were many stakeholders implementing employment and training programs in isolation, resulting in significant duplication. It was suggested that through collaboration, RTA, government agencies and other key stakeholders should continue working towards greater alignment of program objectives to maximise opportunities to enhance development of locally-based skilled workforce and employment pathways and to minimise duplication.

RTA Mitigation Strategies

RTA is committed to providing a work environment which is conducive to the recruitment and retention of local Aboriginal employees, in accordance with its obligations in the WCCCA.

The occupational groupings of the Project workforce would be unchanged from the current workforce and include engineers and other professionals, technicians, tradespeople, plant operators and semi-skilled and unskilled labour. RTA would continue to work with the local communities to invest in employment and training to create a locally-based labour pool with the appropriate skill sets and knowledge to meet the particular employment needs of the Project.

In collaboration with the WCCCC, and the members of its Employment and Training (E&T) Sub-Committee, RTA works to develop and implement a range of employment and training programs aimed at local Indigenous employment, leadership development, increased representation of female local employees and training programs that provide work exposure and increase levels of job readiness. These include the Local Aboriginal Traineeship Program, scholarships, employee support and mentoring programs, work readiness initiatives, and school-to-work pathways. RTA provides a quarterly employment and training report to the WCCCC regarding progress on these initiatives and an annual report of the key outcomes of these activities.

Fostering a collaborative approach with the aim of creating employment opportunities has been an effective strategy for creating a locally-based skilled Indigenous workforce. To successfully

address the social and educational barriers to entering the mainstream workforce, RTA would require a partnership approach with government agencies and other key regional stakeholders. At RTA's Weipa operations, this partnership approach is demonstrated through RTA's participation and engagement with the Western Cape College Forum, Regional Partnership Heads of Agreement (RPA), Western Cape Chamber of Commerce, WCCCC and Ely Coordinating Committee.

In addition to supporting a partnership approach, RTA is currently undertaking the following measures to draw an employee base from local communities throughout the region.

- Initiatives targeting pre-work development, employment and training for local Indigenous people. As part of the Project RTA would:
    - continue to actively participate as a member of the RPA Steering Committee, WCCCC and Ely Coordinating Committee to develop and implement pre-employment and job-readiness programs to support local Indigenous employment across the Western Cape region;
    - develop and implement culturally appropriate recruitment practices for positions at all levels and across various disciplines within the operations;
    - develop and implement programs and services to support the retention of Indigenous employees, including mentoring, employee and family support strategies that aim to address the root causes of socio-economic disadvantage;
    - develop and implement long-term career planning strategies, including professional development and leadership programs for local Indigenous employees;
    - in collaboration with Traditional Owners, continue to deliver cross-cultural awareness programs for all employees and contractors, including curriculum with specific reference to Wik and Wik Way traditional culture and values;
    - proactively consider tenders for Project contracts which involve local Indigenous people and/or local Indigenous enterprises. This may include joint ventures, direct employment, training opportunities, equipment usage or cooperative arrangements with local Indigenous people and enterprises; and
    - provide a supportive career development pathway for local Indigenous people and youth, including traineeships and apprenticeships across a range of disciplines during the construction and operational phases of the Project.
- Continue to work in partnership with the Western Cape College to provide supportive school-to-work pathways and effective case management for students looking to pursue careers at all levels in the mining industry. Where possible, RTA would also support initiatives to enhance educational outcomes for Western Cape College students. This includes the delivery of work experience programs, school-based traineeships, curriculum support, support for academic awards, career talks, university scholarships and development of curricula relevant to the mining industry;
- continue to conduct ongoing recruitment campaigns for mainstream employment as required in line with current production levels for the operation;
- continue to support the implementation of the Rio Tinto Graduate Program with the aim of developing future leaders in both management and technical streams by providing experience at RTA operations in addition to structured learning and development received during university studies; and
- Address any potential skills shortages and labour impacts in the region by working collaboratively with various State and Commonwealth Government agencies, regional stakeholders (including TAFE and other training and education providers) and job network providers to build a locally-based skilled labour pool for construction and operational phases of the Project. This work may include consideration of the extent

and composition of labour force requirements and any demand-supply concerns. The Project would incorporate various vocational and education training programs, including pre-vocational training, traineeships and apprenticeships, on-the-job training, retraining and multi-skilling. These activities would be coordinated through RTA's Weipa Indigenous Training and Development team, which is located in the Operational Training Centre on-site in Weipa.

RTA is committed to facilitate the provision of access and transport for Traditional Owners living in Aurukun and working in the mine. RTA would work with the WCCCC E&T Sub-Committee to identify opportunities for training and employment for residents of Aurukun and ways to provide appropriate access to the mine site and where appropriate engage with other local stakeholders regarding impacts and opportunities associated with improved access to the Project area.

RTA has a specific employment program in place to increase participation in the workforce by Aurukun people (Destinations Program) and would continue to work on how to improve the outcomes.

16.3.5 Community Cohesion

Potential Impacts and Suggested Mitigation Strategies

Law and Order, Alcohol and Substance Abuse

Law and order and alcohol and substance abuse were key issues raised during consultation meetings with a range of stakeholders. These issues have the potential to cause deterioration in community cohesion and are inter-related with other issues raised such as domestic violence, child safety, health and safety and youth crime.

There is a strong perception, particularly among Napranum residents, that increased Project activity (particularly during the construction phase) may lead to increased illegal alcohol transportation from Weipa to Hey River and then to Aurukun, and via a number of other transport pathways. There is also a concern that 'drinking camps', which are usually located in the bush a short way from roads, may increase following construction of the Mine Access Road, particularly if the road was to be accessible to the public. It was requested by many stakeholders that the Mine Access Road not be opened to the general public. These stakeholders included the Napranum Aboriginal Shire Council and administrative staff, Napranum residents, Traditional Owners, the WTA, members of the Aurukun and Napranum Justice Groups, representatives of the Queensland and Commonwealth governments and the QPS.

Aurukun and Napranum Justice Group members, the Department of Communities, Queensland Health, the Government Coordination Office, the Indigenous Coordination Centre, community residents, and other stakeholders stated that the increase in employment of people in the construction phase could lead to an increase in discretionary funds, which may go directly to the purchase of alcohol and drugs. Concerns were further expressed that this may, in turn, lead to increases in domestic violence, child safety breaches and alcohol-related accidents. A number of people consulted in Aurukun expressed concerns over the adequacy of current police numbers to deal with any potential increase in incidents. Wik Projects Limited, an Aurukun Traditional Owner business enterprise, noted that "alcohol consumption is a central and explicit part of every day life in Aurukun. The negative consequences of alcohol consumption are also part of everyday life. These consequences include violence, mental illness including suicide, neglect and role atrophy – especially neglect of parental and other familial roles and responsibilities" (Martin 2008). There is the belief in Aurukun that a large quantity of alcohol is transported into Aurukun from sea and via various tracks located throughout the Project area.

A number of stakeholder groups expressed the view that Weipa may experience a breakdown in community cohesion, with a spill-over into Napranum, during the construction period. This would then mean that theft and youth crime may escalate in Weipa and the general quality of life in the community has the potential to drop significantly.

Police Capacity

In all of the communities, the view was held that current police numbers are inadequate, they simply cannot do their jobs properly and the Project may exacerbate this situation due to the remoteness of the site.

Currently there is significant sea travel between communities and the consultation feedback suggested that this type of travel may increase if increased employment resulted in people having more money. The QPS raised concerns that people may continue to overload "tinnies" and head out to sea, which is a very unsafe practice which should be stopped. The view was expressed by the QPS, government agency representatives in Aurukun, members of the Justice Group, members of the WTA and the Napranum Aboriginal Shire Council that the proposed wharf may increase the safety risk if boats had to travel out to sea to avoid the port exclusion area. An increase in QPS Water Police was suggested as a mitigation measure. It was strongly expressed by a number of stakeholders that the current Water Police complement is not adequate to deal with the potential issues.

Those consulted acknowledged that the supply of alcohol in Weipa is not something that RTA can control directly. However it was highlighted that many stakeholders felt that RTA could positively influence the behaviour of employees and contractors through communication of expectations both at work and after hours, and in particular, whilst on the mining lease. The view that workers are responsible for their own behaviour and cannot come under the control of the mining company when they are not at work was not supported. As a potential mitigation measure, many felt that RTA should develop a Code of Conduct specific to off-work behaviour targeting alcohol abuse and unauthorised activities on the mining lease. It is also expected that RTA would take a proactive role in lobbying government to support an increased police presence, including a 24 hour police station in Weipa (as opposed to the current 12 hour station with call outs from Cairns), and a full complement of officers. This, and the development and enforcement of a strong Code of Conduct, are viewed by many stakeholders as the most effective mitigation against a potential increase in law and order incidents that could result from the Project.

Child Safety

Strongly held views were expressed through the consultation process about child safety, domestic violence, health and safety and youth crime. These issues were raised by many, including Traditional Owners, Napranum and Justice Group members, members of the Welfare Reform Commission, representatives of various Commonwealth and Government agencies, the QPS and community service providers dealing with child safety and domestic violence in Aurukun. They were also raised consistently within the context of law and order, as well as alcohol and substance abuse.

This issue was generally raised as an ongoing community concern, rather than a direct impact of the Project. However, the question was also asked during consultation meetings as to whether RTA would permit the building of more outstations on the mining lease to accommodate Project workers and their families who may wish to live on country, particularly those who lived in overcrowded conditions in Aurukun. The view was expressed by representatives of Government agencies that this idea should not be promoted due to concerns that children would potentially be restricted in terms of access to education, health and wellbeing services if families raised them on outstations. The Queensland government policy position is such that it does not fund or support the creation of outstations. It was suggested as part of the same discussion that RTA should consider building houses in Aurukun as part of the Project to alleviate overcrowding and provide a safer environment for children.

Stakeholders for the most part held the view that the delivery of programs and services in child safety and domestic violence is beyond both the scope and ability of RTA to do so, as is the direct mitigation of any negative impacts. What was made clear, however, was that stakeholders feel that it is the responsibility of RTA as a corporate citizen to work with the community to lobby government and other relevant bodies for improved program and service delivery not only in Weipa, but throughout the region as this service delivery also affects RTA employees, their families, and other residents.

Keeping people employed was put forward frequently by stakeholders, particularly Justice Group members, as a strategy to reduce child safety incidents, domestic violence, excessive consumption of alcohol and youth crime. It was felt that further development and implementation of pre-work (work readiness) employment programs, in conjunction with government and other key stakeholders, and provision of employment opportunities for young people would help to reduce the potential for negative impacts. It was suggested that RTA should continue to work closely with external stakeholders, including government agencies, educational institutions, job network providers, Western Cape Chamber of Commerce and the Regional Partnership Agreement Steering Committee to further these strategies.

RTA Mitigation Strategies

A range of control measures to restrict unauthorised access to the mining lease would be implemented (refer **Section 16.3.1**). This excludes arrangements established to allow Traditional Owner access to areas on country for traditional activities, hunting, fishing and camping. RTA would implement strict policies for employees and contractors in relation to fitness for work, including alcohol and other drugs, with strict pre employment medical programs and an ongoing random drug and alcohol testing regime. RTA would also continue to support the implementation of alcohol management plans for each community, with inclusion of this information in employee and contractor induction programs.

RTA would continue to liaise with QPS and other Government agencies to develop strategies to ensure an effective response to incidents and to raise awareness of regional law and order and alcohol management initiatives. RTA would reinforce the required code of conduct for employees and contactors on the mining leases and emphasise need for appropriate behaviour at all times.

Inductions would be adapted to raise awareness of regional alcohol management initiatives and land access requirements. RTA would continue to work collaboratively with the WCCCC and relevant sub-committees on future requests for outstation development in accordance with the WCCCA (refer **Section 16.3.2**). Improvement in socio-economic conditions as a result of employment, education and training programs would also be expected to assist with community cohesion (refer **Section 16.3.4**).

16.3.6 Dams

Potential Impacts and Suggested Mitigation Strategies

The construction of water storage dams was a key issue raised by a range of stakeholders. The view of the Traditional Owners was that all options for obtaining sufficient water for the Project needed to be exhausted by RTA prior to constructing dams. This view was also supported by a number of other stakeholders. There was concern expressed by both Indigenous and non-Indigenous stakeholders that the construction of dams would potentially have a negative impact on the aspirations of Traditional Owners to manage their own land and, in particular, protect the sensitive areas in and around Norman Creek and the Ward River, including story places and areas of cultural heritage significance where there is currently limited understanding.

Traditional Owners suggested a number of alternatives for consideration, including the option to draw an increased amount of artesian water to reduce the need for dams or the piping of water from the northern areas of the lease which had more water. It was also felt that the cumulative impacts of dams built as part of the Aurukun Project and the Project should be considered. Traditional Owners have requested consideration of shared water infrastructure as a strategy to potentially minimise environmental impacts on the Ward River. It was feared by some stakeholders that the dams would provide the perfect habitat for water borne diseases and a breeding ground for insects that carry disease, mosquitoes in particular. There was also concern that run-off from the dams may be contaminated and would adversely affect the land, the animals and communities.

It is believed that to build the dams in the first place, significant impact on the environment would need to occur, including clearing and damage to habitats. Traditional Owners and fishing groups were concerned that the construction of dams would have a negative impact on the

population of a range of fish species. Both groups also made reference to the number of plant species, such as orchids, that can be found in areas along these waterways and expressed concerns that they would be destroyed.

One of the primary considerations is the potential destruction of the cultural values that exist in downstream reaches of the Norman Creek that could be brought about by constructing dams in the areas proposed. All stakeholders who raised the issue of dams supported the view that this area was of high importance to the Traditional Owners and these values needed to be protected. It was also clear that many non-Indigenous stakeholders also valued the area as a popular fishing location were concerned about potential adverse impacts on the swamps and wetlands of the lower Norman Creek and the lower Ward River.

Consultations were held with Wik and Wik Way Traditional Owners specifically about dams in July 2009 and March 2010. The Wik and Wik Way Traditional Owners stated clearly that all options should be explored by RTA prior to constructing dams in sensitive areas. The concerns raised and alternative approaches suggested by the Traditional Owners are presented in **Table 16-20**, along with the proposed mitigation measures. Following consideration of cost, sustainability, reliability, local community concerns, and the environment, RTA did not pursue the option of a water storage dam on the Ward River. Some direct pumping from the river is proposed to supplement Dam C supply.

The Traditional Owners indicated that, if dams were required for the Project, then opportunities arising from the dams should be explored. These include opportunities during construction, operations and the sustainable use of the dams after mine closure. The opportunities raised by Traditional Owners are presented in **Table 16-21**, along RTA's response.

Table 16-20 Concerns raised by Traditional Owners about dams

Concern	Mitigation/RTA Response
Alternative to dams: • Piping of water from shallow aquifers in existing northern mining areas; • Desalination to be reconsidered prior to future construction of Ward River dam as technology may have changed significantly; and • Sharing of resources between RTA and Chalco to minimise impacts e.g. one dam on the Ward River instead of two.	Both pumping water across the Embley River from existing operations to the Project area and desalination plants have been examined and neither are financially feasible options. Where possible and subject to commercial agreement, RTA would seek to minimise environmental and property impacts in the event that the Aurukun lease is developed (refer **Section 2**). Discussions have been held in relation to the proposed port and overland conveyor alignment; however, the need for a secure water supply works against two different operations using a single source of supply.
Use of alternative power supplies e.g. solar at the dam sites to run pumps.	Continuous day and night pumping from dams would usually be required and solar powered systems are not feasible at the scale required.
The large amount of land that would be flooded by the dams. A suggested alternative was for deeper dams which cover less surface area.	Following consideration of cost, sustainability, reliability, local community concerns, and the environment, RTA did not pursue the option of a water storage dam on the Ward River. Some direct pumping from the river is proposed to supplement Dam C supply. The use of recycled water from tailings and artesian water has been maximised in order to minimise the amount of surface water to be taken (and hence reduce dam footprint).
It is not yet known if areas proposed for the dams include significant sites, artefacts and story places.	Cultural heritage surveys of Dam C are complete (refer **Section 11.1.3** for findings). Mitigation measures will be developed through consultation with Traditional Owners (refer **Section 11.1.6**).
Traditional Owners want to be able to continue to access the area for hunting without having to ask permission. Control of unauthorised access to the dam locations.	RTA would continue to manage access for Traditional Owners to specific areas in accordance with its obligations outlined within the WCCCA. This would be monitored on a regular basis in line with the mine plan, safety requirements during construction and operational phases and the needs of Traditional Owners. In collaboration with Traditional Owners, RTA would develop a land access strategy to provide access for Traditional Owners both during active and non-active mining periods for areas if interest. RTA would work with Traditional Owners and other relevant stakeholders to develop an effective permit system controlling access to non-active parts of the mining lease in order to protect significant cultural heritage sites and environmental values.
Crocodiles are known to nest in the area	Environmental surveys confirmed crocodile nests within the proposed Dam C footprint.

Concern	Mitigation/RTA Response
proposed for the Norman Creek dam. These are very important animals to some people (totems) and these sites should not be disturbed where possible.	However, given the available breeding habitat in the Project area, it is not anticipated that overall crocodile breeding effort within the Project area would be significantly affected (refer **Section 7.19.1**). Cultural heritage surveys of Dam C have been undertaken in accordance with the protocols set out in the WCCCA. The totemic significance crocodiles to some people is recognised and discussed in **Section 11.1.4**.
Effectiveness of fish ladders to allow fish species to continue travelling upstream and downstream.	RTA proposes to design the dam spillways to allow fish passage in times of overflow. The designs would be developed in consultation with the DEEDI (Fisheries Queensland).
Impacts on downstream breeding places for dugong and turtle could be disturbed by the changes in water flows caused by dams. Fishing and hunting in the downstream river areas and along the coast could be affected by dams.	At maximum mine production, the proportion of water entering the Norman River estuary is estimated to be 84.9% of the water entering without the dam. Environmental releases would occur from the dam to ensure the timing of flow downstream matches natural timing. It is not expected that there would be a significant impact on the downstream environment with respect to breeding of dugong and turtle and on fishing and hunting. More detail on the impact of Dam C is presented in **Section 5** Water Resources and **Section 8** Aquatic Ecology.
Cumulative impacts of all dams proposed by both RTA and the Aurukun Bauxite Project.	It is understood that the Aurukun Bauxite Project proposes one dam on a tributary of the Ward River (Tappelbang Creek). RTA acknowledges concerns about the impact of a water storage dam for the SoE Project on the Ward River catchment. Following consideration of cost, sustainability, reliability, local community concerns, and the environment, RTA did not pursue the option of a water storage dam on the Ward River. Some direct pumping from the river is proposed to supplement Dam C supply but this would only reduce mean annual flow to the Ward River estuary by 0.4%. The cumulative impacts are not expected to be significant (refer **Section 5** Water Resources).
Management of exotic weeds and feral animals to ensure these are prevented from entering the area and becoming a problem.	A weed management program would be implemented commencing at the construction phase, and would include a requirement for vehicle washdown prior to entry to the Project area (refer **Section 7.10.2 Weed Management**). A feral pig management program would be developed and would concentrate of controlling numbers in sensitive environments Project area (refer **Section 7.10.2 Feral Animal Management**).
Ability to detect the presence of any dangerous metals and prevent from entering downstream waterways.	Bauxite is highly leached and does not contain elevated levels of heavy metals. Concentrations of metals, including aluminium, would be monitored in dams and in downstream waterways. More detail on water quality presented in **Section 5** Water Resources and **Section 8** Aquatic Ecology.
Length of time to rehabilitate dam footprints, if dams are removed, after mining.	The techniques for rehabilitation of mined out pits are well established. The rehabilitation of previously flooded areas within the dams would be expected to take longer as some different species and different techniques are likely to be required in certain circumstances.

Table 16-21 Opportunities raised by Traditional Owners about dams

Opportunity	RTA Response
Use the dams after the mine closes for: • irrigation for horticulture, vegetables or plantations; • barramundi farming; (It was noted that much more consultation would be required before the types of activities could be determined)	Ongoing consultation with Traditional Owners would be undertaken to investigate potential post-mining land uses associated with Dam C.
Investigate opportunity to access the power supply to dams for places such as Amban and Waterfall.	Amban and Waterfall are located more than 10km from the nearest high voltage power line to the dams. Should others require electricity be supplied to Amban or Waterfall, an independent stand-alone electricity supply would be more economically feasible.
Traditional Owner involvement in ongoing environmental monitoring and management of dam facilities during operations. Employment and training in jobs that are associated with the Project e.g. heritage surveys, biological surveys etc.	RTA would consult with Traditional Owners to explore ways for ongoing involvement in environmental monitoring, biological surveys and management of dams during operations. Traditional Owners would be fully involved in all cultural heritage surveys.
Greater recognition and awareness of local Aboriginal culture, (e.g. traditional naming of dams, mine blocks	RTA supports Traditional Owner initiatives for greater recognition of traditional connections to the land and would work collaboratively with Traditional

Opportunity	RTA Response
and other places) and provision of cultural awareness training.	Owners and the WCCT to develop and implement these initiatives. Initiatives would include the use of traditional names for key locations and the delivery of cultural awareness training for employees and contractors.

16.3.7 Business Development

Potential Impacts and Suggested Mitigation Strategies

Indigenous Business

Wik and Wik Way Traditional Owners, Shire Councils, local businesses and service providers expressed strongly their view that they wish to take advantage of potential business opportunities available through the Project. Viable and sustainable businesses are desired, leading to positive outcomes for Traditional Owners and local Indigenous communities. A particular emphasis was placed on potential opportunities related to land and coastal management, timber harvesting, civil construction, contract mining, eco-tourism services, training and development, seed collection and rehabilitation, cultural heritage management and general goods and services.

Joint ventures and partnerships were also viewed as opportunities to be explored for Traditional Owners as a means of creating sustainable business enterprises and employment. It was considered that economic development in each of the Project's neighbouring communities could be realised through a proactive focus on Indigenous business development.

Non-Indigenous Business

Discussions with the Weipa Chamber of Commerce during June 2007 (SGS 2008) and August 2008 (Project SIA consultations - refer **Section 15.2.6**) revealed a number of key issues affecting local businesses in Weipa and surrounding communities, including:

- High dependency on RTA - Many local contractors are highly dependent on RTA, thus their ability to employ and retain staff varies based on the level of work RTA has available. The Chamber of Commerce noted that some local businesses were exploring opportunities to expand their business operations across the Cape York region to reduce their dependency on the mining industry.
- Retention of employees – Many local businesses were struggling to retain staff as RTA offered better employment packages. For example, one local contractor indicated that they had lost 25 employees to RTA over the 2006/2007 financial year.
- Contractor pre-qualification requirements – RTA contractor pre-qualification criteria resulted in additional costs to local businesses to raise their business operation standards. The changes included improving representation of local Aboriginal people in the workforce and meeting required health and safety requirements. The pre-qualification criteria were thought to affect smaller businesses that did not have sufficient financial means to raise their standards to the level required by RTA.
- Infrastructure – Members of the Chamber of Commerce raised concerns that additional investment in infrastructure is required in Weipa, including the provision of land for industrial, commercial and residential uses as well as a need to upgrade existing facilities such as the Weipa Airport. The Chamber of Commerce has prepared an economic development plan for Weipa that focuses on these issues.

Regional landholders expressed the view that they wished to pursue live cattle exports through Humbug Wharf in the future. A live cattle shipment was recently dispatched from Humbug Wharf to Indonesia, the first shipment in five years. Access would be required to Humbug Wharf once or twice each year over a 3-4 day period. There was considered to be little in the

way of direct impacts by the proposed Project on live cattle exports as long as appropriate forward planning is undertaken.

RTA Mitigation Strategies

The Project is expected to provide substantial direct and indirect business opportunities for the Western Cape region. The potential economic impacts at a local, regional, state and national level are described in detail in **Section 17**. Direct business opportunities relate to the provision of goods and services to RTA and its contractors and indirect opportunities arise through flow-on effects of providing good and services to resident populations and other businesses in local communities.

Direct business opportunities would change over the construction and operation phases of the Project but would include site general services, catering, civil construction and maintenance.

Indirect opportunities in areas such as tourism, retail trade, transport services, timber harvesting, coastal protection programs and management of permit systems could also provide business and employment opportunities for local Indigenous and non-Indigenous people. This potentially could benefit a range of business types from small one-person ventures to larger companies.

Indigenous Business Development

Traditional Owners and local Shire Councils have said that they wish to take advantage of potential business opportunities available through the Project that lead to the development of sustainable business enterprises across the Western Cape. Traditional Owners have identified potential opportunities related to land and coastal management, timber harvesting, civil construction, contract mining, transport services, eco-tourism services, training and development, seed collection and rehabilitation, cultural heritage management and general goods and services.

Joint ventures and partnerships were also identified by Traditional Owners as an opportunity for creating sustainable business enterprise and employment opportunities, whilst developing business skills and capabilities required in the long term.

RTA acknowledges the objectives of Traditional Owners in developing business and entrepreneurial skills and capabilities. Economic development for Indigenous people and the residents of communities located throughout the Western Cape can be realised through a proactive focus on Indigenous business development. Under its WCCCA obligations, RTA would continue to assist in developing such skills and capabilities and through the identification and pursuit of business opportunities during construction and operational phases of the Project.

In order to continue supporting the development of Indigenous businesses in the Western Cape, particularly as it relates to the Project, RTA would:

- proactively consider tenders for Project contracts which involve local Indigenous people and/or local Indigenous enterprises. This may include joint ventures, direct employment, training opportunities, equipment usage or cooperative arrangements with local Indigenous people and enterprises;
- continue to work collaboratively with key regional stakeholders, including the WCCT, WCCCC and the RPA Steering Committee to identify and support the ongoing development of Indigenous businesses throughout the region;
- examine applicable contracts for local and Indigenous business opportunities, including the break down of larger contracts into smaller jobs to increase the potential opportunities for awarding contracts to local providers of goods and services;
- work collaboratively with the WCCT and Traditional Owners to identify and pursue all social, commercial and economic development opportunities associated with the Project;
- provide updates to the WCCT on the status of Indigenous business spending across RTA's operations in line with RTA's existing reporting requirements for employment and training; and

- in collaboration with key local and regional stakeholders, RTA would identify opportunities to support the implementation of a range of business development programs and support services.

RTA supports the establishment of a timber harvest operation south of the Embley River that would harvest timber on areas of the mining lease proposed to be mined, or cleared for development of Project infrastructure, in a manner that does not impeded development work. This may include joint venture arrangements that support the further creation of employment, training and business development opportunities for local Indigenous people, and in particular, for the Traditional Owners whose land is being proposed for development.

Non-Indigenous Business

RTA, through its membership of the Chamber of Commerce, would continue to monitor the impact of its activities on local businesses and work with businesses to address concerns, where possible. Local businesses would be provided with relevant information on future opportunities arising from RTA's proposed development activities.

The Humbug barge terminal shall be designed to minimise interference with the adjacent live cattle export facility.

16.3.8 Workforce

Construction Camp

Potential Impacts and Suggested Mitigation Strategies

The construction camp was raised as a key issue in relation to the management of the workforce. A number of stakeholders were concerned about the construction camp being a wet camp which allowed the consumption of alcohol outside of work hours. Concerns were expressed that unless the canteen is tightly regulated, the illegal transport of alcohol into communities with alcohol bans could escalate, with the camp as the source. There was also concern that intoxicated contractors may leave the camp and access areas with environmental and cultural significance and potentially cause damage to these locations. Many stakeholders expressed the view that workers should be able to access regulated alcohol in a wet canteen on their time off. They suggested that the supply should be regulated tightly with no takeaways allowed and consumption in the canteen only, light beer and mid strength beer should be available, and amounts controlled. The view was also frequently expressed that the camp should have good sport and recreation facilities to provide an alternative to drinking in leisure time. Many of those consulted felt that a dry camp is not an option as it would be very difficult to attract workers. It was recognised by stakeholders that mitigating issues with the construction camp is the responsibility of RTA and it was suggested that camp rules preventing the excessive consumption of alcohol be developed and enforced and that a system be implemented to address external access requirements for after hours recreational pursuits.

Access to the beach was also an issue of concern, particularly for Traditional Owners, "*you need to consider the fact that they will find their way during rostered days off from the construction camp to a beach – restrictions or not*". A range of options was put forward by the Traditional Owners to allow recreational activities and controlling access for controlling access for construction workers.These include the implementation of a permit system managed by Traditional Owners, guided trips with Traditional Owners to the beach for fishing and other activities, and a dedicated bus that operates according to shifts and transports workers to and from controlled access areas. A number of stakeholders also expressed the view that the camp would be easier to manage if there is a qualified 24-hour security service in and around the camp. The QPS also felt this was necessary.

RTA Mitigation Strategies

A licensed wet mess would be available in the construction camp for the responsible service of alcohol to camp occupants only. The consumption of alcohol would be regulated and confined to the wet mess and an immediate delineated area. The following alcohol controls would apply:

- secure storage;

- limits on daily consumption;
- restricted hours of operation/availability;
- close supervision of premises;
- RTA's standard drug and alcohol testing protocols apply, including random testing as a part of the Fitness for Work program to ensure zero alcohol and drug levels in the workplace;
- alcohol from the wet mess or elsewhere would not be permitted to be taken into the rest of the camp by occupants or visitors; and
- management approval would be required to drink alcohol outside the wet mess area.

Entertainment and recreational facilities would be provided in the construction camp. Rosters would be implemented which minimise the amount of recreational time spent locally while working at the Project site. Any activities outside the camp would be controlled via a permit system developed in collaboration with Traditional Owners in order to minimise any potentially adverse impacts on the places of environmental and cultural heritage significance.

Fly In, Fly Out (FIFO)

Potential Impacts and Suggested Mitigation Strategies

The majority of stakeholders strongly expressed the view that non-local construction workers should fly out of Weipa on the final day of their roster and should return to Weipa just before being transported to the construction camp located near Boyd Bay. It was suggested that RTA would need to ensure the availability of additional flights to accommodate the required travel. The FIFO arrangement was considered to have the following advantages:

- avoidance of pressure on limited accommodation in Weipa;
- preventing access to mining lease areas and Aboriginal Deed of Grant in Trust (DOGIT) lands that are not open to the public;
- preventing workers from poaching and hunting on pastoral leases and causing disruption or loss of livestock; and
- decreasing the need for police intervention for anti-social behaviour.

RTA Mitigation Strategy

When not on roster, the construction workers would return to their point of hire. The large majority of these would be from the east coast of Australia and they would fly-in and fly-out of Weipa airport and be transported back and forth to the construction site by RTA in buses. A small proportion of the construction workforce would be local people hired through employment with local sub-contractors. These people would already be housed in the region and would not create additional pressure on housing stocks.

Daily Commute

Potential Impacts and Suggested Mitigation Strategies

Overall, the initial consultation feedback suggested that people living in Aurukun who work at the mine during operations would prefer a daily commute from Weipa with a system for transporting people back to Aurukun on their days off. It was suggested that accommodation for these employees should be provided at the Single Person Quarters. People felt that employee attendance would be greatly reduced if they commuted every day from Aurukun, particularly if they were put under pressure by family members to stay at home rather than going back to work. It was thought that this arrangement would also increase the ability of workers to rest during the day in preparation for night shifts.

Later in the consultation process, however, there was greater emphasis placed the opportunities for employment and business that daily access and transport from Aurukun to the Project area would provide for residents of Aurukun.

RTA Mitigation Strategies

In response to the matters raised about access, RTA investigated a number of different options for employees to travel to and from Aurukun to the Project site on a daily basis, including a 70km long all-weather road. The investigation concluded that the provision of access between Aurukun and the Project area must be considered as part of a broader employment, training and economic development package. RTA would work with the WCC E&T Sub-Committee to identify opportunities for training and employment for residents of Aurukun and ways to provide appropriate access to the mine site and, where appropriate, engage with other local stakeholders regarding impacts and opportunities associated with improved access to the Project area.

It is proposed that the Project's operational workforce would commute daily using the Hornibrook Point to Hey River ferry and Mine Access Road. RTA employees, including those from local communities, would receive a rental subsidy and be able to source accommodation in Weipa or Napranum. This is a continuation of current arrangements.

Rosters/Fatigue Management

Potential Impacts and Suggested Mitigation Strategies

Some stakeholders expressed the view that employees would be exposed to additional fatigue due to the longer daily commute to the Project area. A suggestion was put forward that rosters may need to be altered or transport provided to employees.

RTA Mitigation Strategies

The existing roster arrangements for East Weipa and Andoom operations would be adopted for the Project. RTA would provide bus transport to the workplace from the Hey River ferry terminal and back again so that the workers do not have to drive vehicles along the Mine Access Road. The overall commute time from home to the workplace is expected to be about 50 to 60 minutes. RTA has fatigue management standards governing hours of work and breaks which would be implemented.

Operations Employees

Potential Impacts and Suggested Mitigation Strategies

The perception is widely held in Weipa that individuals demonstrating anti-social behaviour are, more often than not, employed in the mine, either directly or as a contractor. Many of those consulted held the view that employees and contractors of RTA feel they are living in a frontier, where 'anything goes', and the extension of the mine to the south of the Embley River may add to this perception if the issue is not effectively addressed.

Local pastoral landholders in particular felt that the Project may contribute to an increase in unauthorised access to properties by workers, cattle duffing and poaching, unsafe use of firearms and general anti-social behaviour unless behaviour and land access is properly managed. It was suggested strongly that land access needs to be effectively controlled by RTA and existing and incoming workers need to be clearly told that adjacent cattle stations and the nearby Shire Council DOGIT land is private property. This view was supported by members of the Aurukun and Napranum Aboriginal Shire Councils.

Another key issue raised by many stakeholders concerns the pig hunting activities of the general public that has resulted in damage to beaches and damage to turtle nests by quad bikes. Those who raised many of the negative issues about unacceptable behaviour felt that written communication to employees and contractors, in the absence of strong enforcement, would be ineffective in dealing with the issue. It has been suggested that strict enforcement of the company Code of Conduct, effective communication and ongoing collaboration with the QPS is required to actively enforce appropriate behaviour.

RTA Mitigation Strategies

RTA proposes to implement the following measures to address concerns relating to employee and contractor behaviour:

- restricting access to the ferry and barge to those on mine-related business only
- developing, in collaboration with police, a strategy to ensure effective response to incidents
- continuing to implement workforce induction and awareness sessions to communicate requirements relating to safety, security, behaviour and land access both on and off the mining lease
- assist Traditional Owners to develop a permit system controlling access to places of environmental and cultural heritage significance
- continuing to implement a complaints system and incident management process whereby any reported incidents of unacceptable behaviour are investigated, and
- proactive discussion and engagement with community stakeholders to establish a system to monitor and respond to issues, including the implementation of additional management measures where necessary.

RTA would reinforce the required code of conduct for employees and contactors on the mining leases and emphasise need for appropriate behaviour at all times. The use of firearms on the mining leases would not be permitted.

16.3.9 Demographic Changes

Population Influx

Potential Impacts and Suggested Mitigation Strategies

The SIA consultation found an initial perception on the part of Weipa residents and the WTA that the population would increase because the construction workforce of 300-400 people would bring their families and move into Weipa for the duration of the construction period. There was concern that this population increase would not subside as it was expected that the operational phase would require greatly increased staff numbers who, with their families, would put a significant strain on services in Weipa.

Many Weipa residents indicated their support for a FIFO construction operation as opposed to a construction workforce that is accommodated in Weipa. The minority view was expressed that a FIFO operation is damaging to the Weipa economy as workers 'will be spending their money' elsewhere.

RTA Mitigation Strategies

When not on roster, the construction workers would return to their point of hire. The large majority of these would be from the east coast of Australia and FIFO from Weipa airport. A small proportion of the construction workforce would be local people hired through employment with local sub-contractors. These people would already be housed in the region and would not create additional pressure on housing stocks.

Population projections suggest that at a Project production rate of 15Mdptpa, the population of Weipa would be slightly less than the population was in 2007-2008 (refer **Table 16-3**). At a SoE production rate of 30Mdptpa, when Andoom production is likely to have ceased, the population is projected to decrease slightly.. Significant population increases are not projected to occur until production increases to between 30Mdptpa and 50Mdptpa. The timing of increased production beyond 30Mdptpa is subject to market conditions.

The overall population age profiles of Weipa, Napranum, Mapoon and Aurukun are not expected to alter significantly due to the Project.

16.3.10 Economic Profile

Potential Impacts and Suggested Mitigation Strategies

Economic modelling of the Project has been carried out and the full details are contained in **Section 17**. The initial phase of construction would generate a direct and indirect contribution

of $465 million into the local economy. The annual direct and indirect input into the local economy at the 15Mdptpa production rate is estimated to be $671 million.

Weipa's principal industry and driver of economic growth is mining. This sector accounts for about 43% of employment and three-quarters of Weipa's total economic output. Local enterprises are highly dependent, either directly or indirectly, on the business generated by RTA's operations and this would continue with the introduction of the Project. Local businesses are affected both positively and negatively by the dominance of mining. Overall, mine production would increase as a result of the Project and hence businesses supplying goods and services linked to mine production would have opportunities to expand. In contrast, the mine-related workforce is projected to decline somewhat below 2007-2008 levels under the 15Mdptpa and 30Mdptpa production scenarios and hence some local businesses linked to supplying good and services to the local population may decline in relative terms. The Weipa Chamber of Commerce have stated that many local enterprises struggle to retain their staff as they take-up the more attractive employment packages offered by RTA (refer **Section 16.2.5**). This trend is likely to continue.

RTA Mitigation Strategies

Sustainable employment creation is the key to regional economic development. Rio Tinto has found from experience at other sites that employment is usually essential in securing genuine community support for new developments and employment is one of the few benefits that are open to nearly the entire community. However, opportunities for direct employment with the Project need to be balanced against a need to maintain sustainable business and employment growth across the region's existing industries and enterprises. Economic development is about expanding the size of the economy and distributing wealth amongst the community. If only a few benefit from growth at the expense of others, the underlying principles of economic development can be compromised.

To this end, RTA is committed to playing a part in planning for and supporting the economic development of Weipa and the Western Cape region. This includes working collaboratively with community stakeholders and government agencies, including WTA, Shire Councils, RPA Steering Committee, Chamber of Commerce, WCCCC, Ely Coordinating Committee and various educational institutions to enhance education, training and employment for local Indigenous people and community residents, and support the ongoing development of emerging and existing businesses.

16.3.11 Housing and Property Values

Potential Impacts and Suggested Mitigation Strategies

The impact of the Project on property values and rents would be determined by the factors of supply and demand. If supply of land and houses is able to match demand then it is unlikely that property values and rents would significantly change as a result of the Project.

The Project construction workforce would be a "single status" workforce residing in a fully serviced construction camp on-site near Boyd Bay. When not on roster, the construction workers would return to their point of hire. The large majority of these would be from the east coast of Australia and they would fly-in and fly-out of Weipa airport and be transported back and forth to the construction site in buses by RTA. Local hire construction workers would return to their existing residences in Weipa, Napranum, Aurukun or Mapoon when off roster. It is not expected that the construction workforce would lead to an increase in demand for permanent dwellings.

The daily operational workforce would reside predominantly in Weipa. All new RTA employees are provided housing assistance through the provision of the Weipa Accommodation Benefit, including those new employees who have moved to Weipa from other local communities. It is unlikely that employees would live in Mapoon due to the long commute travel time and therefore the Project is not expected to lead to an increase in demand for permanent dwellings in this community. Some employees live in Napranum, where the housing is owned by Napranum Aboriginal Shire Council, the Queensland Government or the church (refer **Section**

16.2.6). If future employees choose to live in Napranum they would need to apply to Napranum Aboriginal Shire Council or the Queensland Government for housing. RTA has investigated a number of different access and commute options for employees residing in Aurukun to travel to and from Project site on a daily basis, including a 70km long all-weather road. The investigation concluded that the provision of access between Aurukun and the Project area must be considered as part of a broader employment, training and economic development strategy (refer **Section 16.3.8**).

Population projections for Weipa have been made based on the estimated mine-related operational workforce size and a population multiplier determined from 2006 Census data (refer **Section 16.2.1**). The projections suggest that when Project production is at 15Mdptpa, the population (3,502) would be slightly less than the population was in 2007-2008 (estimated at about 4,100). The population is projected to decrease to 3,327 under the 30Mdptpa production scenario, when Andoom closes and all mining takes place south of the Embley River.

Based on the projected population, there should be sufficient housing supply to meet demand under the 15Mdptpa and 30Mdptpa production scenarios.

Significant population increases are not projected to occur until production increases to between 30Mdptpa and 50Mdptpa. The timing of increased production beyond 30Mdptpa is subject to market conditions. Such a population increase would increase demand for local housing which would require more residential development.

There are currently approximately 27 vacant residential lots across Weipa. Stage II of the Golf Links Estate would be able provide an additional 65 residential lots in Weipa. Assuming an average household size of 2.8 persons (the current average household size in Weipa) these developments would accommodate more than 250 people. The current alignment of the Weipa town boundary limits future land development beyond Golf Links Estate Stage II. However it is possible for the town boundary to be extended through appropriate planning processes, as it has been in the past.

There are currently four local builders operating in Weipa. More than 100 new houses were constructed in the residential development at Nanum between 2005 and 2007. In 2008, there were 34 new residential properties built, mostly in the Golf Links Estate.

Initially, development would utilise these available lots, however after that an adjustment of the town boundary would be required. WTA have advised that there is suitable land available for this expansion and these types of expansions have been done in the past.

RTA Mitigation Strategies

RTA would seek approval for adjustment of the town boundary and development of additional housing when required.

16.3.12 Cumulative Impacts

Potential Impacts and Suggested Mitigation Strategies

A number of stakeholder groups raised concerns regarding significant duplication of infrastructure and services between RTA and the other bauxite projects proposed for the region (the Aurukun Project and the Pisolite Hills Project, refer **Section 1.4**). Should more than one project proceed, cumulative social and environmental impacts would arise. It was suggested strongly, particularly by the Aurukun Shire Council, that RTA and Chalco should work together to identify potential cumulative impacts and work out a commercial agreement to minimise duplication.

One of the key cumulative impacts raised by stakeholders was environmental damage and the potential disturbance to sensitive areas which could be minimised if infrastructure such as ports, roads, airstrips and dams were shared. Another matter raised consistently by stakeholders was concern about the potential for the establishment of a road connection between the Project's Mine Access Road and Chalco's proposed Aurukun Project, thus facilitating the transport of illegal alcohol. A small number of stakeholders identified this as an opportunity for residents in Aurukun to obtain easier access to Weipa-based goods and services.

There are also significant non-Project related cumulative impacts associated with current government services and programs being implemented in Aurukun. These include the alcohol management plans (AMP) which imposes alcohol bans and Families Responsibility Commission programs designed to encourage parents to take responsibility for their children's school attendance. Although the intentions of the programs are to improve the well-being of the communities, they represent another cumulative social change being experienced by this small, isolated community.

RTA Mitigation Strategies

RTA's proposed port has been designed to allow the shipment of ore supplied by neighbouring mines (in addition to RTA's production) in the event that agreement to do so is reached with RTA. Should ore from neighbouring mines be shipped through the proposed port, such ore would be conveyed by others across ML7024 to a stockpile near the RTA stockpile.

RTA has been liaising with Chalco during the Project planning phase to discuss potential co-location and/or sharing of certain infrastructure. Where possible, and subject to commercial agreement, RTA would look to minimise environmental and property impacts in the event that the Aurukun lease is developed in the future. Some impacts could potentially be mitigated by the following:

- establishment of a common infrastructure corridor for RTA's water pipeline, transmission line and overland conveyor (from the Norman Creek plant) and the Aurukun Project's overland conveyor to the proposed port (refer **Figure 1-3**); and
- co-location of port and stockpile facilities.

In June 2010 the State of Queensland announced that the development agreement between the State and Chalco had come to an end and there is currently some uncertainty about the future development of the Aurukun Bauxite Project. In July 2010 Cape Alumina announced that the proposed Pisolite Hills project was no longer viable due to the declaration of the Wenlock River Basin as Wild River area.

Nevertheless, should any adjacent project proponents proceed with their plans, RTA shall liaise with them and endeavour to identify cumulative impacts and opportunities associated with employment, training and business development for the local communities. RTA would seek to co-ordinate its' programs with others, including government programs and services currently being implemented in the region, and, where appropriate, would partner with the relevant Government agencies.

16.4 Social Impact Management Plan

16.4.1 Project Overview – Social Context

The Project involves the construction and operation of a bauxite mine and associated processing and port facilities to be located near Boyd Point on the western side of Cape York Peninsula. The main infrastructure components are illustrated in **Figure 1-3** and **Figure 1-4** and a detailed project description is set out in **Section 2**.

Boyd Point is approximately 40km south-west of Weipa and 40km north of Aurukun, with the closest mining areas being 4km from Napranum, 15km from Aurukun, and 50km from the nearest cattle station homesteads.

The Western Cape Communities Co-existence Agreement (WCCCA) is a registered Indigenous Land Use Agreement (ILUA) (QIA2001/002) under the *Native Title Act 1993* between RTA, the State of Queensland and the 11 Traditional Owner groups of the ML7024 and ML6024 areas.

The WCCCA recognises and respects the rights of Traditional Owners and allows for consultation over future development of mining operations. The WCCCA recognises RTA's entitlement and powers to develop the mining leases (ML7024, ML6024), property rights and other rights or interests granted under the Comalco Agreement Act. RTA will continue to engage with the Traditional Owners under the provisions of the WCCCA.

The area of land south of the Embley River is recognised as the traditional lands of the Wik and Wik Way people (refer **Section 1.9.9** and **Section 16.1.1**). There are probably more than 50 clan estates and many language groups. Areas of cultural and recreational importance to Traditional Owners include Hey Point, Boyd Bay, Pera Head, Norman Creek, Amban (False Pera Head), Waterfall (near Ina Creek) and Six Ti-Tree. RTA will continue to manage access for Traditional Owners to specific areas (refer **Section 16.3.2**). Cultural heritage impact and management is discussed in **Section 11**. Use of the Project area and surrounds by tourists and the general public is also discussed in **Section 16.3.2**.

There are no rural properties within the Project area and therefore no properties would be directly affected by the Project (refer to **Section 3.1** and **Figure 3-1**).

Bauxite mining commenced in the 1960's in the Weipa area (north of the Embley River). The initial phase of mining operations south of the Embley River would involve production to replace depleted East Weipa production as well as developing third party markets. Production capacity would expand to replace Andoom production once those reserves are depleted. Production capacity would thereafter be expanded to 50Mdptpa when market conditions are suitable. The Project has bauxite reserves capable of sustaining a mine life of approximately 40 years, depending on annual production rate.

Employee numbers would remain relatively stable or slightly decrease in the initial production stage of the Project. The population of Weipa and other communities is therefore not expected to increase significantly until the Project exceeds 30Mdptpa which would not occur until market conditions are suitable (refer **Section 16.2.1**). Social impacts associated with population increases, such as demand for community services, housing and infrastructure, are not expected to change until this time. RTA would assist with the planning and implementation of mitigation measures associated with Project capacity expansions above 30Mdptpa with relevant stakeholders as required.

There are two other bauxite projects proposed in the region (described in **Section 1.4**), however the future of both of these projects is currently uncertain. The potential cumulative social impact of these projects should they proceed at the same time as the SoE Project is discussed in **Section 20.15**.

Stakeholder identification, including key social and political organisations, the consultation program that has been undertaken, and the issues identified during consultation is detailed in **Section 15**.

16.4.2 Management Plan

RTA's proposed mitigation and management measures from **Sections 16.3.1** to **16.3.12** of the EIS are summarised in a Social Impact Management Plan (SIMP) (refer **Table 16-22**). The SIMP refers to matters over which RTA has some control and does not refer to matters that are the responsibility of Government or other parties.

The issues identified through consultation are discussed further in terms of potential social impacts and mitigation measures in **Section 16.3**.

Table 16-22 Social Impact Management Plan

Category	Description of the potential impact	RTA proposed Mitigation and Management Measure	Responsibility and Proposed Timeframe (where relevant)	Residual Impact Significance	Performance Indicators	Monitoring, Reporting and/or Verification Methodology
Traffic and Transport						
Mine Access Road and barge/ferry access and usage	Increased public access area south of Embley River leading to inappropriate activities, e.g. quad bikes on beaches, use of firearms, unauthorised access to traditional lands and active mining areas, transportation of alcohol (grog running).	▪ No public access on barge, ferry or Mine Access Road – access on authorised mine-related business only. ▪ Allowance for access for emergency response ▪ Access controlled and monitored by RTA at barge and ferry terminals ▪ Signage at terminals and access tracks along eastern boundary of lease informing of restrictions on access and activities and controls on alcohol.	RTA - from commencement of barge/ferry operations.	Moderate, negative	Number of incidents involving unauthorised access Number of requests for access	RTA Internal Incident reporting and investigation procedure Performance indicators to be reported to DIP (refer **Section 16.4.4**)
Weipa airport	Airport could not handle increased FIFO traffic during construction phase and would need terminal upgrade and runway lengthening.	▪ RTA would arrange additional flights from commercial air service provider during construction phase (as per previous "NeWeipa" Project arrangements). ▪ No need for airport upgrade as existing infrastructure has sufficient capacity for increased flights and no need for larger aircraft.	RTA – prior to commencement of construction In collaboration with: • Commercial air service provider	Low, negative	% Utilisation of existing flights Number of flights	Commercial air service provider reporting
Security	Vandalism and theft of workers' vehicles left at the Hornibrook ferry terminal carpark, particularly during night shift.	▪ RTA would provide secure parking adjacent to the ferry terminal in a fenced compound with appropriate security systems.	RTA- from commencement of barge/ferry operations.	Low, negative	Number of incidents of damage, theft	RTA internal incident reporting and investigation procedure
Emergency response	Increased number of incidents on land and sea requiring emergency response in remote Project location.	▪ Existing RTA Business Resilience and Response Plan would be extended to cover incidents on land and sea in the Project area. ▪ RTA would have paramedic and ambulance facilities located at the	RTA – prior to commencement of construction The following local emergency services organisations are involved in training sessions (refer **Section 19.3**):	Moderate, negative	Number of emergency incidents	RTA internal incident reporting and investigation procedure Performance indicators to be reported to DIP (refer

Category	Description of the potential impact	RTA proposed Mitigation and Management Measure	Responsibility and Proposed Timeframe (where relevant)	Residual Impact Significance	Performance Indicators	Monitoring, Reporting and/or Verification Methodology
		Project site during construction and operations. ▪ Part of the sealed Mine Access Road near Boyd Bay would be constructed to accommodate RFDS aircraft landings and take-off and provision made for temporary night-time lighting. ▪ Helicopters would be able to use the above section of Mine Access Road as well.	• QPS, • Ambulance, • Rural Fire Brigade, • State Emergency Service, and • Volunteer Marine Rescue.			**Section 16.4.4**)
Land and Sea Management						
Land and sea access	Reduced access for Traditional Owners by road or by sea to areas of cultural and landscape significance. Increased unauthorised access by people hunting, boating, camping and fishing. Damage by quad bike on beaches. Damage to culturally important places and the environment.	▪ RTA would continue to manage access for Traditional Owners to specific areas (including Amban and Waterfall) in accordance with WCCCA obligations, ▪ In collaboration with Traditional Owners, RTA would develop a land access strategy for active and non-active mining periods. ▪ RTA would assist Traditional Owners and other relevant stakeholders to develop an effective permit system (administration of such a system by Traditional Owners would be subject to discussion between Traditional Owners, RTA and other stakeholders).	RTA – prior to the commencement of construction In collaboration with: • WCCCC and relevant sub-committees • Traditional Owners	Moderate, negative	Number of sites open for Traditional Owner access at any one time. Length of time a site is closed. Number of incidents of authorised access to active mining areas.	RTA internal incident reporting and investigation procedure Performance indicators to be reported to DIP (refer **Section 16.4.4**) Quarterly reporting to WCCCC (refer **Section 16.4.4**)
	Reduced access to safe anchorage at Boyd Bay.	▪ Boyd Bay would remain accessible as a safe anchorage. The proposed bulk carrier mooring area is offshore in deeper water. ▪ A limited number of Project-related vessels may be moored in Boyd Bay during construction and would not restrict access to moorings.	RTA – current and ongoing	Low, negative	Number of community complaints about access.	RTA internal complaint reporting and investigation procedure (refer **Section 16.4.3**)

Category	Description of the potential impact	RTA proposed Mitigation and Management Measure	Responsibility and Proposed Timeframe (where relevant)	Residual Impact Significance	Performance Indicators	Monitoring, Reporting and/or Verification Methodology
		▪ Subject to the outcome of an operational safety review, RTA would designate a safe passage underneath the proposed jetty for recreational and charter boats (in accordance with MSQ requirements). ▪ A 50m safety exclusion zone would apply to proposed port facilities.	RTA would designate safe passage under the jetty to be designated in consultation with Maritime Safety Queensland (refer **Section 16.3.2**) RTA – from commencement of construction of port operations.			
	Reduced business for charter fishing business operators due to "industrialisation" of formerly untouched beaches and increase in "Weipa weekend warriors".	▪ RTA would assist Traditional Owners and other relevant stakeholders to develop an effective permit system (administration of such a system by Traditional Owners would be subject to discussion between Traditional Owners, RTA and other stakeholders). ▪ Port would be visible from beaches between Pera Head and Boyd Point, but not from those further north or south.	RTA – from commencement of mine operations In collaboration with: • WCCCC and relevant sub-committees • Traditional Owners	Moderate, negative	Number of community complaints about visual amenity	RTA internal complaint reporting and investigation procedure (refer **Section 16.4.3**) Performance indicators to be reported to DIP (refer **Section 16.4.3**) Quarterly reporting to WCCCC
	Reduced access for recreational fishing at Boyd Bay, Pera Head and Norman Creek.	▪ Proposed port is approximately 2km from both Pera Head and Boyd Point. ▪ RTA would designate a safe passage underneath the proposed port for small recreational boat users(in accordance with MSQ requirements). ▪ RTA would prohibit access to active operational areas for safety reasons. A 50m safety exclusion zone would apply to new wharf and jetty facilities (subject to MSQ requirements).	RTA would designate safe passage under the jetty to be designated in consultation with Maritime Safety Queensland (refer **Section 16.3.2**) RTA – from commencement of construction of port operations.	Low, negative	Number of community complaints about access. Number of incidents of unauthorised access to active operational areas.	RTA internal complaint reporting and investigation procedure (refer **Section 16.4.3**)
Land and coastal management	Opportunity for Traditional Owners to be involved in land and coastal protection management planning and in implementation activities. Opportunity to develop	▪ RTA would collaborate with Traditional Owners to develop a Communities, Heritage and Environment Management Plan (CHEMP) under the auspices of the WCCCA.	RTA - CHEMP to be completed prior to commencement of construction (Section 16.3.2). In collaboration with: • WCCCC and relevant sub-	High, positive	CHEMP developed. Additional indicators to be defined in in the CHEMP	Performance indicators to be reported to DIP (refer **Section 16.4.4**) Quarterly reporting to WCCCC (refer **Section**

Category	Description of the potential impact	RTA proposed Mitigation and Management Measure	Responsibility and Proposed Timeframe (where relevant)	Residual Impact Significance	Performance Indicators	Monitoring, Reporting and/or Verification Methodology
	Indigenous ranger programs, particularly for coastal management activities, e.g. removal of ghost nets, turtle monitoring, feral pig management and develop interpretative signage.	▪ RTA supports the establishment of Indigenous ranger programs to assist with the implementation of plans for land and coastal protection. ▪ RTA, in conjunction with Traditional Owners and other relevant parties, would facilitate access and other support as appropriate for the implementation of relevant programs.	committees • Traditional Owners Mitigation programs for turtles would be developed in consultation with DERM (refer **Section 6.9.4.3**).			**16.4.4**)
	Weeds species introduced to the Project area.	▪ Vehicles would be washed down before entering the Project area. ▪ A wash-down facility would be provided at the Humbug barge terminal.	RTA – prior to commencement of construction In collaboration with: • WCCCC and relevant sub-committee • Traditional Owners Weed management program has been proposed in Section 3.8 of the EM Plan (**Section 21**) and will be discussed with DERM.	Medium, negative	Number of any new weed species and extent of presence.	Internal rehabilitation monitoring (refer **Section 3.10.8**) Performance indicators to be reported to DIP (refer **Section 16.4.4**) Quarterly reporting to WCCCC (refer **Section 16.4.4**)
Rehabilitation	Opportunity to involve Traditional Owners in determination land use options and of rehabilitation standards.	▪ RTA would develop final land use options and standards in consultation with Traditional Owners in accordance with WCCCA obligations (refer to **Section 3.10**) ▪ RTA would involve Traditional Owners in developing a rehabilitation process and end point criteria. ▪ RTA in consultation with Traditional Owners would develop processes for land relinquishment and economic development opportunities	RTA – rehabilitation criteria to be developed within 3 years of commencement of mining (Section 3.10.1) In collaboration with: • WCCC and relevant sub-committee • Traditional Owners Rehabilitation strategy has also been proposed in Section 3.7 of the EM Plan (**Section 21**) and will be discussed with DERM.	High, positive	Development of rehabilitated land completion criteria. Number of Traditional Owners involved in rehabilitation programs. Rehabilitation success criteria (refer **Section 3.10.6**).	Internal rehabilitation monitoring (Section 3.10.8) and mine closure planning. Performance indicators to be reported to DIP (refer **Section 16.4.4**) Quarterly reporting to WCCCC (refer **Section 16.4.4**)
Buffer zones	Damage to areas identified by Traditional Owners as being of	▪ Surveys would be undertaken ahead of infrastructure and mine	RTA - CHEMP to be completed prior to commencement of construction	Medium, negative	CHEMP developed	CHEMP.

Category	Description of the potential impact	RTA proposed Mitigation and Management Measure	Responsibility and Proposed Timeframe (where relevant)	Residual Impact Significance	Performance Indicators	Monitoring, Reporting and/or Verification Methodology
	cultural heritage, environmental and landscape importance (including Waterfall, Amban, Pera Head , Boyd Point)	development with involvement of Traditional Owners to identify and clarify the significance of specific areas. ▪ RTA, in consultation with Traditional Owners, would designate and enforce agreed buffers around these sites. ▪ In collaboration with Traditional Owners, RTA would develop a CHEMP that would provide details of buffer zones and land management strategies for the areas identified above.	(Section 16.3.2). In collaboration with: • WCCCC and relevant sub-committee • Traditional Owners Vegetation buffers and cultural heritage management have also been proposed in Section 3.8.3 and Section 3.11.3 respectively of the EM Plan (**Section 21**) and will be discussed with DERM.		Number of communities, heritage and environmental assessments completed Number of breaches of buffer zones	RTA internal incident reporting and investigation procedure. Performance indicators to be reported to DIP (refer **Section 16.4.4**) Quarterly reporting to WCCCC (refer **Section 16.4.4**)
Dredging, Spoil Disposal and Shipping	Reduced access and/or damage to fishing locations used by commercial fishing operators, charter boat operators, and recreational fishers. Reduced access to Boyd Bay safe anchorage.	▪ Proposed new spoil ground east of port is remote from fishing spots ("Nine Mile" and others). ▪ Bulk carrier mooring area is located away from Boyd Bay. ▪ Dredge Management Plan to be developed to manage environmental impacts of dredging.	RTA will develop a Dredge Management Plan in consultation with DSEWPaC and DERM (refer **Section 6.9.3.1**).	Low, negative	Number of community complaints	RTA internal complaint reporting and investigation procedure (refer **Section 16.4.3**)
Community Consultation and Engagement						
Ongoing Community consultation	Opportunity to inform local stakeholders (Traditional Owners, workforce and residents) regularly about the Project and gain feedback and support.	▪ Development of a Project stakeholder engagement plan ▪ Continue regular employee communications incorporating information on Project, ▪ Implement existing community contact and complaints procedures for Project activities (refer **Section 16.3.3**).	RTA - prior to commencement of construction (proposed early 2012), Current stakeholders include those listed in **Section 15.2** of the EIS.	Medium, positive	Preparation of Stakeholder Engagement Plan Actual vs. planned for communication	Performance indicators to be reported to DIP (refer **Section 16.4.3**)
Traditional Owner consultation	Opportunity to increase Traditional Owner collaboration and involvement in the planning	▪ WCCCA SoE Sub-Committee has been established,	RTA – ongoing	Medium, positive	Actual vs. planned community engagement activities with Traditional	Performance indicators to be reported to DIP (refer

Category	Description of the potential impact	RTA proposed Mitigation and Management Measure	Responsibility and Proposed Timeframe (where relevant)	Residual Impact Significance	Performance Indicators	Monitoring, Reporting and/or Verification Methodology
and collaboration	and implementation of the Project.	▪ RTA would report to the Sub-committee on development of the Project, progress of heritage work, employment and training, business development, consultative mechanisms and environmental work.	In collaboration with: • WCCCC and relevant sub-committee • Traditional Owners		Owners	**Section 16.4.4**) Quarterly reporting to WCCCC Quarterly reporting to WCCCC (refer **Section 16.4.4**)
Recognition of Traditional Owner connection to Project Area	Greater recognition of Traditional Owners connection to the area and awareness of Traditional Owner cultural heritage values in Project area (e.g. use of traditional names for key locations and mine blocks).	▪ RTA to support initiatives and would work collaboratively with relevant WCCCA Sub-committee to identify and implement initiatives promoting connection to land.	RTA – ongoing or as required In collaboration with: • WCCCC and relevant sub-committee • Traditional Owners	Medium, positive	Number of initiatives implemented	Performance indicators to be reported to DIP (refer **Section 16.4.4**) Quarterly reporting to WCCCC Quarterly reporting to WCCCC (refer **Section 16.4.4**)
Complaints and conflict	Unresolved issues cause stakeholder concern.	▪ Use of existing RTA complaints procedures (refer to **Section 16.3.3**)	RTA - ongoing Complaints monitoring has been proposed in Section 3.10.4 of the EM Plan (**Section 21**) and will be discussed with DERM.	Low, negative	Number of community complaints	RTA internal complaint reporting and investigation procedure (refer **Section 16.4.3**)
Employment, Training and Education						
Employment, Training and Education	Opportunities for employment during construction and operations for Indigenous people. Opportunities to continue to support and enhance current pre-work development programs for Indigenous employees.	▪ Continue to actively participate as a member of the Regional Partnership Agreement (RPA) Steering Committee, WCCCC and Ely Coordinating Committee to develop and implement pre-employment and job-readiness programs to support local Indigenous employment across the Western Cape region. ▪ Develop and implement culturally appropriate recruitment practices for positions at all levels and across various disciplines within the operations; ▪ Develop and implement programs and	RTA - ongoing In collaboration with: • RPA Steering Committee • WCCCC and the E&T sub-committee • Ely Coordinating committee • Western Cape College Forum • TAFE	High, positive	% of local Indigenous/other Indigenous employees. Retention rate of local Indigenous/other Indigenous employees. Number of local Indigenous/other Indigenous traineeships and apprenticeships during construction and operations Number of local Indigenous/other Indigenous people obtaining educational, vocational	RTA annual reporting to WCCCC and Annual Sustainable Development Report (public report) Quarterly employment and training report to the WCCCC (refer **Section 16.4.4**) Performance indicators to be reported to DIP (refer **Section 16.4.4**)

Category	Description of the potential impact	RTA proposed Mitigation and Management Measure	Responsibility and Proposed Timeframe (where relevant)	Residual Impact Significance	Performance Indicators	Monitoring, Reporting and/or Verification Methodology
		services to support the retention of Indigenous employees and increased representation of local female employees, including mentoring, employee and family support strategies that aim to address the root causes of socio-economic disadvantage. ▪ Continue to encourage participation in the workforce by Aurukun people through the Destinations program. ▪ Develop and implement long-term career planning strategies, including professional development and leadership programs for local Indigenous employees. ▪ In collaboration with Traditional Owners, continue to deliver cross-cultural awareness programs for all employees and contractors, including curriculum with specific reference to Wik and Wik Way traditional culture and values. ▪ Proactively consider tenders for Project contracts which involve local Indigenous people and/or local Indigenous enterprises. This may include joint ventures, direct employment, training opportunities, equipment usage or cooperative arrangements with local Indigenous people and enterprises. ▪ Provide a supportive career development pathway for local Indigenous people and youth, including traineeships and apprenticeships across a range of disciplines during the construction and operational phases of the Project. ▪ Continue to work with the Western			qualifications. % completing Destinations Program.	

Category	Description of the potential impact	RTA proposed Mitigation and Management Measure	Responsibility and Proposed Timeframe (where relevant)	Residual Impact Significance	Performance Indicators	Monitoring, Reporting and/or Verification Methodology
		Cape College and TAFE to provide supportive school-to-work pathways and effective case management for students looking to pursue careers at all levels in the mining industry. Where possible, RTA would also support delivery of work experience programs, school-based traineeships, curriculum support, support for academic awards, career talks, university scholarships and development of curricula relevant to the mining industry.				
	Potential skills shortages and labour impacts.	▪ Consider extent and composition of labour force requirements and demand-supply concerns. ▪ Incorporate vocational and education training programs.	RTA would continue to implement current programs on an ongoing or as needs basis and would also continue to work collaboratively with State and Commonwealth agencies, relevant WCCCC sub-committees, Traditional Owners, job network providers, and any other relevant stakeholders.	Low, negative	Number of job vacancies unable to be filled	Internal Human Resource data.
Community Cohesion						
Law and Order Alcohol and Substance Abuse Child safety Domestic violence Youth crime	Increased number of offences related to law and order and alcohol and substance abuse resulting in a deterioration of community cohesion. Risk is increased "grog running".	▪ Construction phase workforce would be predominantly on FIFO arrangement. ▪ No public access on barge, ferry or Mine Access Road – access on authorised mine-related business only. ▪ Secure parking provided at Hornibrook ferry terminal. ▪ Access controlled and monitored by RTA at barge and ferry terminals. ▪ Signage at terminals and access tracks along eastern boundary of lease informing of restrictions on access and activities and controls on alcohol.	RTA – established prior to the commencement of construction and ongoing In collaboration with: • QPS • Relevant government agencies identified via the Indigenous Coordination Centre • Local Councils.	Low, negative	Number of community complaints Number of incidents	RTA internal complaint reporting and investigation procedure (refer **Section 16.4.3**)

Category	Description of the potential impact	RTA proposed Mitigation and Management Measure	Responsibility and Proposed Timeframe (where relevant)	Residual Impact Significance	Performance Indicators	Monitoring, Reporting and/or Verification Methodology
		▪ Use of firearms prohibited on mining leases. ▪ RTA would implement strict policies for employees and contractors in relation to fitness for work, including alcohol and other drugs and random drug and alcohol testing regime. ▪ RTA would also continue to support the implementation of alcohol management plans for each community, with inclusion of this information in employee and contractor induction programs. ▪ RTA would continue to liaise with QPS, other Government agencies and local Councils to develop strategies to ensure an effective response to incidents and to raise awareness of regional law and order and alcohol management initiatives. ▪ RTA would reinforce the required code of conduct for employees and contactors on the mining leases and emphasise need for appropriate behaviour at all times. ▪ Inductions would be adapted to raise awareness of regional alcohol management initiatives and land access requirements.				
Dams						
Impacts on cultural heritage sites and environmental values	Inundation of riparian vegetation along Norman Creek. Potential for inundation of cultural heritage sites, crocodile nest.	▪ Maximise tailings storage facility recycle and use artesian water to reduce surface water demand and Dam C footprint. ▪ Detailed cultural heritage surveys of	RTA – prior to commencement of construction of water supply dam and then ongoing In collaboration with: • WCCCC and relevant sub-	Medium, negative		Performance indicators to be reported to DIP (refer **Section 16.4.4**) Quarterly reporting to WCCCC (refer **Section**

Category	Description of the potential impact	RTA proposed Mitigation and Management Measure	Responsibility and Proposed Timeframe (where relevant)	Residual Impact Significance	Performance Indicators	Monitoring, Reporting and/or Verification Methodology
		Dam C by Traditional Owners. ▪ Ongoing consultation with Traditional Owners and other interested stakeholders regarding operational impacts.	committee • Traditional Owners			**16.4.4**)
Post-mining utilisation options	Opportunity to use dams for economic development post-mining.	▪ RTA would consult with Traditional Owners to investigate potential post-mining land uses associated with dams (e.g. irrigation, fish farming).	RTA – develop initial mine closure plan prior to commencement of mining and update plan every 5 years In collaboration with: • WCCCC and relevant sub-committee • Traditional Owners	Medium, positive	Mine closure plan reviewed within proposed timeframe Agreement on post closure uses of the dams	Performance indicators to be reported to DIP (refer **Section 16.4.4**) WCCCC to be provided with the updated Mine Closure Plan following 5-yearly review.
Business Development						
Indigenous business	Opportunities for Traditional Owner participation in businesses, e.g. land and coastal management, timber harvesting, civil construction, contract mining, eco-tourism services, training and development, seed collection and rehabilitation, cultural heritage management.	▪ Proactively consider tenders for Project contracts which involve local Indigenous people and/or local Indigenous enterprises. This may include joint ventures, direct employment, training opportunities, equipment usage or cooperative arrangements with local Indigenous people and enterprises. ▪ Work collaboratively with key regional stakeholders, including the WCCT, Western Cape Chamber of Commerce and the Regional Partnership Steering Committee to identify and support the ongoing development of Indigenous businesses throughout the region. ▪ Examine applicable contracts for local and Indigenous business opportunities, including the break down of larger contracts into smaller	RTA – prior to commencement of construction In collaboration with: • WCCCC and relevant sub-committee • Traditional Owners • Western Cape Chamber of Commerce • WCCT	Medium, positive	Number and value of business arrangements between RTA and Indigenous organisations	Performance indicators to be reported to DIP (refer **Section 16.4.4**) Quarterly reporting to WCCCC (refer **Section 16.4.4**)

Category	Description of the potential impact	RTA proposed Mitigation and Management Measure	Responsibility and Proposed Timeframe (where relevant)	Residual Impact Significance	Performance Indicators	Monitoring, Reporting and/or Verification Methodology
		jobs to increase the potential opportunities for awarding contracts to local providers of goods and services. ▪ Work collaboratively with the WCCT and Traditional Owners to identify and pursue social, commercial and economic development opportunities associated with the Project. ▪ Provide updates to the WCCTon the status of Indigenous business spending across the RTA operations in line with RTA's existing reporting requirements for employment and training. ▪ In collaboration with key local and regional stakeholders, RTA would identify opportunities to support the implementation of a range of business development programs and support services. ▪ RTA supports the establishment of a timber harvest operation south of the Embley River.				
	Development of Indigenous businesses through the involvement of external stakeholders, including government agencies across the Western Cape.	▪ Support for the development of Indigenous businesses in collaboration with Weipa Chamber of Commerce and other Government agencies.	RTA – prior to commencement of construction In collaboration with: • WCCCC and relevant sub-committee • Traditional Owners • Western Cape Chamber of Commerce • WCCT	Medium, positive	Number of business arrangements between local companies and Indigenous organisations	Performance indicators to be reported to DIP (refer **Section 16.4.4**) Quarterly reporting to WCCCC (refer **Section 16.4.4**)
Local	Opportunities for local businesses associated with the	▪ Local businesses would be provided with relevant information on future	RTA - ongoing	High, positive	Number of business arrangements between RTA	Performance indicators to be reported to DIP (refer

Category	Description of the potential impact	RTA proposed Mitigation and Management Measure	Responsibility and Proposed Timeframe (where relevant)	Residual Impact Significance	Performance Indicators	Monitoring, Reporting and/or Verification Methodology
businesses	Project during construction and/or operations.	opportunities arise from RTA's proposed development activities.	In collaboration with: • Western Cape Chamber of Commerce		and local companies	**Section 16.4.4**) Quarterly reporting to WCCCC (refer **Section 16.4.4**)
	Loss of staff to RTA. Dependency on RTA. Strict RTA pre-qualification requirements	▪ RTA, through its membership of the Chamber of Commerce, would continue to monitor the impact of its activities on local businesses and work with businesses to address concerns, where possible.	RTA – ongoing In collaboration with: • Western Cape Chamber of Commerce	Medium, negative	Number of complaints relating to local business impacts	RTA internal complaint reporting and investigation procedure (refer **Section 16.4.3**) Performance indicators to be reported to DIP (refer **Section 16.4.3**) Quarterly reporting to WCCCC (refer **Section 16.4.4**)
Workforce						
Construction Camp	Illegal transportation of alcohol into communities from Camp. Excessive consumption of alcohol on-site leading to damage to places on cultural or environmental significance.	▪ Camp alcohol controls: as restricted hours, sale of alcohol restricted to employees/contractors, limits on consumption, drinking confirm to wet mess. ▪ Zero drug and alcohol limit for work. ▪ Random drug and alcohol testing program	RTA – prior to commencement of construction and ongoing	Low, negative	Number of relevant incidents	RTA internal incident reporting and investigation procedure
	Increased usage and damage to flora/fauna, coastal areas and significant cultural heritage sites by employees/contractors accessing areas outside of working hours.	▪ Entertainment and recreational facilities provided at the camp. ▪ Rosters implemented to minimise recreational time spent south of Embley River. ▪ Controlled external activities for construction workforce to minimise impact on surrounding environment	RTA – prior to commencement of construction and ongoing In collaboration with: • WCCCC and relevant sub-committees • Traditional Owners	Low, negative	Number of permit infringements/unauthorised access Number of community complaints	RTA internal complaint reporting and investigation procedure (refer **Section 16.4.3**) Quarterly reporting to WCCCC (refer **Section 16.4.4**)

Category	Description of the potential impact	RTA proposed Mitigation and Management Measure	Responsibility and Proposed Timeframe (where relevant)	Residual Impact Significance	Performance Indicators	Monitoring, Reporting and/or Verification Methodology
		and communities. ▪ Activities conducted outside of the camp boundaries would be controlled by a permit system. ▪ RTA, in collaboration with Traditional Owners, would identify potential access points for external out of work activities.				
FlyIn/FlyOut (FIFO) Construction Contractors	Opportunity to use FIFO to minimise potential for social disharmony and demands for accommodation from construction contractors.	▪ The majority of the construction workforce would be on FIFO rosters. ▪ A small proportion of the construction workforce would be locally based through employment with local sub-contractors.	RTA – prior to commencement o construction	Low, positive	Number of FIFO construction workers Number of locally based construction workers	Internal RTA records
Daily commute	Social disharmony and fatigue associated with working arrangements for employees who reside in Aurukun.	▪ The Project operational workforce would commute daily from Weipa/Napranum. ▪ Facilitate provision of access and transport for Traditional Owners living in Aurukun and working in the mine. ▪ Existing rental subsidy arrangements would apply to employees.	RTA – prior to commencement of operations and ongoing In collaboration with: • WCCCC and relevant sub-committees • Traditional Owners	Low, negative	Access and transport arrangements for residents of Aurukun to be determined.	Quarterly reporting to WCCCC (refer **Section 16.4.4**).
	Employee fatigue and associated social disharmony associated with additional travel would be required each day during operations to commute to the Project area.	▪ The existing roster arrangements would be adopted at the Project. ▪ RTA would provide a bus for the workforce travelling between Hey River barge/ferry terminal and site. ▪ Appropriate fatigue management strategies would be a priority.	RTA – prior to commencement of operations and ongoing	Low, negative	Number of fatigue related incidents	RTA internal incident reporting and investigation procedure
Operations employees	Potential for anti-social behaviour on Project area while off-work (e.g. alcohol	▪ Continuing to implement workforce induction and awareness sessions to communicate requirements relating to	RTA – ongoing	Low, negative	Number of relevant incidents / complaints	RTA internal complaint reporting and investigation procedure (refer **Section**

Category	Description of the potential impact	RTA proposed Mitigation and Management Measure	Responsibility and Proposed Timeframe (where relevant)	Residual Impact Significance	Performance Indicators	Monitoring, Reporting and/or Verification Methodology
	consumption, use of firearms, unauthorised access to areas of cultural heritage significance, shooting cattle etc).	safety, security, behaviour and land access both on and off the mining lease. ▪ Assist Traditional Owners to develop a permit system controlling access to places of environmental and cultural heritage significance. ▪ Developing, in collaboration with police, a strategy to ensure effective response to incidents. ▪ Continuing to implement a complaints system and incident management process whereby any reported incidents of unacceptable behaviour are investigated. ▪ The use of firearms on the mining leases would not be permitted.	In collaboration with: • WCCCC and relevant sub-committees • Traditional Owners			**16.4.3**)
Demographic Changes						
Population influx	Potential influx of additional people to Weipa associated with construction and operational activities, straining services	▪ Construction contractors would be predominantly on FIFO arrangements. ▪ Operational workforce (and projected population) is no higher than in the past for 15Mdptpa and 30Mdptpa production scenarios. ▪ RTA would assist with the planning and implementation of mitigation measures associated with production capacity expansions above 30Mdptpa.	RTA – FIFO arrangements to be in place prior to construction. Relevant government agencies to be advised prior to capacity expansion above 30Mdptpa.	Low, negative	Workforce numbers. Weipa population.	Internal RTA records ABS records
Economic Impacts						
Economic profile	Contribution to local economy from direct and flow on effects	▪ The annual direct and indirect input into the local economy at the 15Mdptpa production rate is estimated by modelling to be $671	RTA – ongoing In continued collaboration with community stakeholders and	High, positive	ABS economic indicators for Cook Shire Council (which is the local statistical boundary) (refer Section	Performance indicators to be reported to DIP (refer **Section 16.4.4**)

Category	Description of the potential impact	RTA proposed Mitigation and Management Measure	Responsibility and Proposed Timeframe (where relevant)	Residual Impact Significance	Performance Indicators	Monitoring, Reporting and/or Verification Methodology
		million. ▪ Plan for and support economic development of Weipa and the Western Cape region.	government agencies, including WTA, Shire Councils, RPA Steering Committee, Chamber of Commerce, WCCCC, Ely Coordinating Committee and various educational institutions.		17.3 of the EIS)	
	Loss of staff from local businesses to RTA. Dependency on RTA.	▪ RTA, through its membership of the Chamber of Commerce, would continue to monitor the impact of its activities on local businesses and work with businesses to address concerns, where possible.	RTA - ongoing In collaboration with: • Western Cape Chamber of Commerce	Medium, negative	Number of relevant issues raised through the Western Cape Chamber of Commerce.	Performance indicators to be reported to DIP (refer **Section 16.4.4**)
Housing and property values						
Rents, land an housing prices	Increased demand for housing results in excessive inflation of property values and rents in Weipa	▪ Operational workforce (and projected population) is no higher than in the past for 15Mdptpa and 30Mdptpa production scenarios ▪ If required, RTA would seek approval for adjustment of the town boundary and development of additional housing to increase housing supply	RTA – as required In collaboration with: • WTA	Low, negative	Number of vacant lots and houses for sale	RTA / WTA records
Cumulative impacts						
Project and Aurukun Bauxite Project	Duplication of infrastructure and services between the tow projects, resulting in cumulative impacts for the projects on the environment and surrounding communities. Opportunity to share dams, ports, roads, airstrips etc.	▪ RTA has been liaising with Chalco during the Project planning phase to discuss potential co-location and/or sharing of certain infrastructure. Where possible, and subject to commercial agreement, RTA would look to minimise environmental and property impacts in the event that the Aurukun lease is developed (refer **Section 20**). ▪ Some impacts could be minimised by the establishment of a common infrastructure corridor for RTA's water	RTA and other project proponents – as required In collaboration with: • Relevant government agencies	Medium, negative	Commercial agreement between adjacent projects (where relevant)	Performance indicators to be reported to DIP (refer **Section 16.4.4**)

Category	Description of the potential impact	RTA proposed Mitigation and Management Measure	Responsibility and Proposed Timeframe (where relevant)	Residual Impact Significance	Performance Indicators	Monitoring, Reporting and/or Verification Methodology
		pipeline, transmission line and overland conveyor (from the Norman Creek plant) and the Aurukun Project's overland conveyor to the proposed port and by co-location of port and stockpile facilities ▪ RTA, in liaison with other adjacent project proponents, would endeavour to identify cumulative impacts and opportunities associated with employment, training and business development for the local communities. ▪ RTA would seek to co-ordinate its' programs with others, including government programs and services currently being implemented in the region, and, where appropriate, would partner with the relevant Government agency.				

Economic impacts, including the degree of service revenue and project work likely to be generated locally, are discussed in **Section 17**.

These potential impacts (risks) and the proposed mitigation measures will be incorporated into RTA's existing community relations program.

16.4.3 Community Engagement

A comprehensive stakeholder engagement plan for ongoing consultation and engagement would be developed prior to the commencement of construction (refer **Section 16.3.3**). This would ensure continuity of engagement with key stakeholders identified in **Section 15**. To improve the effectiveness of RTA's engagement with local communities, a Community Forum would be established in Weipa to facilitate two-way communication with the broader Weipa community. RTA would also work collaboratively with Aurukun Shire Council to establish a permanent office in Aurukun to coordinate RTA activities.

The WCCCC SoE Sub-Committee would continue to provide the primary consultative mechanism between RTA and Traditional Owners throughout the EIS process. At the conclusion of this period the WCCCC would decide whether there is a need to continue this forum, in addition to the existing Sub-Committees that operate for current Weipa operations. Progress reports and forward looking plans on all activities associated with the Project, including heritage surveys and development of management plans, Traditional Owner consultation and engagement activities, drilling programs and ongoing environmental work, would be submitted for consideration at least quarterly to this Sub-committee. Formal recommendations would be forwarded to the WCCCC for endorsement prior to implementation.

The existing RTA complaints procedure would be adopted for the Project, and includes:

- maintenance of a register of complaints held on-site;
- a process for receiving, handling and investigating complaints;
- providing expeditious investigation and a response as soon as practicable, and
- giving a non-compliance notification to any party whose actions have caused a complaint as a result of non-compliance with environmental requirements.

16.4.4 Monitoring, Reporting and Review

Monitoring of key performance indicators would be carried out, predominantly to address medium and high impacts, but also low impacts where relevant. Monitoring would also track progress on implementation of mitigation strategies and capture information with which to advise communities and government on progress and achievements. This would include current status against targets and planned outcomes at key stages of the Project.

RTA would report the results of monitoring and implementation of key measures identified in the SIMP to the Department of Infrastructure and Planning Social Impact Assessment Unit as follows:

- prior to the commencement of construction;
- prior to the commencement of production; and
- 3-yearly during operations.

The SIMP would be reviewed at the same time as the reports are provided, based on the monitoring results.

Where measures relate specifically to impacts on Traditional Owners, the key mechanism for implementation and monitoring of the SIMP is the WCCCC and relevant sub-committees. Quarterly reports are provided to the WCCCC on a quarterly basis or as otherwise agreed by the committee.

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Environmental Impact Statement

for South of Embley Project

Section 17
Economics

17 ECONOMY

17.1 Introduction

RTA's existing mining operations are located at Andoom and East Weipa. According to the 2006 ABS Census of Population and Housing (2006 Census), more than 40% of the local workforce is employed in the Mining and Mineral Product Manufacturing industry. Mining is the principal driver of the local economy, and all other industries in Weipa. The neighbouring communities of Napranum, Aurukun and Mapoon rely on the existence of mining, to varying degrees, for their own prosperity. This is particularly so for the retailing, manufacturing, construction and business services sectors. The majority of businesses located in Weipa are classified in the Retail Trade and Accommodation, Cafes and Restaurants (Weipa Biz website www.weipabiz). This can partly be attributed to the relatively large tourism trade Weipa accommodates due to the location of nearby recreational fishing activities and to visiting contractors and service providers supporting the mining operations.

During stakeholder consultations held as a part of the 2007 Weipa Community Baseline Study (SGS 2008), prepared on behalf of RTA, the Weipa Chamber of Commerce noted business in Weipa was heavily reliant on RTA's mining operations. It also noted the local mining operations in the region impact upon the ability of local businesses to employ and retain staff given the high demand for labour and the relatively high remuneration offered by employment in the mining industry. As such, the ongoing prosperity and dynamics of the local economy is heavily reliant on, and affected by, the sustained presence of RTA's operations around the townships of Weipa, Napranum, Mapoon and Aurukun. The findings of the Weipa Community Baseline Study showed the Weipa economy and community would experience significant adverse impacts as a result of the withdrawal or decline of the local mining industry. With the planned construction and operation of the Project, it is considered the current contribution of mining to the local economy would only be enhanced, even allowing for when the existing operations at East Weipa and Andoom are exhausted. As shown in this section of the report, the proposed construction and operation of the Project would also serve to deliver significant economic benefits to the regional, Queensland and Australian economies.

The Western Cape region contains significant bauxite resources. As of 31 December 2010, a total of 1,602 million tonnes of bauxite reserves with a 53.0% grade have been reported within RTA's Weipa mining leases, with a considerable proportion of the reserve within the Project portion of ML 7024. Cape Alumina has identified 130Mt in-situ bauxite resource at the Pisolite Hills mineral deposit and it also holds other exploration tenements in the Western Cape area. An in-situ bauxite resource of 439Mt has also been identified in the Aurukun Project area to the east of the Project area.

RTA proposes to develop the Project in response to the gradual depletion of bauxite reserves north of the Embley River, combined with international demand for bauxite. The Project is required in order to continue to supply RTA's Yarwun and Queensland Alumina Limited alumina refineries.

The Project involves a staged increase in production up to 50 million dry product tonnes per annum (Mdptpa). The initial installed capacity is subject to ongoing feasibility studies, but is likely to be either 15Mdptpa or 22.5Mdptpa. Actual production rates and the timing and size of capacity expansions would depend on market conditions. The EIS has been prepared to assess the impact of several different levels of production: a minimum rate of 15Mdptpa, a maximum rate of 50Mdptpa, and a nominal intermediate rate of 30Mdptpa.

There is not expected to be any significant forgone industry outputs as a result of the Project. The Project area is currently not utilised for agricultural purposes. There is also not expected to be a reduction in economic output from the commercial fishing industry.

Community concerns regarding access to the Project area for recreational pursuits, such as camping and fishing, and proposed mitigation measures are described in **Section 16.3.2**. RTA would continue to manage access for Traditional Owners in accordance with existing established access protocols, which would be extended to the Project area. The critical area for camping is Amban and Waterfall which, in accordance with the obligations outlined within the

Western Capes Communities Co-existence Agreement (WCCCA), RTA would maintain access to as far as is safe and practical. This obligation extends to other identified significant sites identified by Traditional Owners. RTA would also work with Traditional Owners and other relevant stakeholders to develop an effective permit system to allow controlled access to the Project area for recreational purposes.

17.2 Overview of the Existing Economic Environment

The economy for which this impact assessment is focussed is that of the combined statistical local areas of Weipa, Aurukun, Napranum and Mapoon. It is estimated the gross regional product (GRP) of the local economy, which includes the above statistical local areas area as well as the Cook Shire Local Government Area, was approximately $475 million in 2009.

At the time of the 2006 Census, the total population of the four statistical local areas of the Western Cape region was 5191 persons. Weipa accounted for most of the region's population with 3089 persons, followed by Aurukun (1039 persons), Napranum (829 persons) and Mapoon (234 persons).

According to the ABS Journey to Work data, the workforce of the local economy consists of 3675 jobs. The 2006 Census also evaluated labour force participation rate, which refers to the number of people who are either employed or actively seeking work, as a percentage of the total population aged 15 years and over. In 2006, Weipa had the region's highest labour force participation rate of 79% followed by Mapoon (66%), Napranum (48%), and Aurukun (47%). Weipa's labour force participation rate was higher than that for the Far North Statistical Division (SD) and Queensland (63% and 62% respectively). Refer to **Section 16.2.5** for more detail on the population and labour force statistics.

A breakdown of household and individual incomes is provided in **Section 16.2.5 Figure 16 – 14** and **Figure 16 – 15**. Gross individual income in Weipa was predominantly in the higher income brackets, with more than 50% of employed residents earning $1000 or more a week, reflecting the large proportion of the workforce engaged in the mining industry. Incomes in Weipa were generally higher than those for Far North SD. Individual incomes for Aurukun, Napranum and Mapoon residents were much lower than for Weipa residents, and also lower when compared to Far North Queensland as a whole. This would largely reflect the lack of employment opportunities in these areas.

RTA is responsible for the administration of the town of Weipa, which it does through the Weipa Town Authority (WTA). The WTA acts in the role of Local Authority to supply infrastructure and services of a similar nature to those supplied by local Councils throughout Australia. These services include road maintenance, water supply, town planning, sports and recreational facilities, and waste collection and disposal. RTA also provides infrastructure, such as electricity supply, a child-care facility, occupational health centre and the airport. In 2006, the running costs for the Weipa town amounted to more than $3.2 million. Refer to **Section 16.2.2, Section 16.2.3,** and **Section 16.2.4** respectively for more detail on other community infrastructure, health, and education facilities.

The proportional representation of employment by industry is provided in **Section 16.2.5** and **Figure 16 – 13**. Mining and Mineral Product Manufacturing was the largest employer, accounting for 43% of resident jobs in Weipa, followed by Education and Training (9%), Public Administration and Safety (9%), Healthcare and Social Assistance (6%) and Retail Trade (6%). The industry breakdown shows the integral nature of the mining industry to the Weipa community. Mining accounts for around three-quarters of Weipa's total economic output (SGS Economics and Planning Pty Ltd (SGS) 2008).

The unemployment rate at the time of the 2006 Census was 1.4% for Weipa and 2.7% in Mapoon, including people employed through Community Development Employment Projects. This was significantly lower than Far North SD (4.4%) and Queensland (4.7%). However, the unemployment rates were higher than both the state and the region in Aurukun (8.1%) and Napranum (5.7%).

Employees and contractors currently working at the Weipa operations live predominantly in Weipa, with some in Napranum. This is expected to continue when the Project is developed. Information on the current housing market is provided in **Section 16.2.6**.

The Stage I Golf Links Estate has three vacant commercial lots, including one lot where a 60-70 bed motel is proposed. There are also two vacant privately owned commercial lots in the Nanum Shopping precinct. Stage II of the Golf Links Estate is approved but not yet developed and would provide an additional 65 residential lots in Weipa.

17.3 Economic Modelling

In order to assess the economic impacts of the Project, SGS prepared and applied a purpose-built, input-output model to assess the likely economic impacts arising from the construction and operation of the Project.

The impact assessment examines how a particular project, business or industry (in this case, the Project) affects an economy through all of the backward and forward expenditure linkages between all industries in the economy (i.e. the inter-industry flows). It takes the initial effect of a project, business or industry stimulus (the Project construction and operation), known as the "economic stimulus", and traces all of the "multiplier", or "flow-on" effects, and "production" and "consumption"- induced effects, in the local, regional, State and national economies.

Production-induced effects relate to how local "upstream" industries (i.e. suppliers to the Project construction and operation) benefit from the increased demand for their goods and services as a result of gaining supply contracts, awarded by RTA in the case of Project, and increases in their own local purchasing, enabling them to service these supply contracts.

C*onsumption-induced* effects relate to the increased spending of wage and salary earners (RTA's employees and contractors at the Project and employees of suppliers to the mine) on items such as food, clothing, personal services, housing, etc. and how local supplier purchases change in order to meet these induced purchases.

The final result is an overall picture of the total economic contribution of the Project's construction and operation on the local, FNQ, Queensland and Australian economies. These estimated economic impacts are documented in **Section 17.4**. Note all impacts identified have been expressed in 2010 prices. The exact nature of these impacts, their definition and how they are quantified is explained below.

Economic Impacts Defined – Output, Value Added and Employment

The Project's initial economic effect and its flow-on, or multiplier effects (refer to detailed explanation below) are expressed in terms of the "output", "value added" and "employment" impacts of the proposed mining operations on the local economy as well as the FNQ, Queensland and Australian economies.

The construction processes required to establish the Project are also considered and their estimated economic impacts quantified.

Impacts to the "local economy" take into account the four statistical local areas as well as the Cook Shire Local Government Area. Given the nature of the statistical boundaries in the region, the Cook Shire was included in the input-output modelling to ensure the most accurate multipliers for the local area. It is important to note, however, the majority of the impacts are assumed to be localised in the Weipa area.

While these measures describe how the initial effects of the construction and operation of the Project are manifested in the local and broader economies in different ways, they are not cumulative or additive. Each type of economic impact considered is described as follows:

- "Output" refers to the value of the total sales of goods and services produced in the local/FNQ/Queensland/Australian economy by the construction and operation of the Project, factoring in a number of inputs, including imports. The direct contribution or total output "to the local economy" is the direct output of the proposed Project, which is located in the local area. However, it does not imply an amount that is entirely

absorbed in the local economy. The total amount of direct output is made up of various components including gross operating surplus, of which some would likely leave the area.

Another component is expenditure on various inputs that are sourced from outside of the area. This, similarly, applies to the analysis of the FNQ and Queensland economies;

- "Value Added" (factor incomes) is the equivalent of net output and refers to the contribution of the construction and operation of the Project to the value of all goods and services produced in the local/FNQ/Queensland/Australian economy, less taxes, imports and inter-industry supplies of non-labour inputs. Value added is the majority component of a region's GRP, the only difference being it does not include taxes (less subsidies). Put simply, value added is the increase in the value of a good at each stage of the production process. Therefore, value added is the difference between the value of final goods produced minus the cost of buying in raw materials and intermediate goods from outside the economy in question. In terms of the Project, the "value added" is the sales price (value of output) minus the cost of raw materials, chemicals, other non-labour inputs and imports used in the production process. It is purely the value-added component of the products measured and not the total sale value being recounted as the product moves from industry to industry.
- "Employment" refers to the number of full-time equivalent (FTE) jobs supported in the local/FNQ/Queensland/Australian economy by the construction of the Project and its operation. "Employees" are people directly employed by RTA on the Project. "Contractors" are people employed on the Project through a contracting company. "Flow-on" or "indirect" jobs are those estimated to be generated elsewhere in the community/region/state/nation by the Project.

Economic Modelling Inputs and Assumptions

As noted above, a purpose-built input-output model was prepared for the Project by SGS to assess the economic contribution of the construction and operation of the Project to the local (Weipa, Aurukun, Napranum and Mapoon), regional (FNQ SD), Queensland and Australian economies.

The National 109 Industry Input-Output (IO) Table (the "IO table"), published by the Australian Bureau of Statistics (ABS), was aggregated to 17 industries for the purpose of this assessment. Using information on the local, regional and state employment structure (from the 2006 Census) and financial data acquired by SGS directly from RTA for this assessment, the IO table was then modified for the local, regional and State economies. The result is a purpose-built, or tailored economic model, which was used to undertake the economic assessment of the Project at the local, regional, State and national levels.

The impact assessment examines how the Project would affect the economy through all of the inter-industry flows in that economy (i.e. the linkages between industries). An indicative production schedule is presented in **Table 1-1,** however, it should be noted the timing and size of production increases are subject to market conditions. For the purposes of the economic impact assessment, given that construction would not start earlier than 2011, a base year of 2013 has been assumed for operations. Modelling begins with an evaluation of the construction impacts, using the financial information provided by RTA, against the local, FNQ, Queensland and Australian IO tables, to estimate the contribution, or worth, of the Project's construction to the economies of interest. Once the construction impacts have been determined, the operational impacts are analysed.

For economic modelling purposes, the Project operations have been separated from the broad industry classifications making up the local economy. That is, the 17 industry IO table has been tailored to an 18 industry IO model for the purposes of this assessment. This allows for specific analysis on the output and flow-on effects of the Project.

It is important to note the impacts detailed below are separate to the existing RTA bauxite mining operations at East Weipa and Andoom. Hence, the impacts reported on in this EIS refer only to the impact of the Project.

The multipliers utilised for this impact assessment are based on a localised version of a national IO table, with the base information being 2004-05 national IO tables. These are the most recent available national data. An assumption behind IO models is that industry dynamics are static, when in reality an economy would evolve over time.

The economic impact assessment modelling is based on assumptions and the input criteria utilised. The accuracy of the assessment outcomes depends on the validity of the assumptions used. The multipliers are calculated based on sound methodology. However, they are estimates of the potential impacts associated with the Project, and do not completely reflect the economy evolving differently as a result of the Project. For example, local industries changing their business operations to better capture the benefits of the impacts. Nonetheless, the results produced by using the multipliers generated by the IO tables provide reliable information regarding the impact under current conditions.

Project-specific input criteria were provided to SGS by RTA for modelling. There is some limitation in classifying some data by industries and having an accurate breakdown of the location of expenditure by RTA. Therefore, assumptions have been made about the industry classification of all expenditure items and the geographical location of these costs.

The Extent of Economic Impact – Initial and Multiplier Effects

The three measures of economic impact defined above – output, value added (factor incomes) and employment - may be calculated given the value of the initial stimulus (output) to the economy.

The output generated by a particular process is termed the direct output or direct stimulus to the economy. Applying the appropriate economic "multiplier" to that output generates the total output produced in the economy by that initial stimulus.

The difference between the total impact of a stimulus to the economy and the initial stimulus itself is called the flow-on impact. This flow-on impact refers to the "multiplier effect". As an example, given an initial stimulus of $1 and an associated output multiplier of 1.3, the total output generated by that $1 is $1.30, $0.30 of which is the flow-on impact. Similarly, the value-added and employment impacts are both calculated using appropriate initial multipliers in the economic model.

It is important to note at this point of the analysis that flow-on, and therefore some of the total impact of a stimulus to the economy, would not always be realised immediately. For example, an initial stimulus from the Project in year one would generate flow-on effects, of which some may not be realised until the years two, three and so on.

17.4 Potential Impacts and Mitigation Measures

17.4.1 Construction Phase Impacts

The construction phase of the Project would take place in stages as capacity expansions occur. The initial stage of construction (conservatively assumed to be site establishment to 15Mdptpa capacity) is reported on in this EIS, as there is insufficient data to analyse the subsequent construction stages. The initial production capacity is subject to ongoing feasibility studies but is likely to be either 15Mdptpa or 22.5Mdptpa. The initial stage of construction is anticipated to take place over three years.

Using output, value-added and employment multipliers generated through IO modelling, as described above, the impacts of the construction of the Project on the local (Weipa, Aurukun, Napranum and Mapoon), FNQ, Queensland and Australian economies over the initial stage of construction has been estimated. **Table 17-1** below provides a detailed breakdown of the initial construction impacts on all the economies of interest.

Note the figures presented in this table are not cumulative and each of the smaller economies is a subset of the larger. For example, any impact on the "local" economy is also included in the "regional" economy. The difference between the two is a measure of the additional impact generated in the regional economy. This applies to any subset of a particular economy and throughout the following sections.

Table 17 – 1 Construction to 15Mdptpa Capacity Economic Impacts (over 3 years)

		Local	FNQ	Queensland	Australia
Output ($ Million)	Direct	$264.0	$527.9	$989.9	$1319.8
	Flow-on	$201.7	$612.2	$1829.3	$2828.2
	Total	**$465.6**	**$1140.1**	**$2819.1**	**$4148.0**
Value-Added ($ Million)	Direct	$74.6	$199.2	$346.5	$467.1
	Flow-on	$52.0	$289.4	$824.1	$1247.9
	Total	**$126.6**	**$488.6**	**$1170.5**	**$1715.0**
Employment (average annual full-time equivalent (FTE) positions)	Workforce	307	307	307	307
	Flow-on	179	395	632	705
	Total	**486**	**702**	**939**	**1011**

Impact on Local Economy – Construction to 15 Mdptpa Capacity

Output

The construction of the Project would generate a direct contribution of $264.0 million into the local economy (Weipa and Aurukun as well as Cook Shire area) over the three-year construction period. This initial stimulus would result in an indirect contribution of $201.7 million, resulting in a total injection of $465.6 million into the local economy over the three-year construction period.

It is estimated the local economy was worth approximately $3.03 billion annually in 2009, with the total contribution to the economy of the initial construction ($465.6 million) approximately 15% of the 2009 local economic output.

Value Added

Of the $465.6 million injected into the local economy during the construction process, $126.6 million can be attributed to the total value-added component. The direct value-added contribution over the construction period is $74.6 million. The indirect contribution to the local economy's value-added component is $52.0 million. The total value-added component is approximately 27% of the GRP estimated for the local economy in 2009 ($475 million).

Employment

During the construction phase, the construction workforce would average 307 full-time equivalent (FTE) jobs (although peak numbers would exceed this). The construction phase would also induce an average of 179 jobs within the local economy over the period, supported by the indirect effect of the initial output stimulus. Thus, the Project would support an average of 486 jobs in the local economy over the construction period. This is significant given the workforce of the local economy (including Cook Shire) consists of 3675 jobs, according to 2006 Census data.

Impact on Far North Queensland Economy –Construction to 15 Mdptpa Capacity

Output

The construction process for the Project would directly contribute $527.9 million to the FNQ economy over the period. The indirect contribution associated with this stimulus would be $612.2 million, making a total of $1.14 billion of output generated during construction. This is

approximately 2.3% of the estimated total output for the whole of the FNQ economy in 2009 ($49.6 billion).

Value Added

The output generated would in direct terms produce a value-added contribution of $199.2 million and an indirect contribution of $289.4 million. This equates to a total value-added component of $488.6 million over the construction period of the Project. The construction value added is worth around 3.6% of the estimated $13.4 billion of GRP generated in the FNQ economy in 2009.

Employment

An average of 307 jobs, including management and owners, would be directly required for construction, leading to an estimated further 395 jobs being generated in the FNQ economy. Thus, the construction of the Project would support an average of 702 jobs in FNQ over this period.

Impact on Queensland Economy – Construction to 15 Mdptpa Capacity

Output

The Queensland economy would sustain a direct contribution of $989.9 million during the construction period of the Project. The indirect contribution associated with this stimulus would be $1.83 billion, making a total injection of $2.82 billion as a result of construction. This equates to around 0.3% of the estimated output generated in the Queensland economy in 2009 ($865.7 billion).

Value Added

There would be $1.17 billion attributable directly to the value-added component of the $2.82 billion of output, made up of a direct value-added contribution of $346.5 million and an indirect contribution of $824.1 million. The total value-added is around 0.5% of the Gross State Product (GSP) of Queensland for the financial year ending 2009 ($243.9 billion).

Employment

Over the period of construction of the Project, inclusive of management and owners, there would be an average of 307 jobs directly required, leading to an estimated further 632 jobs being generated in the Queensland economy. Thus, the first stage of construction would support an average of 939 jobs in Queensland over the initial construction period.

Impact on Australian Economy – Construction to 15 Mdptpa Capacity

Output

The construction process for the Project would directly contribute $1.32 billion to the Australian economy. The indirect contribution associated with this stimulus would be $2.83 billion, making a total of $4.15 billion of output generated for the Australian economy associated with the construction of the Project. This equates to around 0.1% of the total estimated output generated in the Australian economy for 2009 ($4.3 trillion).

Value Added

The output generated would, in direct terms, produce a value-added contribution of $467.1 million and an indirect contribution of $1.25 billion. This equates to a total value-added component of $1.72 billion for the Australian economy over the construction period, which equates to about 0.1% of the Australian Gross Domestic Product (GDP) for the financial year ending 2009 ($1.25 trillion).

Employment

An average of 307 jobs, including management and owners, would be directly required during the construction period, leading to an estimated further 705 jobs being generated in the Australian economy indirectly. Thus an average of 1011 jobs would be supported in the Australian economy over the construction period of the Project.

17.4.2 Operational Impacts

The Project involves a staged increase in production up to 50Mdptpa. The initial production capacity is subject to ongoing feasibility studies but is likely to be either 15Mdptpa or 22.5Mdptpa. Actual production rates and the timing and size of capacity expansions would depend on market conditions. The EIS has been prepared to assess the impacts of several different levels of production: a minimum rate of 15Mdptpa, a maximum rate of 50Mdptpa, and a nominal intermediate rate of 30Mdptpa.

Table 17-2 below provides a summary of the operational impacts of the Project for the three progressive production scenarios of the mine over its life. Again, the figures presented in this table are not cumulative and each of the smaller economies is a subset of the larger.

Table 17 – 2 Operational Economic Impacts (per annum)

15Mdptpa Production Scenario		**Local**	**FNQ**	**Queensland**	**Australia**
Output ($ Millions)	Direct	$575	$575	$575	$575
	Flow-on	$96	$182	$257	$423
	Total	**$671**	**$757**	**$832**	**$998**
Value Added ($ Millions)	Direct	$350	$350	$350	$350
	Flow-on	$33	$86	$116	$188
	Total	**$383**	**$437**	**$467**	**$539**
Employment (average annual FTE positions)	Employees	400	400	400	400
	Contractors	100	100	100	100
	Flow-on	390	788	1,170	1,771
	Total	**890**	**1288**	**1670**	**2271**
30Mdptpa Production Scenario		**Local**	**FNQ**	**Queensland**	**Australia**
Output ($ Millions)	Direct	$1150	$1150	$1150	$1150
	Flow-on	$212	$401	$717	$934
	Total	**$1362**	**$1551**	**$1867**	**$2084**
Value Added ($ Millions)	Direct	$680	$680	$680	$680
	Flow-on	$72	$190	$323	$415
	Total	**$752**	**$870**	**$1003**	**$1095**
Employment (average annual FTE positions)	Employees	760	760	760	760
	Contractors	190	190	190	190
	Flow-on	897	1,772	3,263	3,940
	Total	**1847**	**2722**	**4213**	**4890**
50Mdptpa Production Scenario		**Local**	**FNQ**	**Queensland**	**Australia**
Output ($ Millions)	Direct	$1917	$1917	$1917	$1917
	Flow-on	$335	$631	$1135	$1469
	Total	**$2252**	**$2548**	**$3052**	**$3386**
Value Added ($ Millions)	Direct	$1156	$1156	$1156	$1156
	Flow-on	$114	$299	$509	$651
	Total	**$1269**	**$1455**	**$1665**	**$1807**
Employment (average annual FTE positions)	Employees	1020	1020	1020	1020
	Contractors	255	255	255	255
	Flow-on	1462	2835	5278	6245
	Total	**2737**	**4110**	**6553**	**7520**

17.4.3 Impacts on Local Economy

The direct and indirect contribution of the Project to the local economy are summarised below in terms of output, value added and employment per annum.

Output per annum

The output, directly generated by a production rate of 15Mdptpa would be worth $575 million, whilst the indirect output induced from the local economy would be $96 million. The total value of operations at 15Mdptpa would thus be $671 million.

The size of the local economy was estimated to be $3.03 billion in 2009, in terms of output. Therefore, the Project at 15Mdptpa would be contributing, directly and indirectly, a significant output, to the value of approximately 22% of the local economy's present output. This is significant considering RTA's existing operations in Weipa account for a significant share of the region's mining operations, which is worth an estimated 75% of Weipa's total economic output. At this level of production, the Project would be generating approximately $123 million in taxes and royalties, some of which would be injected back into the local economy.

At the 30Mdptpa production scenario, the output generated by the Project would be $1,150 million. This would generate $212 million of indirect output in the local economy, resulting in a total impact of $1,362 million. This is approximately 45% of the current local economy's output in 2009, and would require payment of around $246 million in royalties and taxes.

At maximum production, the mine would be operating at 50Mdptpa per year resulting in output worth $1.92 billion annually, which induces an indirect impact of $335 million in the local economy. In total, at 50Mdptpa production rate, the value of the Project to the local economy would be $2.25 billion, which is around 63% of the current economy's worth. At this level of production, approximately $410 million in royalties and taxes would be paid by the Project.

Figure 17-1 provides a breakdown of the flows of indirect impacts to the local economy at 15Mdptpa. The majority of indirect impacts would be generated in Property and Business Services (33%), followed by Construction (12%). Note that a similar distribution of indirect impacts would be seen at the 30Mdptpa and 50Mdptpa production rates.

Value Added per annum

At 15Mdptpa, the direct value-added component of the Project would be $350 million. The indirect value added induced in the local economy would be $33 million, resulting in a total value added to the local economy of $383 million annually. This equates to around 81% of the estimated GRP generated in the local economy in 2009.

Under the30Mdptpa production scenario, there would be $680 million of direct value added attributable to the mine. The output of the mine would further induce $72 million of indirect value added in other industries of the local economy, making a total contribution to value added of $752 million (around 1.6 times the estimated GRP generated in the local economy for 2009).

At maximum production, the direct value-added component of the operations would be $1,156 million. This would induce $114 million of indirect value added in the local economy for a total value added at 50Mdptpa of $1.46 billion annually (around 3.1 times the estimated GRP generated in the local economy for 2009).

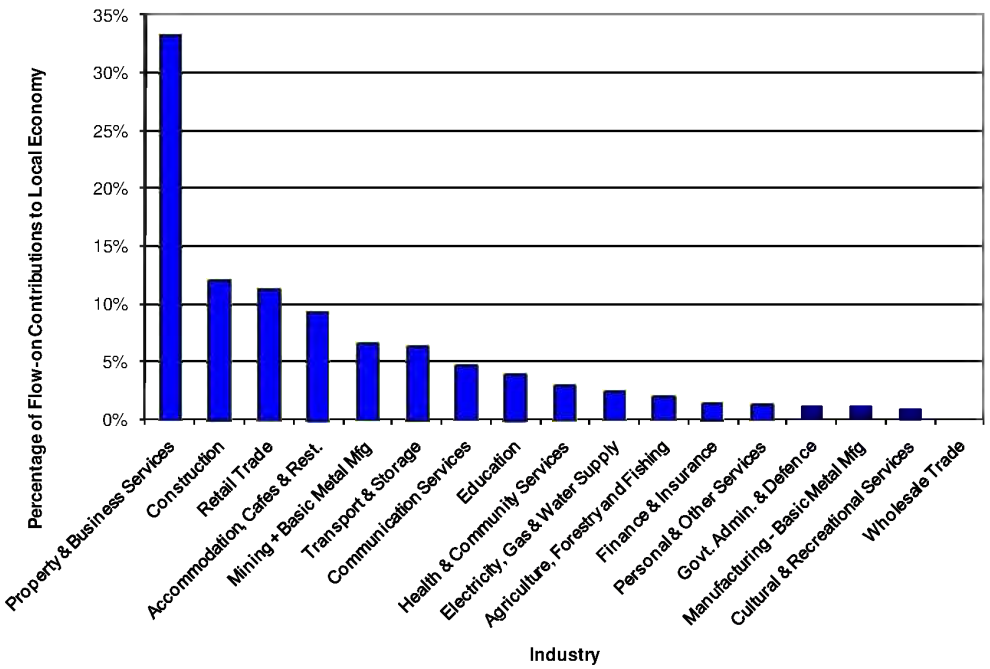

Figure 17-1 Percentage of Flow-on Impacts on Local Economic Output (15Mdptpa)

Employment

The Project would operate with a strong employee-to-output ratio and would generate significant employment opportunities, both directly as well as through the indirect impacts to other sectors resulting from the Project.

At 15Mdptpa, the Project would employ approximately 400 employees and 100 contractors (FTE jobs), while another 390 jobs across other sectors would be generated in the local economy indirectly, resulting in 890 jobs being generated throughout all industries in Weipa and surrounds.

At a production level of 30Mdptpa, there would be approximately 760 employees and 190 contractors employed by the mine, with a further 897 indirect jobs induced locally, making a total of 1847 jobs supported.

At 50Mdptpa, there would be about 1020 employees and 255 contractors employed by the Project. Including the 1462 jobs indirect jobs generated in other industries by the Project, it is estimated there would be 2737 jobs supported in the local economy by the Project at this production rate.

Figure 17-2 provides a breakdown of the flows of indirect employment to the local economy at 15Mdptpa. The majority of indirect impacts would be generated in Property and Business Services (27%), followed by Retail Trade (24%). Note that a similar distribution of indirect employment would be seen at the 30Mdptpa and 50Mdptpa production rates.

The impacts on the FNQ, the Queensland and the Australian economies of the operational period of the Project would be captured by analysis of the indirect impacts, as the direct output generated would remain the same for all.

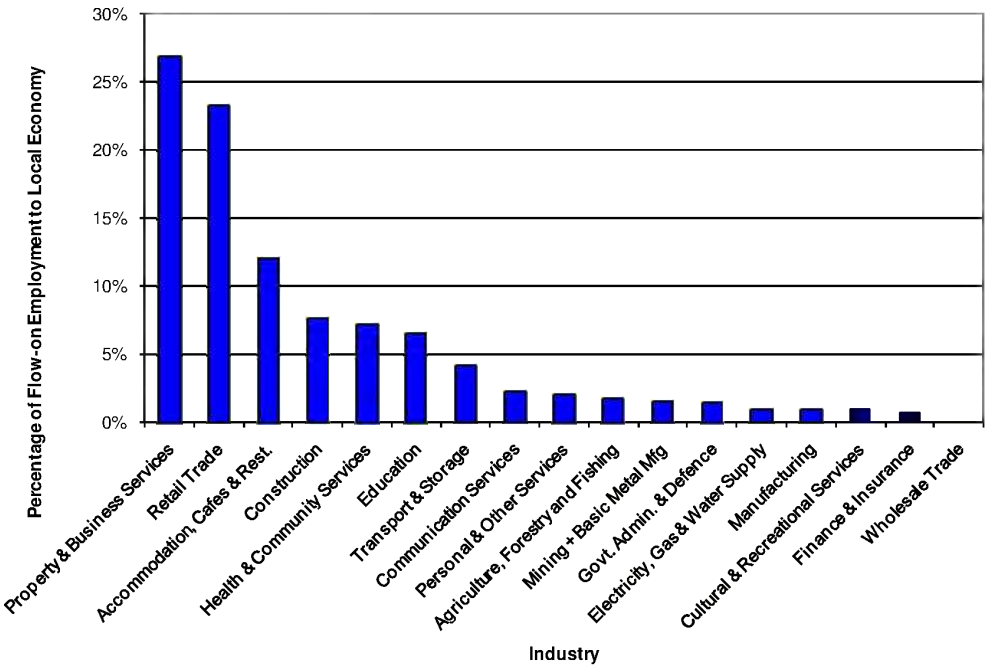

Figure 17-2 Flow-on Employment to Local Economy (15Mdptpa)

17.4.4 Impacts on the Regional Economy

For the FNQ economy, the direct and in-direct effects of the operational aspects of the Project are summarised as follows.

Output per annum

At 15Mdptpa, with direct output of $575 million, the output induced (indirect output) from the FNQ economy would be $182 million. The total value of the Project to the FNQ economy would be $757 million. Therefore, the total output generated by the mine at 15Mdptpa would be worth approximately 1.5% of the regional economy's estimated output for 2009.

Under the production scenario of 30Mdptpa, the output of $1,150 million would generate a further $717 million of indirect output in the FNQ economy. In total, the contribution to the output of the FNQ economy of the Project would be $1.55 billion, which is around 3.1% of the regional economy's estimated output for 2009.

At 50Mdptpa there would be $631 million of indirect output induced in the FNQ economy from the direct output of $1.92 billion. This means at capacity, the total value of operations to the regional economy would be $2.55 billion annually, which equates to around 5.1% of the regional economy's current estimated output for 2009.

Figure 17-3 provides a breakdown of the flows of the indirect impacts to the FNQ economy at 15Mdptpa. The majority of indirect impacts would be generated in Property and Business Services (26%), followed by Retail Trade (13%). Note that a similar distribution of indirect impacts would be seen at the 30Mdptpa and 50Mdptpa production rates.

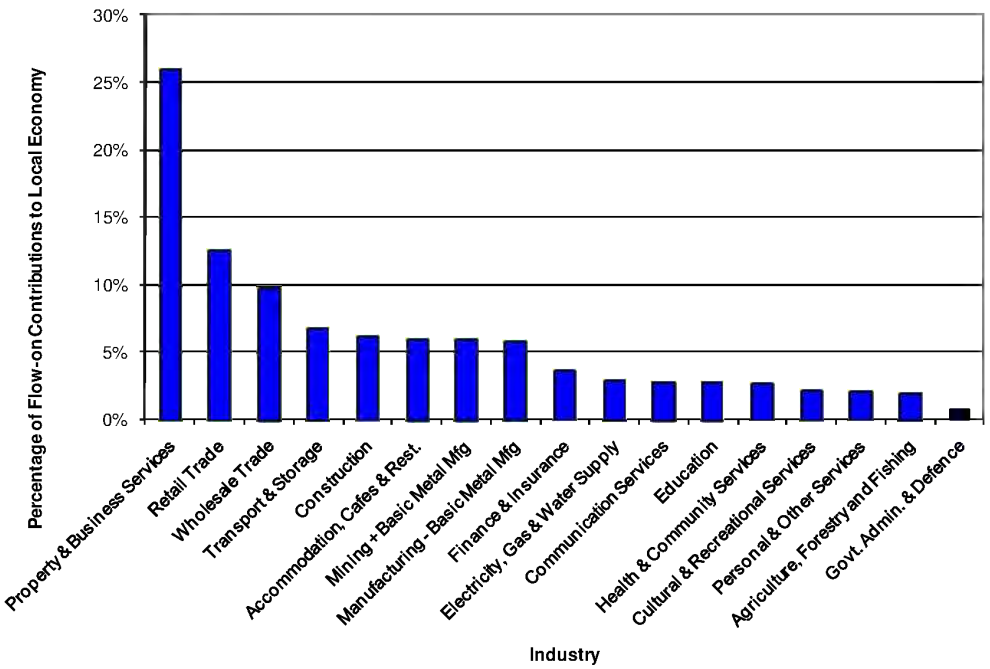

Figure 17-3 Flow-on Impacts on FNQ Economic Output by Industry (15Mdptpa)

Value Added per annum

At 15Mdptpa, there would be a direct value added of $350 million generated and an indirect value added induced of $86 million annually. This would result in a total value added to the FNQ economy of $437 million, which equates to around 3.3% of the total estimated GRP generated in the regional economy ($13.4 billion) for 2009.

Under the 30Mdptpa production scenario, the total value added generated in the FNQ economy would be $870 million, made up of the direct value added of $680 million and the indirect of $190 million. The total value added at this production level equates to around 6.5% of the regional economy's estimated GRP for 2009.

At maximum production (50Mdptpa), the direct value added component of the operations would reach $1,156 million, with output also inducing $299 million of indirect value added in the FNQ economy, giving a total of $1.46 billion annually. This equates to around 10.9% of the regional economy's estimated GRP for 2009.

Employment

It is likely, as a result of the direct jobs provided by the Project at 15Mdptpa, that a further 788 jobs would be generated indirectly across other sectors of the FNQ economy resulting in 1288 jobs being supported throughout FNQ, inclusive of contractors.

There would be 1772 flow-on jobs induced in the FNQ economy by the mine's operations at a 30Mdptpa production scenario, making a total employment contribution of 2722 jobs to the FNQ economy when accounting for the 760 direct employees and the 190 contractors.

At maximum production of 50Mdptpa, 2835 jobs would be supported by the operations in other industries in the regional economy, in addition to the jobs provided directly by the Project. This means a total of 4110 jobs would be supported in the FNQ economy by the Project at 50Mdptpa.

Figure 17-4 provides a breakdown of the flows of the indirect employment to the FNQ economy at 15Mdptpa. The majority of indirect impacts would be generated in Retail Trade

(25%), followed by Property and Business Services (22%). Note that a similar distribution of indirect employment would be seen at the 30Mdptpa and 50Mdptpa production rates.

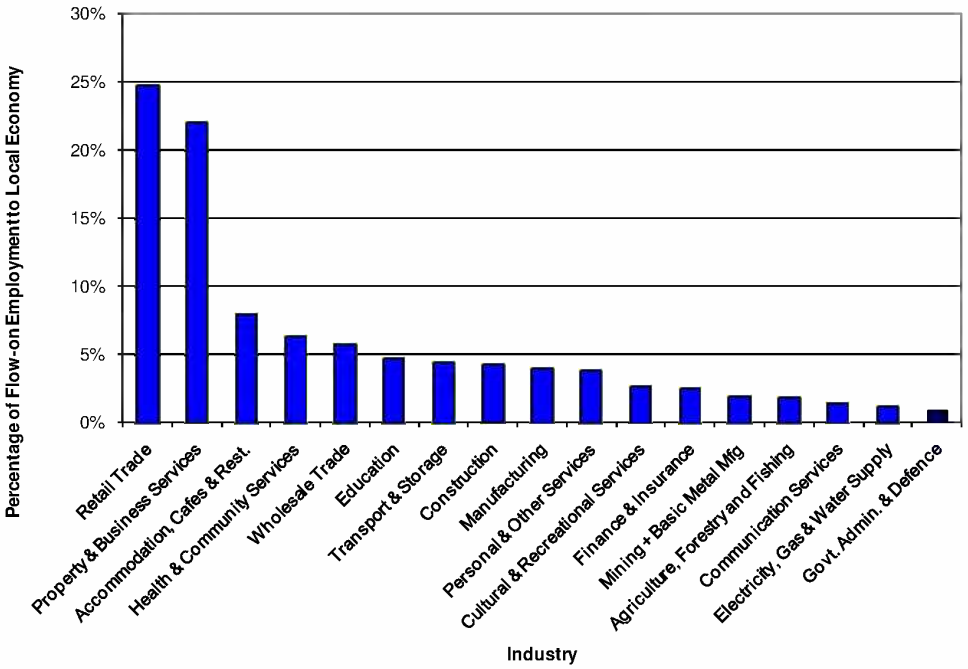

Figure 17-4 Flow-on Employment to FNQ Economy by Industry (15Mdptpa)

17.4.5 Impacts on the Queensland Economy

For the Queensland economy, the direct and indirect effects of the operations of the Project are detailed below.

Output per annum

At 15Mdptpa, with direct output of $575 million, the indirect output induced from the Queensland economy would be $257 million. The total value of the Project to the Queensland economy would be $832 million. In context, the Queensland economy was worth an estimated $865.7 billion annually in output in 2009.

There would be a total output to the Queensland economy of $1.87 billion at a production rate of 30Mdptpa (around 0.2% of the Queensland's estimated annual output for 2009). This would be made up of the $1.15 billion of direct output generated and indirect output of $717 million.

At 50Mdptpa there would be $1.14 billion of indirect output induced in the Queensland economy from direct output of $1.92 billion. This means at a production capacity of 50Mdptpa, the total value of operations to the Queensland economy would be $3.05 billion annually (0.4% of Queensland's estimated annual output for 2009).

Figure 17-5 provides a breakdown of the flows of the indirect impacts to the Queensland economy at 15Mdptpa. The majority of indirect impacts would be generated in Property and Business Services (22%), followed by Retail Trade (12%). Note that a similar distribution of indirect impacts would be seen at the 30 and 50Mdptpa production levels.

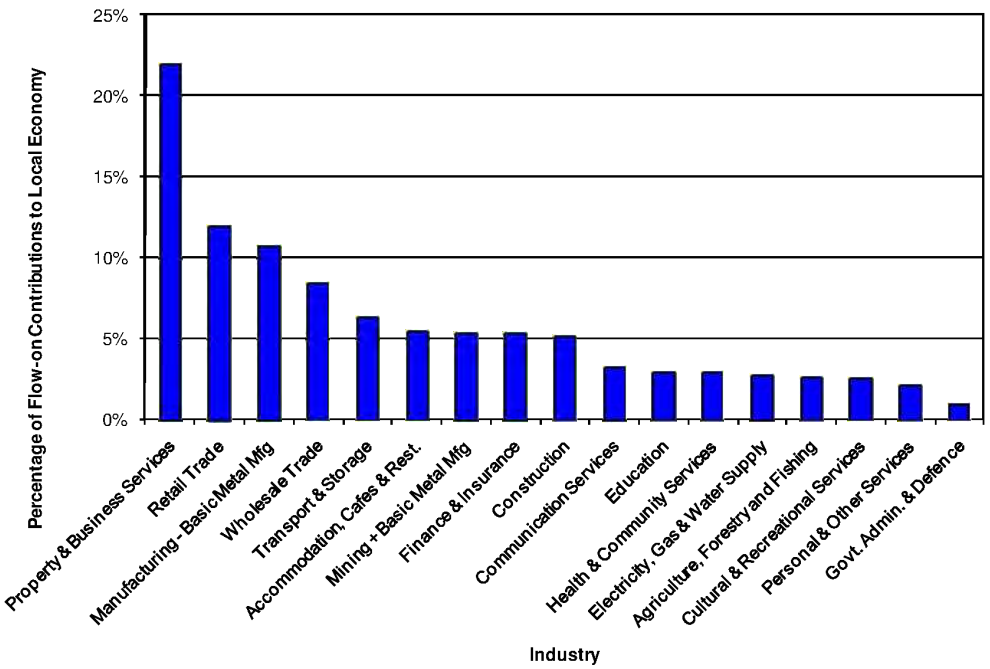

Figure 17-5 Flow-on Impacts on Queensland Economic Output (15Mdptpa)

Value Added per annum

At a production rate of 15Mdptpa there would be a direct value added of $350 million and an indirect value added induced from the Queensland economy of $116 million annually. This would result in total value added to the Queensland economy of $467 million. In context, the Queensland Gross State Product for the financial year ending 2009 was $243.9 billion.

The indirect value added under the 30Mdptpa production scenario would equal $323 million. In addition to the direct value added of $680 million, this would mean a total of $1.0 billion of value added in the Queensland economy (0.4% of Queensland GSP).

At maximum production (50Mdptpa), the direct value added component of the operations would reach $1.16 million, with output also inducing $509 million of indirect value added in the Queensland economy, giving a total of $1.67 billion annually (0.7% of Queensland's GSP).

Employment

It is likely, as a result of the direct jobs provided by the Project at 15Mdptpa, that a further 1170 indirect jobs would be generated across other sectors of the Queensland economy, resulting in 1670 jobs being supported throughout Queensland.

There would be 3263 flow-on jobs induced in the Queensland economy from a production rate of 30Mdptpa. This would result in a total of 4213 jobs generated in the Queensland economy, including direct mine jobs.

At maximum production of 50Mdptpa, another 5278 jobs would be supported indirectly by the Project in other industries, in addition to the direct jobs provided by the Project. This means a total of 6553 jobs would be supported in the Queensland economy by the Project at a production rate of 50Mdptpa.

Figure 17-6 provides a breakdown of the flows of the indirect employment to the Queensland economy at 15Mdptpa. The majority of indirect impacts would be generated in Retail Trade (23%), followed by Property and Business Services (19%). Note that a similar distribution of indirect employment would be seen at the 30Mdptpa and 50Mdptpa production rates.

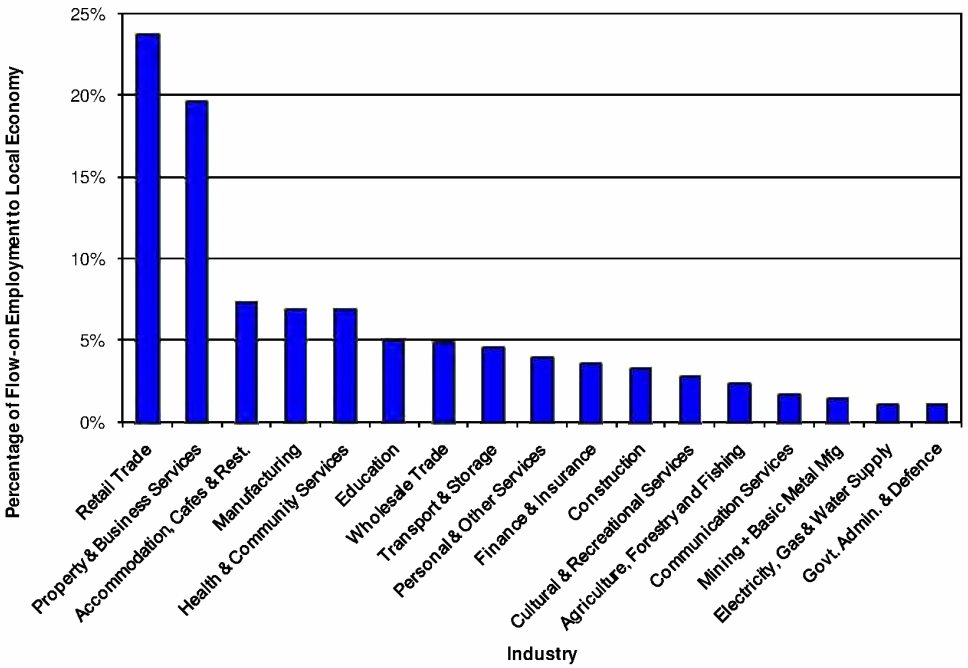

Figure 17-6 Flow-on Employment to Queensland Economy (15Mdptpa)

17.4.6 Impacts on the National Economy

For the Australian economy, the indirect contribution of the Project can be summarised as follows.

Output per annum

At 15Mdptpa, with direct output of $575 million, the output induced (indirect output) from the Australian economy would be $423 million. Therefore, the total value of the Project to the Australian economy would be $998 million. In context, the Australian economy was worth an estimated $4.3 trillion annually in 2009.

At a production rate of 30Mdptpa, the total output generated in the Australian economy would be $2.08 billion (approximately 0.05% of the nation's output in 2009). In addition to the direct output of the mine of $1.15 billion, $934 million of indirect output would be induced from the Australian economy.

At 50Mdptpa there would be $1.47 billion of indirect output induced in the Australian economy from direct output of $1.92 billion. This means at capacity, the total value of Project operations to the Australian economy would be $3.39 billion annually (approximately 0.08% of the nation's output in 2009).

Figure 17-7 provides a breakdown of the flows of the indirect impacts to the Australian economy at 15Mdptpa. The majority of indirect impacts would be generated in Property and Business Services (23%), followed by Manufacturing (not including Basic Metal, 13%). Note that a similar distribution of indirect impacts would be seen at the 30Mdptpa and 50Mdptpa production levels.

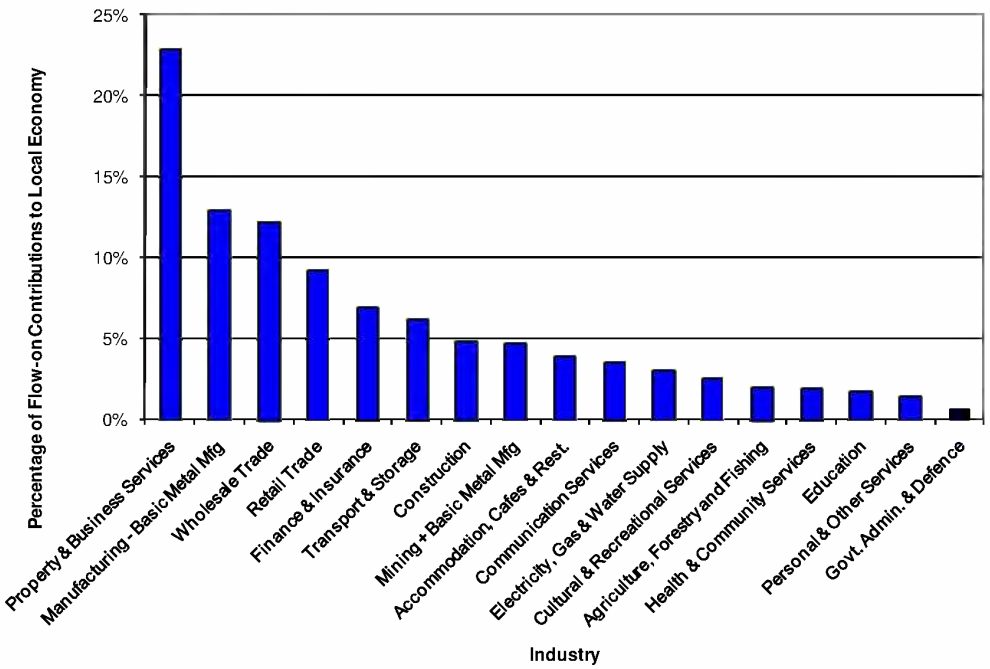

Figure 17-7 Flow-on Impacts on Australian Economic Output (15Mdptpa)

Value Added per annum

Under the minimum production scenario of 15Mdptpa, there would be a direct value added of $350 million and an indirect value added induced from the Australian economy of $188 million annually. This would result in a total value added to the Australian economy of $539 million. In context, the Australian GDP was $1.25 trillion for the financial year ending 2009.

At a production capacity of 30Mdptpa there would be an indirect value added generated in the Australian economy of $415 million. This would result in a total contribution to value added in the economy of $1.1 billion (accounting for the $680 million of initial value added) by the Project. This equates to approximately 0.09% of the nation's GDP.

Under the maximum capacity scenario of 50Mdptpa, the direct value added component of the operations would reach $1.16 billion, with output also inducing $651 million of indirect value added in the Australian economy, giving a total of $1.81 billion annually. This equates to 0.14% of the nation's GDP.

Employment

It is likely, as a result of the direct jobs provided by the Project at 15Mdptpa, that a further 1771 indirect jobs would be generated across other sectors of the Australian economy, resulting in 2271 jobs being supported throughout Australia.

Under the 30Mdptpa production scenario, there would be a total of 4890 jobs supported in the Australian economy, consisting of the direct mine jobs and 3940 indirect jobs induced from the Project's output.

At the maximum production of 50Mdptpa, another 6245 jobs would be supported indirectly by the operations in other industries, in addition to the direct jobs provided by the Project. This means a total of 7520 jobs would be supported in the Australian economy by the Project at 50Mdptpa.

Figure 17-8 provides a breakdown of the flows of the indirect employment to the Australian economy at 15Mdptpa. The majority of indirect impacts would be generated in Property and

Business Services (19%), followed by Retail Trade (18%). Note that a similar distribution of indirect employment would be seen at the 30Mdptpa and 50Mdptpa production rates.

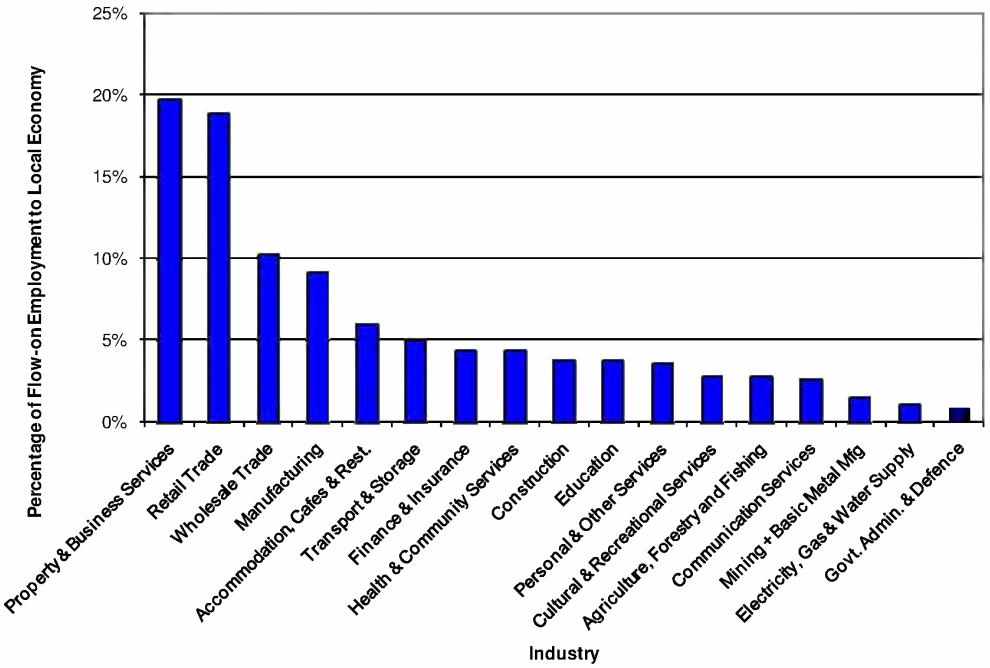

Figure 17-8 Flow-on Employment to Australian Economy (15Mdptpa)

17.4.7 Strategies for Local Participation

WCCCA Obligations

The WCCCA provides a range of benefits, including employment, training, cultural heritage and site protection, cultural awareness, support for ranger programs and educational bursaries, relinquishment of land, and a revenue stream to charitable trusts for community benefit purposes. The Western Cape Communities Trust (WCCT) and the Western Cape Communities Coordinating Committee (WCCCC) were established as a result of the WCCCA.

The WCCT and its Sub-Regional Trusts receive contributions from RTA in return for use of lands and support for RTA's mining activities. The Trusts are charitable trusts for the purpose of community development for Traditional Owner groups' benefit and not for individual benefit.

RTA's current obligations under the WCCCA related to the Weipa operations would also apply to the Project.

Sourcing Local Goods and Services

In addition to direct employment, opportunities are likely to arise as a result of the Project supporting existing local businesses and providing opportunities for new business development as shown by the economic modelling results. In 2008, RTA, together with other partners, WCCT, Western Cape Chamber of Commerce, Aurukun, Napranum and Mapoon shire councils, the Australian Government and the Queensland Government, signed the Regional Partnership Heads of Agreement (RPA). The RPA includes a statement of intent by the parties to work together to improve business development and employment opportunities. RTA is a member of the RPA Steering Committee. The WCCCA also contains commitments for RTA to provide opportunity for local sourcing, subject to availability.

Business development opportunities are discussed in further detail in **Section 16.3.7**, along with proposed mitigation strategies including:

- proactively consider tenders, which involve local Indigenous people and/or local Indigenous enterprises;
- work collaboratively with key regional stakeholders, including the WCCT, WCCC and the RPA Steering Committee, to identify and support the ongoing development of Indigenous and non-Indigenous businesses;
- examine applicable contracts for local and Indigenous business opportunities, including the breakdown of larger contracts into smaller jobs to increase the potential opportunities for awarding contracts to local providers of goods and services;
- inform the WCCT of all Project construction and operation tenders in advance of public notification;
- provide updates to the WCCT on the status of Indigenous business spending across the RTA operations in line with RTA's existing reporting requirements for employment and training, and
- in collaboration with key local and regional stakeholders, RTA would identify opportunities to support the implementation of a range of business development programs and support services.

The *Queensland Government Building and Construction Contracts Structured Training Policy* (DET undated), the *Indigenous Employment Policy for Queensland Government Building and Civil Construction Projects* (DEIR 2008), and the *Local Industry Policy* (DTRDI 2008) are not relevant to the Project as it is not a Government contract or Government-funded project.

Employment for Local Residents

Investing in employment and training would create a locally-based labour pool with the appropriate skill sets and knowledge to meet the particular employment needs of the Project. Information on employment opportunities, recruitment and training programs is included in **Section 16.3.4**.

The RPA includes a statement of intent by the parties to work together to improve opportunities for employment and training of Indigenous people in the Western Cape region. The Agreement established a job placement target of 50 additional local Indigenous people into mainstream jobs within the Western Cape region each year for five years.

The RPA identified four key priorities as the areas to be initially targeted. These included:

- work readiness;
- intra-region transport;
- youth engagement, and
- Indigenous business development.

RTA is committed to providing a work environment which is conducive to the recruitment and retention of local Indigenous employees, in accordance with its obligations in the WCCCA. Detailed mitigation strategies are outlined in **Section 16.3.4** and include:

- initiatives targeting pre-work development, employment and training for local Indigenous people;
- continuation of the partnership with the Western Cape College to provide supportive school-to-work pathways and effective case management for students looking to pursue careers at all levels in the mining industry, and
- continuing support of the implementation of the Rio Tinto Graduate Program.

RTA also proposes to address any potential skills shortages and labour impacts in the region by working collaboratively with various State and Commonwealth Government agencies, regional stakeholders, including TAFE and other training and education providers, and job network providers, to build a locally-based skilled labour pool for construction and operational phases of the Project.

The Project would incorporate various vocational and education training programs, including pre-vocational training, traineeships and apprenticeships, on-the-job training, retraining and multi-skilling. An example of this has been the implementation of a pilot program specifically for Aurukun, known as the RTA Destinations Program. The program involves a structured recruitment and selection process that includes site visits to the mining operations in Weipa and extensive community and stakeholder engagement (refer **Section 16.2.5**).

RTA would continue to implement outcomes from the Employment and Training Sub-committee of the WCCCC (E&T Sub-committee). Through collaboration with Traditional Owners, including members of the E&T Sub-committee of the WCCCC, RTA would continue to monitor and evaluate the progress of the various projects and activities as they relate to employment and training activities for local Indigenous people.

17.4.8 Strategies to Mitigate Disruption to the Local Economy

Both construction and operational phases of the Project would provide positive economic impact to the local economy through direct economic output, flow-on impacts and employment (refer **Section 17.4.1** and **Section 17.4.3**).

Construction workers would be accommodated, where possible, on-site and thus would not impact on the local housing market. In terms of the operational phase, the Project would purely be a continuation of the mining practices currently being undertaken, and should have a negligible impact. As the Project's capacity grows, the current operations at Andoom would be winding down.

There is likely to be limited impact to housing in the initial stages of the Project (refer to **Section 16.3.11**). Significant population increases are not projected to occur until production increases to between 30Mdptpa and 50Mdptpa at which time RTA would seek approval for adjustment of the town boundary and development of additional housing.

Impacts on Indigenous and non-Indigenous businesses and associated mitigation strategies are discussed in **Section 16.3.7**.

Transport routes for the workforce are described in **Section 14.1.4**. RTA recognises there would be additional travel time for employees and contractors working on a daily basis at the Project. Strategies to manage fatigue are described in **Section 14.1.7**.

Other potential impacts on households are addressed in relevant sections of this EIS (e.g. air quality is addressed in **Section 9** and noise is addressed in **Section 10**). The nearest households to the Project area are at Napranum, which are approximately four kilometres from the closest mining areas and 40km from the Boyd infrastructure area and proposed Port (refer **Figure 9-1**). Aurukun is 15km from the nearest mining areas and 35km from the Norman Creek infrastructure area. The nearest cattle station homesteads are more than 50km to the east of the nearest mining areas. There are no other anticipated impacts to households.

Therefore the disruption to the local economy associated with the construction and operation of the Project would likely be minimal and not considered material.

17.4.9 Impact on Property Value

Residential

Employee and contractor numbers are forecast to be comparable with the current operation in the early years of the Project. Additional houses would be required in Weipa and Napranum when production increases above 30Mdptpa. The impact of the Project on housing and property values is discussed in **Section 16.3.11**. RTA would work with WTA to develop additional

subdivisions as required to allow for the construction of additional houses. No impact is expected on housing or rental prices due to the capacity to expand housing supply if needed.

Commercial/Industrial

Suitable industrial land within the town boundary is currently limited. Previous construction projects, such as "NeWeipa" (which included the Andoom tailings storage facility and beneficiation plant, and Lorim Point and Andoom power stations) in 2002-2003, resulted in the creation of additional industrial lots at Evans Landing. It is anticipated most industrial activities associated with the construction of the Project would take place in the Project area. Therefore it is unlikely the Project would generate a demand for additional industrial land at Weipa during construction.

Production from the Project would replace production from the existing operations at East Weipa and Andoom. Therefore, a requirement for additional industrial land is not anticipated as a result of the Project for the 15Mdptpa and 30Mdptpa production scenarios. There would be limited impact on industrial property values. At maximum production (50Mdptpa), some additional industrial capacity is predicted to be required. There would be a need at this time to increase the supply of industrial land, which would require an extension of the town boundary. Again, the timing of such an increase would be tied to the timing of an expansion beyond 30Mdptpa and hence to market conditions. WTA have advised suitable land is available outside the town boundary for future industrial lot developments. RTA would assist with industrial lot developments if required.

17.4.10 Impact upon Property Management

There has been no cattle production/agriculture in the Project area for many years and, as such, there would be no direct impact on agricultural land uses or management practices of surrounding land. Further information on agricultural production is available in **Section 16.2.8**.

17.5 Sustainable Development

The key objectives of sustainable development, as outlined in the *National Strategy for Ecologically Sustainable Development* (ESDSC 1992) are:

- to enhance individual and community well-being and welfare by following a path of economic development that safeguards the welfare of future generations;
- to provide for equity within and between generations, and
- to protect biological diversity and maintain essential ecological processes and life support systems.

Each of the objectives in the context of the Project are addressed below.

Individual and Community Well-being and Welfare

The Project would provide benefits to the community in terms of income generation and employment. These benefits are fully quantified and assessed in **Section 16** and **Section 17**. Community consultation has been undertaken as outlined in **Section 15**. The assessment shows the Project would provide net benefit to the community, both now and in the future.

The Intergenerational Equity Principle

The Project would not significantly reduce, or fail to maintain, the health, diversity and productivity of the Queensland environment or affect future generations.

The Project would extend the duration of the current mine life, providing the opportunity for continuation of the current social and economic benefits detailed in **Section 16** and **Section 17**, for another 40 years.

Protection of Biological Diversity and Essential Ecological Processes

Surveys of the flora and fauna species in the vicinity of the Project have been undertaken and are provided in **Section 6**, **Section 7**, and **Section 8**.

An assessment of potential impact from the Project on marine, terrestrial and freshwater aquatic ecology has been undertaken and is also provided in **Section 6**, **Section 7** and **Section 8** respectively. This assessment included species of conservation significance listed under the *Nature Conservation (Wildlife) Regulation 2006 (Qld)* and the Commonwealth *Environment Protection and Biodiversity Conservation Regulation 2000 (Cwlth)*.

The impact assessment has taken into account the cumulative impacts of the Project from a life-of-project perspective.

There would be an unavoidable impact on the terrestrial environment due to mining. However, this would not lead to a loss of species. Rehabilitation of areas disturbed by mining would aim to establish ecological processes such that these areas are:

- safe to humans and wildlife;
- non-polluting;
- stable; and
- able to sustain an agreed post-mining land use.

The rehabilitation process and objectives are described further in **Section 3.10**.

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Environmental Impact Statement

for South of Embley Project

Section 18

Health and Safety

18 HEALTH AND SAFETY

This section examines the health and safety implications associated with the Project during the construction and operational phases. The health and safety of Project personnel and the public are assessed, and mitigation strategies outlined where appropriate.

Community impacts for health and safety are addressed in respective sections of the EIS. For example, the potential for air emissions and impact on community health are addressed in **Section 9**. There are no sensitive receptors, such as kindergartens, schools, hospitals, aged care facilities, residential areas, and commercial places close to the mining, processing or port areas (refer **Figure 9-1**). As such, there would be no planned discharges from the Project which could impact on public health values in the short or long-term.

Most activities proposed for the Project are similar to those currently carried out by the existing RTA operations north of the Embley River and therefore the health and safety risks remain the same.

18.1 Overview of the Existing Environment - Health and Safety

RTA considers the safety and health of employees and contractors as paramount and a fundamental requirement for continued operation and growth. The success and performance of RTA in these areas is judged by employees, contractors, regulators and the community and influence the ability of RTA to enhance and develop future resources.

The RTA Health, Safety and Environment (HSE) Policy (refer **Appendix 1A**) clearly demonstrates the commitment by RTA to health and safety.

Performance is measured and reported publicly in the Weipa operation's annual Sustainable Development Report and is summarised in **Table 18.1**. Annual targets are set, with an aim of improving performance each year.

Table 18-1 Recent Health and Safety Performance - Weipa Operations

	2007	2008	2009	2010 target	Comments
Lost Time Injury (LTI) frequency rate	0.47	0.30	0.10	0.09	An LTI occurs where the person injured at work cannot return to their normal duties on the next shift.
All Injury (AI) frequency rate	0.85	0.46	0.60	0.54	AIs include LTIs and also any injury that requires medical treatment.

(1) The "frequency rate" is the number of LTIs or AIs per 100 people working per year.

In 2008, RTA Weipa had its lowest AI frequency rate and LTI frequency rate on record. These results occurred during a period of record production and construction work by contractors on the East Weipa tailings storage facility.

18.2 Guidelines, Policies and Legislation

The primary relevant health and safety legislation and regulatory requirements applicable to the Project are listed in **Table 18-2**.

Table 18-2 Primary Health and Safety Legislation

Relevant Legislation	Legislative Requirements	Compliance
Mining and Quarrying Safety and Health Act 1999 (Qld) and *Regulation 2001 (amended 2008)*	Ensuring and promoting improved health and safety performance in mining and quarrying.	Risk Management System Accountabilities for safety and health.
Workplace Health and Safety Act 1995 (Qld) *(amended 2009)* and *Regulation 2008*	To prevent a person's death, injury or illness being caused by the workplace, or activities.	RTA Weipa HSE Management System. Include safety in design for construction and operations.

Relevant Legislation	Legislative Requirements	Compliance
Building Act 1975 (Qld) and *Building Fire and Safety Regulation 2008*	Safe design and operation of all buildings so as not to endanger persons, property or the environment.	RTA Weipa HSE Management System. Compliance with the Building Code of Australia.
Fire and Rescue Service Act 1990 (Qld) and *Fire and Rescue Service Regulation 2001*	Establish effective relationships and implementation of the Queensland Fire and Rescue Service and provide for the prevention of and response to fires and certain other incidents endangering persons, property or the environment.	Involve the Queensland Fire and Rescue Service in emergency planning.
Electrical Safety Act 2002 (Qld) and *Electrical Safety Regulation 2002*	Ensure safe utilisation, instalment and use of electricity so as not to endanger persons, property or the environment.	Safety in design and Safety Management System for construction and operational phases.
Dangerous Goods Safety Management Act 2001 (Qld) and *Regulation 2001*	The Act establishes standards for the transport and storage of hazardous substances and the systems to be adopted based on these substances.	Comply with Australian Standards and implement management systems as defined for the storage and use of substances.
Radiation Safety Act 1999 (Qld) and *Regulation 1999*	The Act establishes the requirements for handling radioactive substances and the monitoring of persons exposed to the hazard.	Undertake the requirements of the regulations as stated, including radiation monitoring and screening as required.
Transport Operations (Road Use Management) Act 1995 (Qld) and associated regulations for dangerous goods and other relevant aspects.	Provide for the effective and efficient management of vehicle and road use associated with all components and stages of the project.	RTA Weipa HSE Management System for construction and operational phases.
Transport Operations (Marine Safety) Act 1994 (Qld) and *Regulation 2004*	Provide for efficient management of marine safety and related marine operational issues.	Rio Tinto Marine HSE Management System.
Health Regulation 1996 (Qld)	Ensure dispensary activities (i.e. from an on-site occupational health clinic) do not endanger human health or the environment.	RTA Weipa HSE Management System, including procedures for setup of first-aid facilities, accountabilities of first-aid attendants, and approved contents of first-aid kits.
Workers' Compensation and Rehabilitation Act 2003 (Qld) and *Regulation 2003*	Ensuring and promoting improved health and safety performance.	Risk Management System.
	Ensuring safety in the provision and supply of food.	Compliance safety audit required to ensure compliance with Food Standards Code and operators' food safety program.
Petroleum and Gas (Production and Safety) Act 2004 (Qld) and *Regulation 2004*	Includes requirements relating to gas work licences and authorisations in relation to gas devices.	RTA Weipa HSE Management System, including procedures for pressure vessels and pipelines.
and Reliability) Act 2008 (Qld)	To ensure safe and reliable water supply.	Weipa Town Authority manages potable water in the town of Weipa. RTA Weipa manages water on-site through HSE Management System and potable water monitoring program.
Occupational Safety and Health (Maritime Industry) Act 1993 (Cwlth) and *Regulation 1995*	To ensure the health, safety and welfare at work of maritime industry employees; and to protect persons at or near workplaces from risks to health and safety arising out of the activities of maritime industry.	Rio Tinto Marine operates under their MarineSafe system.

The process to achieve compliance with the above legislation is discussed in the following sections.

18.3 Project Health and Safety Management System

RTA's existing integrated Health Safety and Environment (HSE) Management System (known as CLASSIC) is certified to ISO 14001 and OHSAS 18001 and is audited on an annual basis by an external auditor. An overview of the HSE Management System is provided in **Appendix 18A**. RTA would implement the existing CLASSIC HSE Management System as part of the Project.

Similarly, Rio Tinto, as operators of the Lorim Point shiploader at the Port of Weipa, has implemented the MarineSafe system which implements the requirements of the Australian Maritime Safety Authority and other relevant international statutory authorities, relevant class rules, regulations and ship management contracts. The ship managers of all Rio Tinto Marine fleet vessels are required to have certification to the International Safety Management Code (IMO 2002) and vessels must have on board a copy of the "Document of Compliance" endorsed for annual verification. RTA would implement the MarineSafe system at the port proposed for the Project.

Both systems incorporate Occupational Health and Safety Standards that are currently in use at all Rio Tinto operations, which provide the basis for effective management of employee and contractor health and safety.

A Health Safety Environment and Communities Management Plan (RTA 2007) was developed specifically for the Project area for resource assessment activities. This plan would continue to be maintained, regularly reviewed and updated as activities change on-site until such time as the Project area is incorporated into the existing HSE Management System. This would occur upon completion of construction.

Monitoring of health and safety performance and internal and external audits of implementation of the system at the Project site would ensure effective implementation.

Health and safety risks are identified via the HSE Risk Management System, described in **Section 19**. **Section 19.2.2** defines the categories of risk. The high risks identified in the preliminary Project hazard analysis and risk assessment are summarised in **Table 19-6**. The primary health and safety risks are discussed in further detail in the following sections.

18.4 Personal Protective Equipment

Personal Protective Equipment (PPE) refers to protective clothing, helmets, goggles, or other garments designed to protect the wearer's body or clothing from injury by blunt impacts, electrical hazards, heat, chemicals, and infection, for job-related occupational safety and health purposes. The following mandatory PPE would be required in all external areas within the Project area:

- safety helmet;
- steel-cap boots;
- safety glasses; and
- high-visibility clothing.

Other job-related PPE would be utilised where required and would be identified in Safe Work Procedures.

18.5 Health Impact Assessment and Mitigation Measures

The primary health risks identified through the preliminary Project hazard analysis and risk assessment and the associated control strategies that would be implemented through the HSE Management System are discussed in the following sections. The control strategies address legislative and Australian Standard requirements where applicable.

18.5.1 Air Emissions

Dust is the principal atmospheric contaminant in the workplace. The crystalline silica (quartz) component of dust is of interest due to its potential as a carcinogen. RTA has undertaken respirable crystalline silica monitoring in the workplace between 2005 and 2008 with results to date indicating the mean exposure to be <0.01mg/m^3, with a maximum exposure measured at 0.04mg/m^3. The *NOHSC:1003 Adopted National Exposure Standards For Atmospheric Contaminants In The Occupational Environment* (NOHSC 1995) for crystalline silica is currently under review. The monitoring results are well within RTA's Occupational Exposure Limit for respirable crystalline silica (quartz), which is 0.1mg/m^3 for an eight-hour shift.

Risks associated with potential air emissions from hazardous substances such as hydrocarbons are addressed in **Section 18.5.8**. The Project is not expected to produce any odour which may be detrimental to the health and safety of employees, visitors or the general public. There are no other air emissions that would be expected to impact the health and safety of employees or contractors.

The Project would implement particulate and gas/vapour exposure standards and controls according to the *CLASSIC 5.01 Particulate and Gas*, which would apply to dust, fibres, mist, fume (including diesel particulates), gas, and vapour exposure in the workplace. The standards and procedures would cover, amongst other things, evaluation of particulate and gas/vapour hazards, and development of a control program to ensure that employees and contractors do not suffer adverse health effects in the work environment from particulates or gas/vapours, either used or generated by the Project. Where required, the dust control program would include engineering controls (e.g. air-conditioning filters, dust-suppression systems, vacuum cleaners and fume-extraction systems) and use of respiratory protection devices.

With the implementation of these control measures, the residual health risks associated with emissions to air are expected to remain moderate.

The impact of air emissions on the community are addressed in **Section 9**.

18.5.2 Noise and Vibration

Noise in the workplace can cause permanent hearing loss. RTA would continue to comply with the *NOHSC:1007 National Standard for Occupational Noise* (NOHSC 2000) for the Project.

All equipment (both fixed and mobile) would be purchased and maintained in accordance with *CLASSIC 3.15 HSE Guidelines for Purchase and Hire of Plant, Equipment and Services*, the *AS1269 Occupational Noise Management* series (Standards Australia 2005a) and the *Mining and Quarrying Safety and Health Act 1999*. It is the duty of the supplier to ensure equipment is compliant with safe levels of vibration and they must provide documented proof of compliance (i.e. test results).

CLASSIC 5.02 Noise Management and Hearing Conservation would apply to all phases of the Project. The following controls would be implemented throughout construction and operation to ensure employees and contractors would not suffer adverse health effects from noise generated in the workplace:

- all noise sources in their area would be identified and assessed at least five-yearly;
- noise sources in their area would be reassessed after any significant change;
- areas where hearing protection is required would be mapped and appropriately signposted;

- where hearing protection is required a range of hearing protection devices that are approved for site would be available;
- training would be provided in fitting, maintenance and the limitations of hearing protectors;
- there would be documented procedures for inspection, assessment, and maintenance of noise reduction devices and noisy equipment to ensure noise levels are minimised;
- employees would be given information, instruction and training regarding noisy environments, including the hazards, potential health effects and control mechanisms;
- a formal review of the practicality of engineering controls would be conducted annually in areas where a hearing conservation programme is required;
- each area where hearing protection is routinely worn (i.e. employees are exposed to noise levels greater than 82dB(A) or 140dB(C)) would have a plan of action for the control of noise, and
- all employees would attend audiometric testing as required.

With the implementation of these control measures, the residual health risks associated with noise and vibration are expected to remain moderate.

The impact of noise emissions on the community are addressed in **Section 10**.

18.5.3 Wildlife Hazards and Disease Vectors

Certain wildlife, such as the estuarine crocodile, dingoes, venomous snakes and spiders, pose a risk to workers if they are bitten. The occupational health clinic and first-aid facilities would be equipped to respond to incidents of this type and provide appropriate treatment where required. Safe Work Procedures would be developed for activities (e.g. water sampling creeks) carried out near marine aggressor (crocodile, stingers, sharks) habitat. Personal protective equipment, such as boots, trousers and long sleeves would be required at all areas on the Project area, which would provide minimum protection from snake and spider bites. Gloves would also be provided for use during appropriate tasks.

A vector is an organism that does not cause the disease itself but transmits infection by transferring pathogens from one host to another. Bedbugs, cockroaches, flies, lice, mosquitoes, rat fleas, rats and mice are all capable of transmitting disease. In Australia, diseases such as Dengue Fever, Ross River Virus, and Barmah River Virus can be transmitted by mosquitoes. In addition, ships can spread disease to ports via infected vectors. The control of disease vectors such as insects and rodents is necessary for the maintenance of employee and community health.

The Weipa branch of the Australian Quarantine and Inspection Service (AQIS) undertakes monitoring of tropical disease vectors such as mosquitoes regularly and has not reported vectors of a quarantinable human disease to date. At the time of preparation of this EIS, there was no evidence to suggest the recent outbreak of dengue fever in Queensland had extended to the Weipa area (Queensland Health 2009).

Control programs for disease vectors such as rats and mosquitoes and other insects would be undertaken in infrastructure areas on a regular basis by a licensed Pest Control Technician.

The Project would implement *CLASSIC 5.06 Travel Remote Site Health*, which includes the following controls for mosquito (and biting midges) safety:

- reduction or elimination of preferred breeding water sources such as stagnant water in containers;
- staying indoors during mosquito activity hours;
- wearing clothing that reduces the amount of skin exposed (i.e. long trousers and shirt sleeves) between dusk and dawn, and
- applying insect repellent.

Water storages and other impoundments of water can be used by mosquitoes and biting midges for breeding. Water storages and other impoundments of water constructed on the Project site would be greater than 60cm deep and not conducive to mosquito breeding, in accordance with the *Guidelines to minimise mosquito and biting midge problems in new development areas* (Queensland Health 2002).

Overseas ships would be subject to AQIS requirements for vessels, including the requirement to manage potential disease vectors.

The Project is not expected to increase the number of pests during construction or as a result of site operations.

18.5.4 Drinking Water Supply

The Weipa Town Authority (WTA) is responsible for providing potable water services to the town of Weipa, where employees and contractors would live throughout the operation of the Project. WTA collects water samples on a weekly basis for bacterial testing and a quarterly basis for minerals, hardness and pH. Test results are provided on the WTA web page and are available for public viewing at the Town Office.

Potable water would be provided at the Project construction camp, the proposed port and infrastructure areas. The water would be sourced from dams and groundwater sources and treated to ensure a potable standard. RTA would regularly monitor potable water quality to ensure compliance with the *Australian Drinking Water Guidelines* (NHMRC 2004).

The risk of unsafe drinking water is considered to remain low.

RTA would not be a "water service provider" in the Project area for the purposes of the *Water Supply (Safety and Reliability) Act 2008,* as the infrastructure would be for mining purposes and the service would only be used by the owner's employees and visitors.

18.5.5 Use of Recycled Water

During construction, it is anticipated that effluent from the sewage treatment plant would be recycled for use in landscaping areas. During operations, water from tailings storage facilities and infrastructure area sewage treatment plants would be recycled (refer to water management system **Figure 5-8** and **Figure 5-9**).

In both instances, recycled water would be managed in accordance with the *Water Supply (Safety and Reliability) Act 2008* and relevant environmental and health regulatory guidelines. This would include monitoring to ensure water quality meets the *Water quality guidelines for recycled water schemes* (DNRW 2008). Details of operations of the sewage treatment plants, including proposed water quality monitoring and recycled water criteria are discussed in **Section 13.3.7**.

Recycled water would not be used for irrigation of food crops or in other areas that may impact the human food chain.

18.5.6 Food Hygiene

Areas involved with the provision and supply of food, such as the construction camp, would operate in accordance with current food and hygiene legislation. RTA would engage the services of a contractor to supply food to the construction workforce. All catering contractors would be required to undertake food handling training and hold relevant licences under the *Food Act 2006*.

Under this Act, caterers are required to develop and implement food safety programs and, depending on the number of people catered for, the program may need to be accredited. Accredited programs are required to have a compliance safety audit completed by an accredited auditor to ensure the business is complying with their program and the *Food Standards Code* (FSANZ 2000). This requirement is likely to be triggered during the construction phase of the Project.

Performance monitoring of all contractors would be undertaken in accordance with RTA's Supplier and Contractor Management Standard.

18.5.7 Other Biological Hazards

Infectious diseases may also be transmitted via bodily fluids, such as medical staff exposed while treating a patient. All first-aid facilities would be equipped with gloves and other protective equipment in accordance with standard medical practice. Clinical waste would be segregated and disposed of at the Evans Landing Landfill (in accordance with the existing Licence).

Personnel are also at risk of bacterial or infectious disease when working on or near sewage treatment facilities. Safe operating procedures would be developed for this work, including the use of appropriate PPE and hygiene practices (e.g. washing hands before consuming food).

Legionella can be contracted via inhalation of water vapour containing the Legionella bacteria. Regular testing of at-risk water sources (e.g. beneficiation plant, hot-water storages etc) would be carried out and the water treated where required.

With the proposed control measures in place, the risks associated with other biological hazards are considered to be moderate.

18.5.8 Hazardous Substances

Fuels (predominantly diesel), detergents, lubricants and oils, solvents, degreasers, paints, resins and domestic cleaning agents would form the majority of chemicals required at the Project site. The following controls would be implemented:

- All chemicals would be managed in accordance with the *NOHSC:1015 National Standard for the Storage and Handling of Workplace Dangerous Goods* (NOHSC 2001), the *NOHSC:1005 National Model Regulation for the Control of Workplace Hazardous Substances* (NOHSC 1994), and *NOHSC:1008 Approved Criteria for Classifying Hazardous Substances* (NOHSC 2004).
- In addition, chemicals would be managed in accordance with *CLASSIC 2.06 Hazardous Substances Control*, which requires a risk assessment to be completed, taking into account information from the Material Safety Data Sheet (MSDS), prior to the substance being brought to site.
- A register of all approved chemicals would be maintained.
- All chemicals would be labelled and stored according to the requirements of the respective MSDS and relevant Australian Standards. Copies of MSDS's would be kept near storage areas.
- PPE (e.g. gloves, face shields or respiratory-protection devices) and first-aid equipment (e.g. emergency showers and eye-wash stations), as identified in the MSDS and/or risk assessment would be maintained and available for use.
- Training would be provided to employees and contractors through the site induction and specific chemical awareness programs for relevant workers.

With the implementation of proposed controls, the residual health risk presented by hazardous substances is expected to be moderate.

18.5.9 Radiation

Exposure to ultra-violet radiation and heat stress from the sun is a significant risk in the tropical environment. All employees and contractors would be required to wear long-sleeve shirts, trousers and hats to help reduce sun exposure. Awareness training would be provided through site inductions and high-protection sunscreen and drinking water would be made available on-site.

RTA would comply with the *NOHSC:1013 National Standard for Limiting Occupational Exposure to Ionizing Radiation* (NOHSC 1995). Nuclear density gauges would be utilised on-site and have

the potential to impact health if stored or disposed of inappropriately. *CLASSIC 5.04 Radiation Management* would be implemented, and would include the following controls to ensure employee and contractor exposures to all forms of radiation are as low as reasonably achievable:

- appropriate licences would be obtained prior to radiation sources being brought to site;
- Radiation Safety Protection Plans (RSPP) would be developed and approved by Queensland Health;
- appropriately qualified Radiation Safety Officers would be available to complete the requirements of the RSPP;
- replacement of radiation gauges would be managed as required in accordance with relevant legislation and the RSPP, and
- monitoring and maintenance would be conducted as required in accordance with relevant legislation and the RSPP.

Even with the proposed control measures in place, the residual risk associated with radiation remains high due to the potentially serious consequences of exposure.

18.5.10 Manual Handling

Manual tasks requiring force, repetition or awkward postures can lead to musculoskeletal injuries. As much as possible these types of tasks would be eliminated through good design. Where required, lifting devices would be provided to reduce manual handling. RTA would comply with the *National Standard for Manual Tasks* (Australian Safety and Compensation Council 2007). *CLASSIC 5.03 Manual Handling* will be implemented by the Project and provides the following controls:

- good design, layout and practice, to minimise adverse health consequences due to manual handling and vibration factors;
- completion of an assessment of manual handling and vibration risks associated with a task or activity; and
- an assessment of ergonomic, manual handling and vibration risks for new plant or equipment or modifications to existing plant or equipment.

With these controls in place, the risk of injury caused by manual handling injuries is low to moderate.

18.6 Safety Impacts and Mitigation Measures

The primary safety risks identified through the preliminary Project hazard analysis and risk assessment and associated control strategies that would be implemented through the HSE Management System are discussed in the following sections. The control strategies address legislative and Australian Standard requirements where applicable.

18.6.1 Lighting

Poor lighting levels or the lack of emergency lighting in times of power failure or emergency situations has the potential to cause hazard. The following would be provided for both construction and operation phases to provide a safe and comfortable visual environment:

- task lighting;
- access and stair lighting, and
- emergency lighting.

Workplace lighting would be designed and installed in accordance with the *AS1680 Interior lighting* (Standards Australia 1998), which recommends a minimum interior lighting level of 160lux for general work areas and 40lux for walkways and access areas.

Emergency lighting would be installed in accordance with the *AS2293 Emergency escape lighting and exit signs for buildings* (Standards Australia 2005b).

The Project would implement *CLASSIC 3.06 Lighting* which requires lighting surveys to be carried out in all areas with permanent lighting on a regular basis or following a major change, and includes a testing and maintenance schedule for emergency lighting. While exterior lighting would adhere to health and safety requirements, they would be modified where required to minimise the impact on nesting turtles (refer to **Section 6.9.4.3** for further information).

With the implementation of proposed controls, the residual risk presented by poor lighting is expected to be low.

18.6.2 Vehicle Collisions

Vehicles on the proposed mine would include haul trucks, front-end loaders, scrapers, rollers and light vehicles (four-wheel drives). The vehicles would operate on haul roads and existing access roads. Collisions between these vehicles have the potential to cause serious injury to mine personnel. Haul roads would be designed to comply with requirements of the *Mining and Quarrying Safety and Health Act 1999* and roads graded to an adequate safe level for the vehicles.

Some of these vehicles would also travel on the new Mine Access Road which would be constructed from the Hey River Terminal to the infrastructure area. This would be a private road for use by Project-authorised vehicles only and have relatively low usage as employees and contractors would be transported to and from the site by buses. Heavy mobile equipment such as haul trucks, front-end loaders, scrapers and rollers would be transported under escort by float on this road. Fuel would be transported in highway compliant B-doubles on a daily basis.

The Project would implement *CLASSIC 2.09 Mine Road Access*, which provides minimum requirements for the control of access to the existing Weipa mine operations area through the provision of a Mine Roads Driving Permit. Construction workers and mine personnel operating vehicles on-site would be trained and licensed, so vehicles are driven in a safe and responsible manner. Safe work procedures regarding driver safety (including speed limits) and dust control would be implemented. Speed limits around the site would be indicated by appropriate signage, and watering of roads and access areas would be undertaken to suppress dust and improve visibility for the driver. Adequate lighting would be installed on-site to ensure night driving and operating conditions are safe. Vehicle inspection checks would be undertaken as part of the routine maintenance programme to control the risk. All vehicles would be fitted with two-way radios.

The potential for injury from vehicles on the Project site during construction and operations is considered moderate.

18.6.3 Physical Interaction with Machinery

Personnel may be at risk of interacting with moving machinery (such as conveyors) and vehicles resulting in potentially serious injury. Hazards in this category may occur during the construction of infrastructure, movement of heavy equipment, maintenance programs or repair work.

RTA's safe work procedure regarding the control of energised equipment and machinery would be implemented incorporating isolation safety systems to reduce the likelihood of exposure to sudden releases of all forms of energy to low levels (*CLASSIC 2.01 Isolation*).

Appropriate speed limits and traffic rules would be identified for the Project area. Barricades and visual demarcation would be used to reduce the risk of pedestrian and vehicle interactions, as well as physical interaction with other machinery such as conveyors.

The proposed controls would reduce the likelihood of occurrence personnel interacting with moving machinery and therefore the risk to low levels.

18.6.4 Fuel Storage and Handling

Fuel storage on-site is predominantly diesel, which presents a predominantly low risk of combustion taking place and a moderate environmental risk. Fuel tankers would travel onto site to refill bulk storage tanks on a daily basis.

All hydrocarbons would be stored in accordance with the *AS1940 The storage and handling of combustible and flammable liquids* (Standards Australia 2004a). Use of this standard reduces risk to a low level.

To minimise the hazards associated with fuel oil leaking during tanker unloading, the following controls would be implemented to reduce risks to health and safety of site personnel and potential adverse impacts to the environment:

- equipment inspection and testing programs would be undertaken to ensure reliable performance of fuel tanks and bunds;
- safe work procedures would be prepared to address the refilling of fuel storage tanks and mine vehicles, maintenance and spill response;
- operator training would be provided in the safe operation of the equipment and knowledge of emergency response procedures in the event of fuel oil leakage;
- spill containment bunds would be installed to contain any spillage of liquids;
- sumps would be constructed to collect any spillage and allow recovery;
- ignition sources would be strictly monitored and maintained to avoid fire;
- appropriate fire-fighting facilities and suppression systems would be installed, maintained and available to extinguish fires;
- an approved fire protection system would be installed and maintained around hydrocarbon storage areas; and
- inspections of all storage facilities would be carried out on a regular basis.

Licensed transporters operating in compliance with the *Australian Code for the Transport of Dangerous Goods by Road and Rail* (NTC 2007) would undertake the transport of dangerous goods to the Project site.

The proposed controls would reduce the likelihood of occurrence and therefore the risk to moderate levels.

18.6.5 Working at Heights and Falling Objects

There would be times where workers are required to work at height during the construction phase (e.g. mine site building and conveyor construction) and the operation phase (e.g. maintenance of facilities). The Proponent would plan activities so work is performed at ground level where practical to eliminate the requirement to work at heights. However, where working at heights is unavoidable, the Project would implement *CLASSIC 2.04 Working at Height*, which requires the following controls:

- Working at heights is accessing, egressing, ascending, descending or working in any position where a person can fall from, into or through anything from one level to another level. Work at heights is identified where a risk assessment highlights a danger of people falling or any work above 1.8m.
- The hierarchy of controls are identified as follows:
    - Wherever possible work shall be performed from ground level.
    - In the event of raised plant and equipment, work shall be performed wherever possible from permanently-positioned safe access to the task and work area.
    - Where this is not possible access via a temporary platform or elevated work platform can be used.

  - An alternative option is to use a person-fall restraint system that does not allow the user to fall.
  - Only in the event that none of the above options are possible, the work can be performed by using a fall-arrest system after obtaining a working-at-heights permit.
- Personnel working at heights must be trained and deemed competent.
- Tasks undertaken from elevated work platforms require fall protection equipment to be worn at all times and connected to an approved anchor point.

With these controls in place, the risk of injury caused by a fall from height is low to moderate.

Items falling from height can also present a safety risk. PPE that protects against objects falling from height include steel-capped boots and hard hats, which would be worn in designated areas.

Procedures also require the area below people working at height be barricaded as per *CLASSIC 2.11 Barricade Procedure* and appropriately signed, to prevent access from other personnel in the work area.

The residual hazard for this risk is still high, as safety statistics at mine sites indicate injuries caused from items falling from height contribute to work-related injuries.

The Project would implement *CLASSIC 2.12 Scaffold Management*, which refers to the standards associated with the erecting of scaffolding on-site. The purpose of this standard is to:

- Eliminate the risk to people using and working around scaffolding;
- Eliminate the risk to other company assets from persons working on or from scaffolding, and
- Ensure compliance to the Australian Standards.

The minimum standard for scaffolding on-site would be the relevant Australian Standards unless a higher level of compliance is required by *CLASSIC 2.12*.

18.6.6 Lifting Equipment

Failure of lifting equipment can result in serious injury. The Proponent would plan activities in accordance with *CLASSIC 3.02 Lifting Equipment*, which requires the following controls:

- only competent operators can set up, inspect or operate lifting equipment;
- all lifting equipment would be inspected, maintained and stored to ensure the equipment is able to function to its design specifications;
- lifting equipment must be used within their Safe Working Load for the conditions of use, and
- a register of lifting equipment shall be maintained to record periodic inspections.

With these controls in place, the risk of injury caused by failure of lifting equipment is low to moderate.

18.6.7 Electrical Energy

The *Mining and Quarrying Safety and Health Act 1999* prescribes obligations for operators of mines and plant and has specific requirements for electrical work and the design, operation and maintenance of electrical equipment. A diesel-fuelled power plant would be constructed to provide power for mine-site facilities and the beneficiation plant to be located in the vicinity of the infrastructure area.

All electrical installations would be designed, installed and maintained in accordance with relevant Australian Standards, including *AS 3000 Electrical Installations* (Standards Australia 2007) and *AS 3007 Electrical Installations for Surface Mines* (Standards Australia 2007).

The Project would implement the existing *CLASSIC 3.11 Safe Electrical Work, Equipment and Installations*, which includes the following controls:

- electrical equipment and installations shall be designed, installed and maintained to ensure that:
    - persons are not able to contact exposed conductors energised at lethal voltages;
    - under fault conditions persons are not exposed to lethal voltages, currents or arc flash;
    - under fault conditions equipment does not pose a fire risk;
    - control systems, including protection systems, emergency stopping systems and safety alarms operate safely under all operating conditions, including power supply instability or failure;
    - there is an effective means for positive isolation of equipment or an installation, and
    - prior to accessing any electrical equipment, the hazards should be well understood and appropriate isolations, permits and PPE identified and implemented.
- electrical workers are competent for the tasks they perform;
- electrical equipment is regularly tested and maintained;
- earthing systems are installed and maintained, and
- electrical plans are developed and maintained for services on-site.

With these controls in place, the risk of injury caused by electrical energy is low to moderate.

18.6.8 Confined Space

A confined space is an enclosed or partially enclosed space which is at atmospheric pressure during occupancy and is not intended or designed primarily as a place of work, and:

1. is liable at any time to:
    - have an atmosphere which contains potentially harmful levels of contaminant;
    - have an oxygen deficiency or excess; or
    - cause engulfment; and
2. could have restricted means of entry and exit.

RTA would comply with *AS 2865 Safe Working in a Confined Space* (Standards Australia 2009). The Project would implement *CLASSIC 2.03 Confined Space Entry Controls*, which identifies the controls and processes required to be in place prior to entry into a confined space, including:

- assess and identify all confined spaces, including gas atmosphere testing;
- ensure only trained and authorised persons are permitted to enter confined spaces through use of a permit system;
- ensure correct PPE is available for personnel working in confined spaces, and
- rapid recovery procedures.

With these controls in place, the risk of injury in confined spaces is low to moderate.

18.6.9 Transportation

Equipment, cargo and workers would be transported to the Project area as described in **Section 14**.

All vehicles for transport of personnel would comply with regulatory requirements and maintained in a roadworthy condition.

Where relevant, vessels would comply with the National Standard for Commercial Vessels, which defines safety equipment standards for various classes of commercial ships. Vessels would be operated in accordance with MSQ requirements and safe work procedures would be developed for these activities in consultation with the local MSQ personnel.

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Environmental Impact Statement

for South of Embley Project

Section 19
Hazard and Risk

19 HAZARD AND RISK

This section describes the process for identifying, assessing and managing hazards associated with the Project. A preliminary health, safety and environmental hazard analysis and risk assessment has been carried out to identify potential hazards, accidents, spillages and abnormal events occurring during the Project. The hazards are analysed to identify any significant residual risks to human health, safety or the natural environment following the implementation of proposed mitigation measures.

19.1 Dangerous Goods

The Project would utilise a number of hazardous substances during the construction and operation phases, such as fuel and oil that are regulated by the Australian Code for the Transport of Dangerous Goods by Road and Rail (NTC 2007). **Table 19-1** lists the principal dangerous goods that would be used during various phases of the Project, by name, classification, raw and storage concentration, United Nations (UN) number, packaging group and purpose. No explosive raw material would be handled or stored on-site.

Table 19-1 Relevant Dangerous Goods and their Classification

Chemical Name	DG Class	Raw Conc (Wt%)	Storage Conc (Wt%)	U.N. Number	Packing Group	Purpose/Use
Diesel Fuel	3 (Class C1)*	n/a	n/a	1202	III	Fuel for mobile equipment and power generation
Petroleum Products, including Grease, Lubrication and Hydraulic Oils	3 (Class C2)**	n/a	n/a	1268	n/a	Lubricate plant and equipment
Paints	3	n/a	n/a	1263	III	Protective coating
Solvents	3	99.5	99.5	1090	II	Workshop degreasing agent & cleaning painting equipment
Acetylene Gas	2	n/a	n/a	1001	n/a	Combined with oxygen for metal cutting (welding) purposes
Carbon Dioxide Gas	2.2	n/a	n/a	1013	n/a	Welding
Liquid Petroleum Gas	2.1	n/a	n/a	1075	n/a	Heating and equipment fuel
Detergent	3	n/a	n/a	1198	III	Equipment cleaning
Liquid Nitrogen	2.2	n/a	n/a	1977	n/a	Equipment assembly
Oxygen (compressed)	2.2	n/a	n/a	1072	n/a	Combined with Acetylene and Carbon Dioxide for welding purposes
Novec 1230 Gas	2.2	n/a	n/a	3163	n/a	Fire protection fluid

* Class C1 (AS1940) – a combustible liquid that has a flashpoint of 150°C or less.

** Class C2 (AS1940) – a combustible liquid that has a flashpoint exceeding 150°C.

Construction

Table 19-2 provides an indicative list of dangerous goods and hazardous substances and materials, which may be used during construction. The table details the relevant rate of use and maximum amount of the substance/material stored at the site during construction.

Refer to **Table 19-1** for the physical properties of dangerous goods. The appropriate Material Safety Data Sheet (MSDS) would be provided by the suppliers of chemicals, and information communicated to all site personnel involved in the storage, transportation, use and disposal of dangerous and hazardous substances and materials.

Table 19-2 Indicative Dangerous Goods and Hazardous Substances – Construction

Chemical Name	Annual Rate of Use	Maximum Inventory
Diesel	16,000kL	125kL
Lubricating and Hydraulic Oils	155kL	5kL
Grease	18kL	2,000L
Construction Sealants	7,300L	150L
Construction Adhesives	7,300L	150L
Paint	7,300L	2,000L
Solvents	1,825L	200L
Oxygen Gas	18kL	1,000L
Acetylene Gas	18kL	1,000L
Carbon Dioxide Gas	37kL	500L
Liquid Petroleum Gas	10kL	800L
Detergent	4,680kg	540kg
Liquid Nitrogen	Infrequent	1 container
Novec 1230 Gas	As required	1,800L

Operations

The key hazards during operations are associated with the substances being transported, stored and used for mining activities. The Project makes use of several hazardous substances, whose transport is regulated by the Australian Dangerous Goods Code.

The indicative rate of use and the maximum amount stored on-site during the different production scenarios are shown in **Table 19-3**.

Table 19-3 Indicative Dangerous Goods and Hazardous Substances – Operations

Chemical Name	15Mdptpa		30Mdptpa		50Mdptpa	
	Annual Rate of Use	Maximum Inventory	Annual Rate of Use	Maximum Inventory	Annual Rate of Use	Maximum Inventory
Diesel Fuel	38,000kL	500kL	70,000kL	1,000kL	109,000kL	1,500kL
Lubricating and Hydraulic Oils	230kL	5kL	450kL	10kL	700kL	10kL
Grease	1,825L	920L	3,650L	2kL	3,650L	2kL
Construction Sealants	50L	10L	100L	20L	160L	20L
Construction Adhesives	25L	10L	50L	20L	80L	20L

Chemical Name	15Mdptpa		30Mdptpa		50Mdptpa	
	Annual Rate of Use	**Maximum Inventory**	**Annual Rate of Use**	**Maximum Inventory**	**Annual Rate of Use**	**Maximum Inventory**
Paint	50L	20L	100L	40L	160L	40L
Solvents	180L	20L	360L	40L	580L	40L
Oxygen & Acetylene Gas	1,200L	480L	2,400L	960L	3,800L	960L
Carbon Dioxide Gas	1,200L	150L	2,400L	300L	3,800L	300L
Liquid Petroleum Gas	4,680kg	270kg	9,360kg	540kg	15,000kg	540kg
Detergent	200L	600L	400L	1,200L	640L	1,200L
Liquid Nitrogen	Infrequent	1 container	Infrequent	1 container	Infrequent	1 container
Novec 1230 Gas	As required	1,800L	As required	3,600L	As required	3,600L

It is unlikely the chemicals used in the Project area would vary significantly from those already in use in the existing RTA operations north of the Embley River. Any new chemicals would be assessed for health, safety and environmental risks, prior to being brought to site.

Strategies would be employed to minimise health, safety and environmental risks associated with dangerous goods and hazardous substances.

The storage, handling and use of dangerous goods and hazardous substances would be in accordance with current Australian Standards, including:

- *AS 1940:2004 The storage and handling of flammable and combustible liquids;*
- *AS 1894:1997 The storage and handling of non-flammable cryogenic and refrigerated liquids;*
- *AS 1596:2008 The storage and handling of LP gas;* and
- *AS 4332:2004 The storage and handling of gases in cylinders.*

Secondary containment would be utilised to reduce the risk of spills occurring as a result of accidental rupture of tanks or leaks from transfer points.

The transfer of dangerous goods and hazardous substances by barge would be carried out in accordance with relevant regulatory requirements. Regulations for the prevention of pollution by harmful substances carried by sea are contained in Annex III of the International Convention for the Prevention of Pollution from Ships (MARPOL) (IMO 2006). The Annex applies to all ships carrying harmful substances in packaged form, or in freight containers, portable tanks, or road and rail tank wagons. The *Transport Operations (Marine Pollution) Act 1995* (Qld) gives effect to the MARPOL in Queensland.

Procedures would be developed for storage, handling, transfer and disposal of hazardous substances to minimise the risk of spills. MSDS's for all chemicals to be used would be available at appropriate locations such as the chemicals storage facilities and the laboratory.

Relevant employees and contractors involved in the storage, handling use and disposal of hazardous substances and materials would be trained to ensure they are aware of their responsibilities in relation to hazardous substances.

Procedures would be developed for spill clean-up and appropriate emergency response equipment provided at key locations to reduce the risk of harm resulting from a spill. Further information regarding emergency response is provided in **Section 19.3.1**.

Implementation of the proposed controls of these materials would reduce the risk to employees, adjacent land users, members of the general public, and the environment to an acceptable level.

19.2 Project Risk Management

The RTA risk management system has been developed in accordance with the Australian Standard *AS/NZS 4360:2004 Risk Management.* It provides an integrated approach to risk management of the operations, which incorporates on-site risks as well as external risks to the Project.

A risk register, containing health, safety and environmental (HSE) risks is maintained for the existing Weipa operations and regularly reviewed. In addition, a preliminary hazard analysis, using the method outlined in the following sections, has been carried out for the Project.

19.2.1 Hazard Identification

The hazard identification process is dynamic, requiring ongoing monitoring of the tasks, controls and human elements of risk management, to ensure changes in the work or work environment throughout different phases of the operation trigger review of the adequacy of the controls.

A preliminary hazard analysis has been carried out by Rio Tinto for the Project, based on experience at the existing Weipa mining operations and other similar construction and operational projects. The assessment outlines the implications for, and the impact on, the surrounding land uses, and refers to the RTA Weipa Business Resilience and Recovery Plan (BRR Plan) where appropriate. The preliminary hazard analysis incorporates:

- All relevant HSE hazards;
- The possible frequency of the potential hazards, accidents, spillages and abnormal events occurring during all stages of the project, including possible frequency of occurrence;
- Indication of cumulative risk levels to surrounding land uses;
- The hazardous substances to be used and stored on site and the rate of usage, and
- Potential wildlife hazards such as snakes and disease vectors.

Potential hazardous event scenarios from activities at the mine were identified through consideration of:

- The range of activities carried out and facilities present during all phases of the Project. These included construction activities, energy supply, water supply, bauxite extraction, beneficiation, tailings management, and decommissioning; and
- The range of potentially hazardous events (also known as "incidents") that might be associated with each of the activities/facilities identified at the site.

The identification of hazards is aided through the application of a prompt list. The list is based on the possibility of a damaging energy as a result of a loss of control of that energy. The standard hazard categories used at Rio Tinto are as follows:

- Biological
- Climatic/Natural Events
- Electrical/Magnetic
- Ergonomics
- External Threats
- Gravity
- Lighting
- Land Use
- Mechanical
- Personal/Behavioural
- Pressure
- Radiation
- Social/Cultural
- Sound/Vibration
- Substances/Chemicals
- Thermal/Fire/Explosion
- Vehicles and Transportation
- Waste
- Work Environment

Note not all energies are relevant to this Project.

Having identified the range of hazards likely to occur at the site, the following matters were considered for each hazard:

- Appropriate controls and mitigation factors expected to be put in place for the management of each hazard, as described in the relevant sections throughout this document;
- The consequences of each of the hazardous events if they were to occur. Assessment of the severity of the consequences takes into consideration the maximum reasonable outcome with the proposed mitigation measures in place;
- Possible causes and the probability of these causes occurring and leading to the hazardous event identified. The probability of each hazardous event occurring takes into consideration the proposed control measures. This information was then tabled to prioritise the risks and evaluate these levels against the concept of "As Low As Reasonably Practical" (ALARP), and
- Where a high or critical risk was identified, appropriate, prevention and/or mitigation measures were identified and the hazardous event reassessed with these controls in place.

There are no sensitive receptors, such as kindergartens, schools, hospitals, aged-care facilities, residences, or commercial places close to the Project mining, processing or port areas. As such, there are no hazards identified for the Project that could impact on public health values in the short or long-term. Modelling of the potential impact of dust and noise from operations has found there would be no adverse impact on Aurukun, Napranum and Weipa (refer **Section 9 Air Quality** and **Section 10 Noise and Vibration**).

19.2.2 Risk Assessment

Risk assessment of each identified hazard was carried out using a matrix, which is a tabular portrayal of risk as the combination of the probability of occurrence and consequence severity. The risk assessment matrix presented in **Figure 19-1** is based on the Rio Tinto risk matrix, which is consistent with the Standards Australia (2004b) handbook *HB436:2004 Risk Management Guidelines* (companion to *AS/NZS 4360:2004*).

The consequences may vary from a safety or health consideration to an environmental or community outcome. Where there may be multiple outcomes for a hazard, the highest risk rating (based on the assessment of multiple consequence categories) has been presented in **Appendix 19A**.

The highest risk events are judged to have the highest priority for consideration of additional risk-reduction options. Low-risk events are subject to normal operational controls and ongoing improvement processes.

The consequences assessed include both threats to the natural environment and to the health and safety of the public based on definitions shown in **Table 19-4**. Where a hazardous event may have several outcomes, each potential outcome was assessed in turn. The severity classes for each of the outcomes are based on the Rio Tinto consequence descriptors, which in turn, are consistent with *HB436:2004 Risk Management Guidelines*.

Figure 19-1 Risk Assessment Matrix

Likelihood	Consequence				
	1 - Minor	2 - Medium	3 - Serious	4 - Major	5 - Catastrophic
A - Almost Certain	Moderate	High	Critical	Critical	Critical
B - Likely	Moderate	High	High	Critical	Critical
C - Possible	Low	Moderate	High	Critical	Critical
D - Unlikely	Low	Low	Moderate	High*	Critical
E - Rare	Low	Low	Moderate	High*	High*

Table 19-4 Consequence Classes for Hazardous Events

Consequence	Minor	Medium	Serious	Major	Catastrophic
Health	Reversible health effects of little concern, requiring first-aid treatment at most. Can include minor irritations of eyes, throat, nose and/or skin, or minor unaccustomed muscular discomfort. Community concern about health resolved via existing site procedures.	Reversible health effects of concern that would typically result in medical treatment. Can include temperature effects; travel effects; stress; and sunburn. Unresolved minor community concern about health.	Severe, reversible health effects of concern that would typically result in a lost-time illness. Can include acute/short-term effects associated with extreme temperature effects; musculo-skeletal effects; vibration effects; nervous system effects; some infectious diseases. Repeated community concerns about health requiring site management or business response.	Single fatality or irreversible health effects or disabling illness. Can include progressive chronic conditions and/or acute/short-term high-risk effects. Severe community concern about health.	Multiple fatalities or serious disabling illness to multiple people. Can include effects of carcinogens, mutagens, teratogens and reproductive toxicants (known and suspected), and life-threatening respiratory sensitisation and malaria. Severe, prolonged community concern about health.
Safety	Low-level, short-term subjective inconvenience or symptoms. Typically a first-aid and no medical treatment.	Reversible injuries requiring treatment, but does not lead to restricted duties. Typically a medical treatment.	Reversible injury or moderate irreversible damage or impairment to one or more persons. Typically a lost-time injury.	Single fatality and/or severe irreversible damage or severe impairment to one or more persons.	Multiple fatalities or permanent damage to multiple people.
Environment (on-site)	Near-source confined and promptly reversible impact.	Near-source confined and short-term reversible impact.	Near-source confined and medium-term recovery impact. Repairable damage to site or item of cultural significance.	Impact that is unconfined and requiring long-term recovery, leaving residual damage. Irreparable damage to site or item of cultural significance.	Impact that is widespread, unconfined and requiring long-term recovery, leaving major residual damage. Irreparable damage to site or item of international cultural significance.
Environment (off-site)	Community complaint resolved via existing site procedures.	Near-source confined and promptly reversible impact.	Near-source confined and short-term reversible impact. Repairable damage to site or item of cultural significance.	Near-source confined and medium-term recovery impact. Irreparable damage to site or item of cultural significance. Breach of international convention and/or national law relating to communities, and/or non-compliance with formal community agreement.	Impact that is unconfined and requiring long-term recovery, leaving residual damage. Irreparable damage to site or item of international cultural significance.

A likelihood of occurrence was assigned to each identified hazardous event based on definitions shown in **Table 19-5**. The contribution of preventative and protective features was taken into account when assessing the likelihood of occurrence and potential consequence from each hazardous event. The likelihood of occurrence also assumes any recommendations provided in this document are implemented. The descriptions for probability of occurrence used for this risk assessment are based on the Rio Tinto likelihood descriptors, which in turn, are consistent with *HB 436:2004 Risk Management Guidelines*.

Table 19-5 Likelihood Descriptions for Hazardous Events

Likelihood	Likelihood Description	Frequency	Substance Exposure
Almost Certain	Recurring event during the lifetime of an operation/project	Occurs more than twice per year	Frequent (daily) exposure at > 10 x OEL*
Likely	Event that may occur frequently during the lifetime of an operation/project	Typically occurs once or twice per year	Frequent (daily) exposure at > OEL
Possible	Event that may occur during the lifetime of an operation/project	Typically occurs in 1-10 years	Frequent (daily) exposure at > 50% of OEL Infrequent exposure at > OEL
Unlikely	Event that is unlikely to occur during the lifetime of an operation/project	Typically occurs in 10-100 years	Frequent (daily) exposure at > 10% of OEL Infrequent exposure at > 50% of OEL
Rare	Event that is very unlikely to occur during the lifetime of an operation/project	Greater than 100 year event	Frequent (daily) exposure at < 10% of OEL Infrequent exposure at > 10% of OEL

* OEL: Occupational Exposure Level

The following sources of information were used to undertake the Project risk assessment:

- the Weipa operations HSE Risk Register;
- RTA Weipa Resource Assessment 2007 Health Safety Environment & Communities Management Plan, which was implemented during the drilling activities undertaken in the SoE Project area and other areas on the mining lease;
- Experience brought to the process from other parts of Rio Tinto (Rio Tinto Technology & Innovation and Rio Tinto Coal Australia's recent Clermont Mine construction);
- Project-specific impact assessment studies developed by Project environmental consultants and RTA personnel, and
- Information on other proposed bauxite mining projects adjacent to ML7024 (i.e. Cape Alumina Pisolite Hills project as originally proposed in 2008 and Chalco's Aurukun Bauxite Project). However, as stated in **Section 1.4,** there is currently some uncertainty about the future development of these projects.

The preliminary Project HSE Risk Register was compiled by Rio Tinto and is provided in full in **Appendix 19A**. Where relevant, potential cumulative impacts from other projects were considered (refer also to **Section 20** for a detailed description of cumulative impacts). There were 13 "high", 55 "moderate", and 11 "low" risk scenarios identified. There were no "critical" risks.

Based on the risk assessment, the Project's overall risk profile is at a moderate level. The "high" risk scenarios are shown in **Table 19-6**, which also refers to the section of the EIS where the proposed prevention or mitigation measures are described. Note that, in addition to the information referred to in this table, a quantitative dam Failure Impact Assessment has been conducted for Dam C (refer **Section 5.2.6**).

The risk register would be incorporated into the site's HSE Management System and would be regularly reviewed and updated throughout the Project.

Table 19-6 Preliminary HSE Risk Assessment – High Risks

Category	Hazard	Phase	Scenario Description	Summary of Controls and Relevant EIS Section	Consequence	Likelihood	Risk Classification
Environment	Biological	All	Inefficient operation of the Sewage Treatment Plant (STP) causing surface or groundwater contamination.	STP designed to treat to Class A effluent quality; water would be reused in process, rather than discharged; monitoring of E.coli levels in water. *(Section 13.3.7 Waste)*	3-Serious	C-Possible	High
Environment	Biological	All	Spread of significant weeds from mobile equipment.	Washdown of vehicles prior to entering site and control of washdown water; weed surveys and appropriate treatment where required. *(Section 7.10.2 Terrestrial Flora & Fauna)*	3-Serious	C-Possible	High
Environment	Land Use	All	Unauthorised disturbance of native vegetation, habitat or cultural heritage site.	Field surveys and mapping; "Community Heritage and Environment Permit" process; and environmental buffer system. *(Sections 7.9.2 and 7.17.2 Terrestrial Flora & Fauna)* Cultural heritage assessments; "CHE Permit" process, and site protection plans. *(Section 11.1.5 Cultural Heritage)*	4-Major	D-Unlikely	High
Environment	Lighting	All	Port lighting disorienting marine turtles.	Port lighting: use long-wave length lighting; minimise lighting to that required for safe operation; and consider shielding, height and direction in design to minimise light spill. *(Section 6.9.4.3 Marine)*	3-Serious	C-Possible	High
Environment	Substances	Construction	Dredging and spoil disposal causing impact to marine or estuarine environment.	Minimise dredging period; ensure barge door seals are in good condition; taking loaded barges to spoil disposal area and discharging as soon as possible to minimise clay settling and adhering to the barge lining; where possible, placing a sandy silt lining (from dredge material) on the bottom of the barge before loading clays to facilitate clay discharge, and even distribution of dumped spoil. Monitoring would be carried out and reactive management implemented if required. *(Section 6.9.3.1 Marine)*	3-Serious	C-Possible	High
Health	Radiation	All	Over-exposure to the ultraviolet radiation.	Long-sleeve shirts, trousers and hats, high-protection sunscreen, and awareness training. *(Section 18.5.9 Health & Safety)*	3-Serious	C-Possible	High
Safety	Gravity	All	Aircraft crash.	Commercially-operated planes; and existing airport infrastructure. *(Section 14.3 Traffic & Transport)*	4-Major	E-Rare	High
Safety	Personal/Behavioural	All	Unauthorised access to operational area resulting in harm to member of public.	Procedure to control unauthorised persons on mine haul roads; and only RTA authorised persons to use barge/ferry/Mine Access Road. *(Section 18.6.2 Health & Safety)*	4-Major	E-Rare	High

Category	Hazard	Phase	Scenario Description	Summary of Controls and Relevant EIS Section	Consequence	Likelihood	Risk Classification
Safety	Pressure	All	Personnel struck by lines during towing or berthing.	Vessels would comply with National Standard for commercial vessels; vessels would be operated in accordance with Maritime Safety Queensland requirements; and Safe Operating Procedures would be developed. *(Section 18.6.9 Health & Safety)*	4-Major	D-Unlikely	High
Safety	Thermal/Fire/ Explosion	All	Major facility fire or explosion.	Fire-protection systems for fuel storage areas; and appropriate electrical equipment and installations. *(Section 18.6.4 and 18.6.7 Health & Safety)* Appropriate siting of buildings; provision of fire breaks; and adequate vehicle access and water supplies for fire fighting. *(Section 19.3.3 Hazard and Risk)*	4-Major	D-Unlikely	High
Safety	Vehicles & Transport	All	Mobile equipment collisions or accidents (public access roads).	Repair and maintenance of existing road network; additional temporary signage; fatigue management for RTA workers and DTMR procedures to manage fatigue for external transporters; RTA driver training; upgrade of intersections near ferry and barge terminals, and use of long-haul transport to be minimised where possible. *(Section 14.1.7 Traffic & Transport)*	3-Serious	C-Possible	High
Safety	Vehicles & Transport	All	Mobile equipment collisions or accidents (mine roads).	Haul road design and maintenance, Mine Roads Driving Permit; speed limits; dust control; vehicle inspections and maintenance; and radio communication. *(Section 18.6.2 Health & Safety)*	3-Serious	C-Possible	High
Safety	Vehicles & Transport	All	Pedestrian struck by uncontrolled movement of mine equipment.	Barricades and visual demarcation; speed limits; traffic rules, and lock-out/tag-out systems *(Section 18.6.3 Health & Safety)*	4-Major	D-Unlikely	High

19.3 Emergency Management Plans

The existing Weipa operations maintain and implement, as required, a detailed BRR Plan (also known as an "Emergency Management Plan"). The BRR Plan would be updated to include the Project area and updated regularly throughout each stage of the Project to ensure it continues to appropriately manage risks.

The BRR aims to:

- identify the BRR team members, RTA support staff and external support agencies, and their contact details;
- define the accountabilities of the BRR team members;
- provide details of the facilities (location and equipment) for BRR event management;
- provide details of external parties that may need to be contacted if a BRR event occurs;
- identify opportunities for cooperation with neighbouring communities and organisations, and
- identify the key threats and provides guidance on their management.

The BRR Plan is written to allow for management and development of an appropriate response to any type of emergency situation. However, the plan includes specific procedural guidance for appropriate response to a wide range of threats that have been identified as a potential risk at the Weipa operations. These include, but are not limited, to:

- aircraft incident;
- major fire/explosion;
- fatalities (including multiple fatalities);
- natural disaster (including cyclone);
- vehicle incident;
- loss of communications/information technology;
- workplace violence;
- widespread illness (including influenza pandemic);
- loss of utilities, and
- loss or potential for loss of structural integrity of tailings dam.

BRR exercises would be carried out at least annually and the plan updated to reflect changing conditions.

Designated first-aid and emergency rescue facilities and equipment would be available on site during the construction and operation phases. A paramedic and ambulance would be based at the Boyd infrastructure area (on shift) and a nearby two-kilometre section of the Mine Access Road would be designed to accommodate Royal Flying Doctor Service flight landings and take-offs. First-aid response would be included in the workplace induction training.

The site would have fire brigade-approved fire-fighting equipment and fire alarms. All fire-fighting facilities and equipment would be installed, serviced, maintained and inspected by a certified body.

Stores, workshops and offices would be fitted with approved and certified fire-detection systems (smoke and thermal detectors). First-aid, fire-fighting equipment and exit locations would be suitably signed. All work areas would be within the required distance to reach emergency exits.

Induction training would include fire-response techniques. The site would have fire equipment or a suitably equipped water truck or trailer that can support fire response requirements. Site fire-fighting capabilities would also be addressed in the BRR Plan.

Fire drills would be undertaken every six months. Permanent facilities, such as fuel storage areas, would have a dedicated fire alarm, suppression and fire-fighting equipment.

The BRR Plan outlines the level of event which would require notification or involvement of off-site emergency services. Generally, an on-site event that is visible or detectable off-site but does not present an off-site threat (e.g. a fire in bushland) may require notification of off-site emergency services, but no action by them. Other events of a more serious nature (e.g. a serious injury or fatality, explosion or very serious building fire), or those that have the potential to escalate to a more serious incident may require action by State Emergency Services. In these cases, the BRR Team Leader is responsible for contacting the off-site emergency services and this notification would result in the State Emergency Services liaising with the RTA Fire and Rescue team to identify an appropriate response. The site BRR team also has representatives on the Weipa Town Disaster Management Committee which enables the coordination of both RTA and State Emergency Services resources in the event of a disaster that impacts on the region such as a cyclone.

Local emergency services including Police, Ambulance, Rural Fire Brigade, State Emergency Service and Volunteer Marine Rescue, have been involved in training scenarios where the BRR Plan has been used.

19.3.1 Accidental Release of Hazardous Goods or Other Materials

The risk of spills of dangerous goods would be controlled through transport, storage and use of these materials, in accordance with the relevant Australian Standards as well as relevant Department of Environment and Resource Management (DERM) and Australian Maritime Safety Authority guidelines.

However, spills of these materials can potentially occur through equipment failure or damage to equipment (e.g. through storm damage). Generally, spills of this nature are of small volumes and would be easily contained and cleaned up through implementation of RTA's Hazardous Substances management procedures. Large spills and/or those with the potential to cause a significant risk would be dealt with through the BRR Plan. Diesel would be transported from the Hey River barge terminal to the infrastructure areas by B-double tanker trucks via the Mine Access Road. The potential for accidents to occur on this road is low as it would be a sealed road of high quality, and would have limited traffic volume. However, should an accident occur that results in a spill, the following response would be undertaken:

- Incident would be reported immediately including location and nature of spill;
- A grader or loader would be dispatched to the location of the spill to form a bund to contain the spill. Where appropriate, equipment from a nearby operating area would be utilised;
- If the spill enters waterways or dams, oil-absorbent material would be used to contain the spill;
- Contaminated soil or water would then be removed and taken away for treatment; and
- Monitoring would be undertaken where required to ensure there is no environmental harm.

Accidental fuel, oil and chemical spills related to shipping activities associated the proposed port operations is considered low (refer **Section 14.4.6**). If a spill was to occur, Maritime Safety Queensland (MSQ) has the responsibility to provide an effective oil spill response in coastal waters across the State. To assist MSQ in local oil spill response, North Queensland Bulk Ports Corporation Limited (NQBP), formerly called Ports Corporation of Queensland, has entered into an agreement to provide a first-strike response in the Weipa Port area under the direction of the Regional Harbour Master. NQBP provides trained personnel, equipment and vessels to clean up any hydrocarbon spills.

RTA would prepare an oil spill response plan for the barge-carrying fuel tankers. In the event of a spill during fuel delivery or transfer, a first-strike response would be initiated to prevent or

minimise any hydrocarbon damage to the environment. Where required, MSQ would provide resources out of Cairns or other centres for larger spills.

The BRR Plan provides guidance for appropriate response in the event of loss of utilities such as sewage services and power. It also provides for response for potential overflow of sewage should a major power outage occur, including checks of all valves and pumps as well as containment where possible. Where required, in the event of an overflow, the Plan includes communication to the community, Queensland Health, and Department of Environment and Resource Management, as well as environmental monitoring, and recovery of the overflow if possible.

The BRR Plan also includes guidance on the loss or potential loss of structural integrity of tailings storage facilities. The tailings storage facilities contain non-hazardous material (refer **Section 5.2.2** and **Section 13.3.4**), however a structural failure may pose a health, safety and environmental risk. Response to this threat includes ensuring health and safety of employees and any third parties in the immediate area, and then notification and consultation with relevant authorities to determine containment/remediation protocols.

19.3.2 Flooding

Wet season inundation of flood plains resulting from overtopping of the main channel banks is a seasonal characteristic of the area. Flooding in the Project area is on broad flood plains with generally slow-moving, shallow water. The main impact is restricted access for vehicles rather than flood damage. Therefore, there is limited risk of harm.

Infrastructure would be designed to withstand flood events as described in **Section 4.2.2**. Therefore, it is unlikely that major infrastructure would be adversely affected by flood events. The Mine Access Road is designed such that flooding to a depth greater than 300mm may occur once in 10 years. In such an event, the workforce would be evacuated prior to the road closing. The BRR Plan for the Weipa operations outlines the appropriate procedures for evacuating people. In this event, an alert signal would sound and personnel would move to designated assembly areas. Non-essential personnel would be evacuated from site. If necessary, personnel may be evacuated by boat (from the port) or by aircraft.

The BRR Plan also addresses the risk that a protracted loss of power, sewage and/or water services could occur as a result of flooding. In this instance, site operations may cease and non-essential personnel evacuated. The BRR Plan also includes the identification of additional resources to ensure services are returned as soon as possible. As the Project is self sufficient in terms of water and power supply, the risk of impact is considered to be low.

19.3.3 Fire

Bushfires and grassfires are an intrinsic part of the Cape York environment. The extent to which the current fire regime of annual burning is human or naturally induced is difficult to determine. Indigenous Australians have long used fire as a land management tool; however fire can also be initiated by tourists, hunters, hazard-reduction burns and lightning.

Grassfires are common at the end of the dry season, they tend to be fast-moving, passing in five to 10 seconds and smouldering for minutes. They have a low to medium intensity and can damage livestock and farming infrastructure such as fences. Bushfires are generally slower moving, but have a higher heat output. This means they generally pass in two to five minutes, but they can smoulder for days. Fire in the crown of the tree canopy can move rapidly. In the Project area, fires pose a potential health and safety risk for employees and may cause damage to mine infrastructure and areas revegetated after mining.

Bushfire risk mapping as modelled by the Rural Fire Service and Queensland Fire and Rescue Service (2008), has been reviewed for the Project area as a guide to the risks associated with bushfires. The majority of the area is classified as having a medium bushfire risk, with watercourse and wetland type areas classified as a low-risk category. The majority of the area surrounding the township of Weipa is also classified as a low-risk.

The RTA Weipa BRR Plan outlines the appropriate response to the threat of both bushfire and fires associated with incidents arising from mining activities. The response includes call-out of the emergency response teams, ensuring the safety of people in the area (e.g. through evacuation), and eliminating further danger from existing storage and/or production facilities. RTA maintains a Fire and Rescue Service in Weipa that is trained and equipped to appropriately respond to fire risk.

The risk of bushfire damage to people and property shall be mitigated by:

- Appropriate siting of buildings;
- Provision of fire breaks;
- Provision of adequate vehicle access for fire-fighting, and
- Provision of adequate water supplies for fire-fighting.

Controlled burning may be used to reduce the risk of uncontrolled fires where there is potential for fire to enter new rehabilitation areas or damage mine infrastructure.

These measures are consistent with *State Planning Policy 1/03 Mitigating the adverse impacts of Flood, Bushfire and Landslide*.

19.3.4 Cyclones

Cyclones are one of the highest risks to the Project, due to the frequency of their occurrence in the Gulf area and their potential severity as discussed in **Section 4**.

RTA maintains a detailed Cyclone Emergency Procedure, which aims to minimise personal injury and damage to property through:

- Community involvement;
- Adequate warning and pre-cyclone preparation;
- Public instruction, and
- An effective organisation.

The Project would be directed from RTA's Weipa Cyclone Control Centre, which is established and operated throughout cyclone emergencies. This control centre is located at the Fire and Rescue Service Building at Lorim Point.

Cyclone conditions would be identified through an assigned colour code as follows:

Yellow - Initial warning of cyclone conditions approaching.

Blue - Cyclone conditions are likely. Detailed clean-up to commence on-site and emergency services checked and made ready.

Red (1) - Cyclone conditions are most probable. Operations would cease, final battening down would commence, and employees, except for those detailed for emergency duty, would be sent home. During the construction period, workers would be sent to a cyclone–proof accommodation.

Red (2) - Cyclone in area, emergency personnel only in area, personnel to stay under cover.

Green - Cyclone moving away, assessment of damage and re-establishment of civil and company operations.

Procedures would be prepared for each operational area detailing specific requirements and responsibilities for each of the cyclone conditions, which would include the following:

- General clean-up, including securing of loose items that could become projectiles;
- Assess ship situation with Marine Pilot and Shipping Agent;
- Check drainage systems and pumps, ensure culverts run freely;
- Ensure all water tanks, water carts and fill points are full;

- Refuel light vehicles;
- Park heavy equipment in secure location and secure machinery such as stackers;
- Tie down ship loaders and conveyor belts;
- Isolate equipment where required, such as radiation density gauges;
- Tape windows where required, and
- Close doors.

Once the cyclone has passed, damage would be assessed and resources allocated as required to address. External assistance may be requested where required.

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Environmental Impact Statement

for South of Embley Project

Section 20

Cumulative Impacts

20 CUMULATIVE IMPACTS

20.1 Introduction

This section describes the potential cumulative impacts on land, surface water, groundwater, marine, terrestrial and aquatic ecosystems, air quality, noise, cultural heritage, visual amenity, transport and socio-economic issues from the construction and operation of the Project.

Cumulative impacts are defined as:

- impacts that arise from the interrelationship of residual Project impacts. These may include multiple forms of impact at one location, and an environmental value being impacted at several locations or by a number of forms of impact; and
- impacts of the SoE Project in combination with other proposed mining projects and existing mining activity north of the Embley River.

Cumulative impacts have been considered based on the residual impacts associated with the Project. Where cumulative impacts have been discussed in previous sections of the EIS, those impacts are discussed in this section also. Proposed mitigation strategies that would minimise potential cumulative impacts and details of monitoring programs (including details of variables to be monitored and guidelines or criteria used to evaluate monitoring results) that would be relevant to assessing the cumulative impacts of the Project are specifically discussed again in this section.

Cumulative impacts that arise from a proposed project acting in combination with other known or proposed activities in the region or catchment may be significant. The objective of regional, State and Commonwealth policies, planning initiatives, guidelines and regulations is to provide a framework for environmental impact assessment, management of impacts, and decision making for future development to minimise and manage such cumulative impacts. The requirements of relevant policies and regulations and how RTA proposes to design and operate the Project consistent with these to minimise cumulative impacts are addressed in the relevant sections of the EIS.

20.2 Other Proposed Mining Projects

In March 2007 the State of Queensland entered into a development agreement with the Aluminium Corporation of China Limited (Chalco) to develop the Aurukun Bauxite Project. Chalco was granted mineral development licence MDL 378 located immediately to the east of RTA's ML 7024 (refer **Figure 1-1**). A bauxite mine producing 6.5Mdptpa was proposed, with product to be transported by conveyor across ML 7024 for shipment from a new port located close to Boyd Point. The Proponent proposed to accommodate a fly-in fly-out workforce on-site. In June 2010, the Queensland Government announced that the development agreement had come to an end and there is currently uncertainty about the future development of the Aurukun Bauxite Project.

RTA liaised with Chalco during the planning phase for their proposed project to discuss any potential for co-location and/or sharing of certain infrastructure. Where possible, and subject to commercial agreement, RTA would seek to minimise environmental and property impacts in the event that the Aurukun lease is developed in the future. Some impacts could potentially be mitigated by the following:

- establishment of a common infrastructure corridor for RTA's water pipeline, transmission line and overland conveyor (from the Norman Creek plant) and the Aurukun Bauxite Project's overland conveyor to the port (refer **Figure 1-3**); and
- co-location of port and stockpile facilities.

The SoE Project's water supply and power supply are designed to be independent of any other project.

Cape Alumina Pty Ltd holds two Exploration Permit – Minerals (EPMs) over the Pisolite Hills resource area (EPM 14547 and EPM 15278 situated 50km north-east of Weipa), with an

additional EPM to cover a barge loading facility (EPM 15984) (refer **Figure 1-1**). The Pisolite Hills Project as originally proposed in 2008 would have nominally produced five to seven Mdptpa of bauxite for 10 to 15 years. Product would have been trucked across ML 7024 to a barge-loading facility on the coast. RTA does not currently conduct mining activity or have infrastructure in the vicinity of this proposed haul road. A fly-in fly-out workforce was proposed, with accommodation to be provided in a camp on-site. In July 2010, Cape Alumina announced that the proposed Pisolite Hills Project was no longer viable due to the declaration of the Wenlock River Basin as a Wild River area.

Oresome Australia Pty Ltd is the proponent for the Urquhart Point Mineral Sands Project. The proposed project area is within mining lease application MLA 20669, a 366 hectare area north west of the SoE Project's Hey Point mining area (refer **Figure 1-1**). The proposed project would involve excavating sand ridges using slot mining, processing 700,000 to 800,000t of sand per annum to produce heavy mineral sands, and barging approximately 50,000t of heavy mineral sands product per annum. The project life would be four to six years with a target commencement date of 2012. A draft Terms of Reference (ToR) for the Urquhart Point Mineral Sands Project was advertised in March 2011.

The impacts of the SoE Project in combination with these two other possible future bauxite mine projects, the Urquhart Point Mineral Sands Project, as well as existing RTA operations north of the Embley River, have been considered and are presented in this section.

20.3 Land

There are no significant residual impacts relating to land use (use of the Project area and surrounds for agriculture, recreation and tourism) or soil (impacts related to soil erosion, soil contamination and management of potentially acid sulphate soils) that would interact with other impacts (refer **Section 3**) and result in a cumulative impact. Cumulative impacts relating to access by Traditional Owners to known places of cultural heritage significance is discussed in **Section 20.11.1**. Cumulative impacts relating to vegetation clearing are discussed in **Section 20.6**.

20.4 Surface Water

20.4.1 Ward River Hydrologic Regime

In order to maintain the reliability of the overall surface water supply at a production rate of 30Mdptpa or greater, some water would be pumped directly from the lower reaches of the Ward River (refer **Figure 1-3** for location of pump) to supplement the Dam C supply. An in-stream weir or dam structure would not be required. The annual volume of water pumped from the Ward River would be capped at 1% of mean annual river flow at the pump station (2.67GL). In addition, no pumping would occur when the Ward River flow was less than 1000L/s and the rate of pumping at all times would be less than 20% of the river flow rate.

A daily water balance model was used to estimate the Ward River flow at the pump station and the pumped volumes (refer **Section 5.2.4**). The downstream flow (river flow minus pumped volumes) was compared to the upstream flow to evaluate the effect of the pumping on the hydrological regime. The effect of the pumping on downstream monthly flow is summarised in **Table 5-20**. The effect of pumping at the 30Mdptpa and 50Mdptpa production scenarios would reduce mean annual flow immediately downstream of the pump station by a very small amount (0.8% and 0.9% of original flow respectively). The overall impact of pumping on the Ward River hydrological regime would be minor.

The proposed 6.5Mdptpa Aurukun Bauxite Project is within the catchment of the Ward River estuary (GHD 2007a). While there are uncertainties as to whether this project would proceed, the operation of both projects simultaneously could result in a cumulative impact. If the Aurukun Bauxite Project surface water demands were proportional to the surface water demands of the Norman Creek beneficiation plant operating at 25Mdptpa, the demand for that project would be to 4.2GL per annum. If this demand was met from a dam on a tributary of the

Ward River, the cumulative overall decline in mean annual discharge to the Ward River estuary would be very minor (< 1%) and well within natural seasonal variation.

The Ward River catchment makes up a minor part (3.8%) of the Archer Bay Aggregation along with the Watson and Archer Rivers. This Project would not have any impact on the Watson River or Archer River and therefore the impact of discharge to the Archer Bay Aggregation would also be very minor, if any.

The Urquhart Point Mineral Sands Project is located outside of the catchments affected by the SoE Project area.

20.4.2 Water Infrastructure

One of the key cumulative impacts raised by stakeholders was environmental damage from the construction of water infrastructure and the potential disturbance to sensitive areas which may be minimised if infrastructure such as dams were shared with other projects (refer **Section 16.3.6**). There was concern expressed by both Indigenous and non-Indigenous stakeholders that the construction of dams would potentially have negative environmental and cultural heritage impacts. Traditional Owners have requested consideration of shared water infrastructure as a strategy to potentially minimise environmental impacts of dams. The Wik and Wik Way Traditional Owners stated clearly that all dam options should be explored by RTA prior to constructing dams in sensitive areas. The concerns raised and alternative approaches suggested by the Traditional Owners are presented in **Table 16-20**, along with RTA's responses. In the case of water infrastructure, RTA did not pursue the original proposal for a second dam on the Ward River. While discussions have been held with Chalco regarding the potential sharing of port facilities (subject to RTA agreement) (refer to **Section 20.1**), shared water infrastructure is not feasible due to the need for a secure water supply.

20.4.3 Mining and Catchment Hydrology

The proposed Aurukun Bauxite Project is located in the catchment of the Ward River estuary. While there are uncertainties as to whether this project would proceed, the operation of both projects simultaneously could result in a cumulative impact on aquatic ecosystems in the Ward River estuary catchment. Potential cumulative impacts associated with catchment hydrology changes on aquatic ecosystems are discussed in **Section 20.7**.

The impact of the Project on catchment hydrology is described in detail **Section 5.2.4**. For each main catchment within which mining is planned, the annual discharge of the catchment was estimated for different stages of disturbance. The catchment discharge is the sum of the surface run-off and baseflow, and is dominated by the baseflow component. A summary of the annual catchment discharges is presented in **Table 5-22**.

The Ina Creek catchment has the largest proportion of area that would be mined, but the overall change to average annual discharge would be very small (-1.4% at maximum mining impact; -2.2% post-closure). There would only be very small changes to the discharge from the overall Norman Creek system (-1.0% at maximum mining impact; -1.8% post-closure) and overall Ward River system (-0.2% at maximum mining impact; -0.5% post-closure).

The operation of both the Aurukun Bauxite Project and SoE Projects simultaneously could result in a cumulative impact on catchment hydrology in the Ward River estuary catchment. In the absence of publicly stated areas of disturbance, estimations of mining disturbance associated with the Aurukun Bauxite Project were calculated using publicly available information on bauxite reserves. It is predicted that mining disturbance associated with the Aurukun Bauxite Project would total approximately 9,300ha. This would increase the potential aggregate mining disturbance in the Ward River estuary catchment to approximately 14,900ha but would have a very minor change on the annual discharge from the overall Ward system (-0.6% at maximum mining impact; -1.2% post-closure).

The modelling indicates that the overall impact of mining on catchment discharge would be much less than the normal year-to-year variation driven by rainfall variation. This is consistent with the calibrated rainfall-runoff model which shows that surface run-off is extremely low and

hence changes to surface drainage patterns would have little impact on overall discharge into streams.

20.4.4 Surface Water Quality

The catchments within the Project area are described in **Section 5.1.1**, and include the Ward River catchment and sub-catchments. There is potential for cumulative impacts on surface water quality in the lower Ward River system arising from activities associated with the Aurukun Bauxite Project and the SoE Project occurring simultaneously.

Proposed mining activities may result in residual impacts on surface water quality, including potential impacts on sediment loads (sedimentation and turbidity/total suspended solids) and water chemistry (hydrocarbon contamination and altered metals concentrations) (refer to **Section 5.2.5**). The potential risks of increased sediment loads and water chemistry impacts in surface waters, and mitigation strategies, are discussed below. The potential of impacts of increased sediment loads and water chemistry impacts in surface waters on aquatic ecosystems are discussed in **Section 8.15.1** and **Section 8.15.1**, and potential cumulative impacts on aquatic ecosystems are discussed in **Section 20.7**.

Clearing vegetation cover for mining activities and associated infrastructure may result in elevated sediment loads in catchment runoff during some stages of mine development. However, as less than 1% of incident rainfall results in direct surface runoff (refer to **Section 5.1.1**) and mining pits retain overland flow, the risk is considered low.

Mining activities may introduce contaminants to surface waters via hydrocarbon spills, ore spills, mining activities altering the hydrology and thus the geochemistry of an area (resulting in a change of metals concentrations), and recycled process water, tailings liquor and ore stockpile runoff increasing metal concentrations.

The storage, handling and use of dangerous goods and hazardous substances on land would be in accordance with current Australian Standards and industry codes of practice. Spill prevention measures and emergency response measures for spills would be implemented (see **Section 19.1** and **Section 19.3.1**). Implementation of these proposed controls would reduce the risk to employees, adjacent land users, members of the general public and the environment to an acceptable level.

Product spillage into the marine environment could occur during routine loading operations. However, bauxite is non-hazardous and the risk of impact to marine ecology is considered to be low.

Mining activities may alter the geochemical (e.g. manganese and iron) makeup of surface waters by modifying the volume of contributing groundwater and surface waters. However, generally the mining pit floor would be above the groundwater table and thus the risk to alteration of groundwater is considered minimal (refer to **Section 5.3.2**).

Crude ore from the Project area, ore and tailings solids from existing Andoom and East Weipa operations, tailings liquid, water from tailings recovery slots, shallow aquifer groundwater, and runoff from existing product stockpiles were analysed (Rio Tinto 2009b; refer to **Section 13.3.4** and **Section 8.15.1.2** for data). The results suggest that bauxite stockpiles are unlikely to be a significant contributor of aluminium to surface water ecosystems via runoff. Tailings liquid and some tailings seepage waters may contain aluminium concentrations greater than 80^{th} percentile calculated for any freshwater site in the Project area, but within the range found in late dry season sampling of site waters. The following metals were not detected in tailings liquid at concentrations greater than the reporting limit: arsenic, boron, cobalt, copper, lead, nickel, selenium, zinc and mercury. This indicates these elements are not considered potential constituents of concern for the Project area. Tailings solid and ore samples were collected for leach analyses using two analytical methods. Based on these results, leaching from either is not anticipated to have an adverse affect on surface water or groundwater.

Given the nature of bauxite mining, the design and operation of the Aurukun Bauxite Project is likely to be similar to the SoE Project and therefore the cumulative residual impacts on surface water quality are expected to be low.

Potential cumulative impacts to surface water quality could be reduced by the establishment of a common infrastructure corridor for RTA's infrastructure and the Aurukun Bauxite Project's overland conveyor, and co-location of port and stockpile facilities.

Surface water monitoring would be undertaken in the Ward River system to assess potential water quality impacts. A range of metals and turbidity would be regularly monitored in surface waters to provide an early indicator of any potential impacts (refer to **Section 5.5.1**).

20.5 Groundwater

20.5.1 Shallow Aquifers

The potential impact of mining on shallow aquifers is discussed in detail in **Section 5.4.1**. In summary, mining may have the potential to affect the shallow aquifer in two ways:

- alterations to the surface drainage regime by the creation of internally draining post-mining landform may lead to changes in the shallow aquifer response; and
- removal of a portion of the lateritic bauxite strata that may host the aquifer.

The modelling of mining impacts (refer **Section 5.2.4**) has shown that mining has a temporary impact on the partitioning of surface run-off and baseflow and that as rehabilitation matures the overall hydrological regime at a catchment scale returns toward an "undisturbed" situation. The main reason that change due to mining has a small impact is that direct surface run-off from the bauxite plateau is a very small proportion of incident rainfall (<1%). Hence, redirection of surface flow does not alter aquifer recharge characteristics much.

The removal of bauxite would only have the potential to change discharge from the shallow aquifer in situations where the bauxite is an appreciable source of baseflow. Typically in the Project area, the water table is within the bauxite only at the height of the wet season, if at all. In the dry season, the water table generally falls to 4 to 8m below the base of the bauxite. Stream flow during the dry season tends to maintained by baseflow originating predominantly from kaolinitic strata. The overall effect of mining on the baseflow and deep baseflow component of the water balance is very small (**refer Section 5.4.2)**.

Mining activities within the Aurukun Bauxite Project area would be likely to have similar shallow aquifer impacts, and therefore a cumulative effect on shallow aquifers from both projects would be unlikely.

Shallow aquifer monitoring is described in **Section 5.5.2**. Groundwater monitoring results would be used to assess potential cumulative impacts on shallow aquifers.

20.5.2 Artesian Aquifers

Drawdown

RTA proposes to install an artesian borefield that accesses the Gilbert River Formation artesian aquifer, to contribute to the water supply for the Project. RTA has an existing artesian Water Licence for 9GL per annum which allows abstraction from bores located on ML 7024. RTA proposes to apply to increase this artesian allocation to cover the increase in water demand arising from the Project (refer **Section 5.2.1**). RTA proposes that the Water Licence be based on a 5-year moving average of 12GL per annum, with a maximum of 15GL in any one year. There are currently no other large users of artesian groundwater on Cape York.

The potential impacts of artesian groundwater abstraction were modelled under two different scenarios:

- A constant 12GL per annum over the 40 year mine life (the '12GLpa scenario')
- 12GL per annum for the first 13 years and then 18GL per annum for the remainder of the 40 year mine life (the '18GLpa scenario').

The 12GL per annum scenario was used to determine the maximum potential impact under the proposed licensed abstraction regime. The 18GL per annum scenario was modelled to obtain an

indication of the upper bounds of aquifer sustainability. Details of the artesian groundwater modelling are presented in **Section 5.4.2**.

The modelling results indicate that under the proposed licensed abstraction regime, the existing Water Licence condition relating to a 5m maximum relative drawdown would be met (refer **Section 5.3.4**). The modelling predicted that the existing Water Licence condition relating to maximum relative drawdown would also be met for an 18GL per annum scenario, except for a slight exceedance of the 5m drawdown over a relatively short period of time at one monitoring bore. The results indicate that the aquifer could sustainably support abstraction rates greater than the proposed rate of 12GL per annum.

Abstraction of groundwater from the Gilbert River Formation and Garraway Beds artesian aquifers is to be investigated as a potential water supply source for the Aurukun Bauxite Project (GHD 2007a). If groundwater abstraction did occur it would be likely to cause drawdown of the Gilbert River Formation and Garraway Beds artesian aquifers. Data on the proposed location of artesian bores and the proposed abstraction regime for the Aurukun Bauxite Project would be required to make an assessment of the cumulative impacts associated with groundwater abstraction on artesian aquifers in the region. However, modelling results for the SoE Project indicate that abstraction rates could be increased by nearly 6GL above the proposed abstraction rate and still comply with RTA's current Water Licence conditions in relation to maximum relative drawdown (refer **Section 5.4.2**).

The 280 ML per annum proposed to be abstracted from artesian aquifers for the Urquhart Point Mineral Sands Project is very small compared to the volumes proposed to be abstracted for other projects in the region, and is therefore unlikely to significantly contribute to a cumulative impact on groundwater aquifers.***Spring Factors***

Section 39 of the *Great Artesian Basin Resource Operations Plan* (GAB-ROP) (DNRW 2007) prescribes conditions that must be met for the chief executive to make a decision about a water licence, if the decision is associated with a management unit connected to a spring, and the water is for purposes other than domestic and stock watering. A decision associated with abstraction from a management unit connected to a spring is subject to the cumulative spring factor not exceeding 400mm head of water. The GAB-ROP (DNRW 2007) prescribes how the spring factors are to be calculated (refer **Section 5.4.2**).

The proposed artesian groundwater abstraction from existing and proposed new bores would take water from the Gilbert River Formation, which is connected to watercourse and recharge springs. The spring factors for those recharge springs and watercourse springs within the Dividing Range closest to the existing and proposed borefields were calculated by multiplying the spring factor multiplier by the abstraction rate for the two abstraction rate scenarios (12GL and 18GL per annum). The calculated spring factors are presented in **Table 5-30**. The calculated spring factors represent the highest possible cumulative spring factor for each spring because the spring factors are calculated on the assumption that all of the water is abstracted from the closest bore.

The calculated spring factors for both the 12GL and 18GL per annum scenario are all well below the spring factor limit of 400mm head of water (the highest calculated spring factor was 144mm head of water), demonstrating that the spring factor requirement would be met in all cases.

Data on the proposed location of artesian bores and the proposed abstraction regime for the Aurukun Bauxite Project would be required to make an assessment of the cumulative impacts associated with groundwater abstraction on spring factors. However, calculated spring factors for the SoE Project indicate that abstraction rates could be increased by nearly 6GL above the proposed abstraction rate and still readily comply with the cumulative spring factor of 400mm head of water prescribed under the GAB-ROP (DNRW 2007).

Artesian aquifer monitoring is described in **Section 5.5.3**. Groundwater monitoring results would be used to assess potential cumulative impacts on artesian aquifers.

20.6 Marine

Marine components of the Project include the port facility, the proposed new spoil disposal ground, the existing disposal ground (Albatross Bay) and the barge and ferry terminal facilities. The reasons the location was chosen for the proposed spoil ground, as well as the alternatives considered, are discussed in **Section 1.6.11**.

Potential cumulative impacts arising from interrelationship of marine components of the Project are discussed in **Section 6.9.7**. In summary, it is not predicted that any cumulative effects between marine components of the Project would arise.

Potential impacts of the Project on the marine environment in combination with current activities are also discussed in **Section 6.9.7**. The additional residual impacts of the Project are not expected to cause significant cumulative impacts on elements of the marine environment.

The Aurukun Bauxite Project is proposed to include construction and operation of a jetty, wharf and berth pocket area approximately 1.5km south of Boyd Point. Activities would include dredging and disposal of sediments. On-shore facilities associated with the port would be located on ML 7024 (GHD 2007a). If the Aurukun Bauxite Project constructed and operated an additional port facility near the proposed SoE Project port, there would be a cumulative impact on the marine environment in the Boyd Point area. The nature and significance of such impacts cannot yet be assessed due to lack of available information on the proposed port associated with the Aurukun Bauxite Project. However, it could be expected that there may be potential cumulative impacts on corals at Boyd Point, marine turtle nesting and the off-shore marine environment (depending on where the Aurukun Bauxite Project dredged spoil was disposed).

The Urquhart Point Mineral Sands Project may impact on beaches that contain marine turtle nesting habitat to the north of the SoE Project (Oresome Australia Pty Ltd 2011). Although the areas of impact would not overlap, there may be a cumulative impact on marine turtle nesting. The nature and significance of such impacts cannot yet be assessed due to lack of available information on proposed infrastructure and activities associated with the Urquhart Point Mineral Sands Project.

The Urquhart Point Mineral Sands Project proposes to transport personnel, plant and equipment to the site, and heavy mineral sands product from the site, via barge. Although no detail on barge routes or frequencies are available, given the relatively small scale of the project and its maximum 6 year mine life, if the Urquhart Point Mineral Sands Project and SoE Project were to operate simultaneously potential cumulative impacts on the marine environment from boat activity are unlikely to be significant.

Capacity may be provided at RTA's proposed port and on-shore facilities for third parties, following agreement on suitable commercial terms (see **Section 1.4**). Such an arrangement would minimise the cumulative impacts associated with constructing and operating two ports.

20.7 Terrestrial Ecosystems

20.7.1 Flora

Any impacts on flora would occur at the construction and operational phases of the Project. Direct impacts on vegetation would occur as a result of vegetation clearing within the proposed mining areas, and a much smaller area of vegetation clearing for the construction of Project infrastructure. Clearing for mining would be restricted to the bauxite plateau and would affect only Darwin Stringybark woodland, whilst disturbance of vegetation for infrastructure would affect a variety of vegetation types including woodland, riparian and wetland vegetation types, and also some regrowth vegetation.

Secondary impacts on vegetation may occur during the operations phase of the Project linked primarily to potential effects from altered hydrological regime due to mining activity and operation of the water supply dam. The potential introduction of exotic and weed flora, feral pig activity, and fire regimes also pose potential mechanisms for impacts on native vegetation within the Project area.

These direct and indirect impacts on flora represent potential cumulative impacts as they arise from an environmental value being impacted by a number of forms of impact. Vegetation clearing associated with the two other nearby proposed bauxite mining operations could also result in cumulative impacts. Both these types of cumulative impacts are discussed below.

Darwin Stringybark Vegetation

The areas of each regional ecosystem (REs) to be directly disturbed by the Project relative to the overall Project area, the Weipa Plateau subregion, and the wider Cape York bioregion are presented in **Table 7-10** in **Section 7.9.1**.

Regional ecosystem 3.5.2 (Darwin Stringybark woodland) would be the most extensively disturbed vegetation type within the Project area as it occurs on the bauxite plateau where mining would occur. Approximately 28,970ha or 33% of the area of this vegetation type within the Project area would be disturbed, representing 4.3% and 3.7% respectively of its Subregional and Bioregional distribution. With the exception of RE 3.5.2, the disturbance to most other REs would be much less than 10% (0.2% to 7.5%) of their total extent within the Project area apart from RE 3.3.5 (28.8%).

Of the 15 threatened plant species either confirmed as present or assessed as possible or likely to occur in the Project area, three are known to occur in Darwin Stringybark woodland on the bauxite plateau within the Weipa region and are as follows:

- *Acacia ommatosperma* ("Near threatened" under the *Nature Conservation Act 1992* (Qld) (NC Act), possibly occurring on site);
- *Albizia retusa* ("Near threatened" NC Act, possibly occurring on site); and
- *Heterachne baileyi* ("Near threatened" NC Act, possibly to occurring on site).

None of these species were confirmed as present during field surveys.

The potential habitat area for *Heterachne baileyi* and *Acacia ommatosperma*, within the dam footprint, would comprise approximately 3% of the potential habitat for these species within the Project area, so the majority of potential preferred habitat would not be affected. Most of the potential habitat for these species is likely to occur within environmental buffer areas. It is unlikely that indirect effects on any potentially occurring populations would occur as a result of alterations to hydrology or edge effects.

Albizia retusa is known to occur in Darwin Stringybark woodland predominantly in the vicinity of vine forest. The proposed environmental buffer system would prevent mining in the vicinity of vine forest and avoid disturbance of this area. Indirect effects due to altered hydrology and edge effects are unlikely to affect any potential populations of this species, and the proposed fire management plan is likely to favour this species.

Potential direct and indirect impacts on threatened flora, and mitigation strategies, are further discussed in **Section 7.11**.

While there are uncertainties as to whether the Pisolite Hills Project and Aurukun Bauxite Project would proceed, the cumulative impact of vegetation loss associated with the SoE Project together with these two projects has been considered (refer to **Section 7.9.1**). In the absence of publicly stated clearing rates, estimations of disturbance within RE 3.5.2 associated with the Pisolite Hills Project and the Aurukun Bauxite Project were calculated using publicly available information on bauxite reserves. It is predicted that clearing of RE 3.5.2 associated with the Pisolite Hills Project and the Aurukun Bauxite Project would be approximately 2,600ha and 9,300ha respectively. In addition, total clearing (past and future) associated with the current Weipa operations is projected to total approximately 33,300ha by the end of mine life.

Considering clearing associated with these current projects, possible future Projects, and the SoE Project, total clearing within RE 3.5.2 would be approximately 74,200ha within the Weipa Plateau Subregion. If the Pisolite Hills Project and Aurukun Bauxite Project were to proceed, the Subregional extent of RE 3.5.2 would be reduced to approximately 89% of its current distribution (DERM RE mapping updated with ground-truthed mapping undertaken for the Project). The Cape York Bioregional extent of RE 3.5.2 would be reduced to approximately 90%

of its current distribution (DERM RE mapping updated with ground-truthed mapping undertaken for the Project). The total clearing associated with current operations and proposed projects in the Weipa Plateau Subregion would not cause RE 3.5.2 to become regarded as "Of concern" or "Endangered" under the *Vegetation Management Act, 1999*.

The occurrence or likely occurrence of threatened flora species within RE 3.5.2 for the Pisolite Hills Project and Aurukun Bauxite Project is not known and therefore the significance of any cumulative impacts on these species cannot be assessed. However, it is assumed that the threatened species distribution within RE 3.5.2 would be similar to the SoE Project and therefore that the cumulative impacts on threatened species would be similar to the cumulative impacts on RE 3.5.2.

A review of the DERM RE mapping within the Urquhart Point Mineral Sands Project area indicates that it contains coastal and beach ecosystems and estuary and saltpan ecosystems only, and no areas of RE 3.5.2.

It is unlikely that indirect effects on any known potentially occurring populations of threatened flora species would occur as a result of alterations to hydrology or edge effects (refer to **Section 7.11.1**). Also, the proposed fire management plan is likely to favour most threatened species. There is unlikely to be a cumulative impact on Darwin Stringybark vegetation arising from multiple forms of impacts (that is, direct and indirect impacts) from the SoE Project.

Non-Darwin Stringybark Vegetation

Of the non-Darwin Stringybark vegetation types to be directly disturbed by Project infrastructure, only very minimal areas would be affected - representing negligible reductions in the Subregional and Bioregional extent. The reduction in the spatial extent of these vegetation types within the Project area, and the subsequent impacts on threatened flora occurring within these vegetation types, as a component of a possible larger cumulative reduction across the Cape York Bioregion (from other possible future projects) is anticipated to be minimal.

The environmental buffer system would mitigate impacts on riparian and vine forest threatened species by avoiding direct disturbance (apart from the Dam site and infrastructure corridors) and minimising potential hydrological effects and edge effects on the vegetation communities supporting these species. All of the fire sensitive species would be favoured by improvements to riparian habitat condition in undisturbed areas as a result of the fire management program. The terrestrial rooted species would also benefit from the feral pig control program. The proposed feral animal management program would reduce damage to vegetation in general, and to any of the threatened flora species that may be present. These mitigation strategies would reduce any cumulative impacts on riparian and vine forest communities and species. There is unlikely to be a cumulative impact on non-Darwin Stringybark vegetation arising from multiple forms of impacts (that is, direct and indirect impacts) of the SoE Project.

The Urquhart Point Mineral Sands Project area contains coastal and beach ecosystems and estuary and saltpan ecosystems only. These vegetation types within the SoE Project area would not be disturbed by mining and would be protected from direct and indirect impacts by the environmental buffer system. Only minor areas of beach and estuary ecosystems would be impacted by the SoE Project.

20.7.2 Fauna

Direct impacts on fauna habitats would be linked to the removal of vegetation to accommodate mining and Project infrastructure. These impacts have been described in **Section 7.17** and **Section 7.18**. Construction and operations phases of the Project may potentially impact some fauna within certain habitats. Clearing for mining would affect only Darwin Stringybark open forest habitat, whilst disturbance of vegetation for certain infrastructure (e.g. the water supply dam) would affect a selection of habitat types including Darwin Stringybark open forest, riparian gallery forest, and a small area of Paperbark wetland. The areas of each regional ecosystem that would be directly disturbed by the Project based on interaction with the 40 year mine plan, proposed Dam C, and the location of Project infrastructure, are summarised in **Table 7-10**.

Secondary impacts on fauna habitats may occur during the operational phase of the Project and are linked primarily to potential effects from altered hydrological regime due to mining activity and the construction of Dam C (refer **Section 7.10.1**). Feral pig activity and the frequent fire regime are existing mechanisms that impact on fauna habitat within the Project area.

Details of vegetation clearing associated with the SoE Project, the Pisolite Hills Project and Aurukun Bauxite Project, as well as past and future clearing associated with the current Weipa operation, are presented in **Section 7.9.1**. While there are uncertainties as to whether the Pisolite Hills Project and Aurukun Bauxite Project would proceed, as fauna habitat removal associated with these possible future mining projects are located in the same bioregion as the SoE Project and current mining operations, potential cumulative impacts on fauna have been considered.

The cumulative impact of the SoE Project and other potential and existing projects is assessed by identifying fauna species of conservation significance that have limited distribution and that may be significantly affected by bauxite mining and associated infrastructure.

Seventeen threatened fauna species (NC Act and/or EPBC Act listed) are either confirmed as present or assessed as possible or likely to occur in the Project area and considered likely to utilise habitat to be disturbed by the Project (refer to **Section 7.15** and **Section 7.19** for further details). For 13 of these 17 species, habitats that would be disturbed by infrastructure construction are considered suitable habitat. For 9 of those 13 species, habitats that would be disturbed by mining are also considered to be suitable habitat. A summary of these species, their distribution and potential impacts from the Project is provided in **Table 20-1**.

The remaining 4 of the 17 threatened species either confirmed as present or assessed as possible or likely to occur in the Project area, are the Black-necked Stork, Beach Stone Curlew, Eastern Curlew and Little Tern, which are known to use foreshore and beach strand habitats and have been confirmed as occurring within the Project area. Disturbance to foreshore and beach strand habitats at the location of the proposed Port facility would be minor and is not expected to have any adverse effect on the usage of the area by threatened fauna. The area is not anticipated to be used for roosting or breeding by the Beach Stone Curlew or Little Tern. Only minimal repulsion effects from the noise and lights associated with the facility would be expected for species that may be feeding in the area such as the Black-necked Stork, Eastern Curlew and Little Tern.

The migratory species confirmed as present, likely, or possible to occur within the Project area predominantly utilise habitats that would be located within environmental buffers and not directly affected by mining. Disturbance to foreshore and beach strand habitats at the location of the port facility would be very minor and is not expected to have any adverse affect on the usage of the area by migratory fauna. Apart from potential impacts outlined for the Estuarine Crocodile (refer **Table 20-1**), there are not anticipated to be any significant impacts on migratory fauna resulting from the Project (refer **Section 7.20.1**).

The potential impact on vegetation communities and fauna habitat from hydrological change resulting from mining, Dam C on a freshwater tributary of Norman Creek, and water extraction from the Ward River, is regarded as being minor (refer **Section 7.10.1**), apart from localised effects (particularly immediately downstream of Dam C). The proposed environmental buffer system (refer **Section 7.9.2**) would buffer sensitive habitats from land clearing, and impacts are not expected to significantly alter the overall availability or utilisation of habitats by threatened fauna. Consequently, significant impacts on threatened fauna are unlikely to occur (refer **Section 7.18.1**).

Table 20-1 Threatened Fauna Species that could be affected by the SoE Project

Species **Common name**	**Distribution and Likelihood of Occurrence within the Project Area**	**Potential SoE Project Impact from Mining**	**Potential SoE Project Impact from Infrastructure Construction**
Accipiter novaehollandiae Grey Goshawk	Occurs in coastal and sub coastal areas from southern Australia around the east coast to the Kimberley. (Possibly occurs on site)	Areas to be disturbed for mining purposes are not considered suitable habitat for this species.	For the Grey Goshawk, Red Goshawk, Square Tailed Kite, Masked Owl, Northern Quoll, Bare-rumped Sheathtail Bat, Papuan Sheath-tail Bat, Chestnut Dunnart, and the Burrowing Snake, the habitat areas within the proposed dam footprint are not regarded as especially significant for foraging or breeding (although pre-construction confirmation of the breeding status of Red Goshawk would be conducted). Given that the habitat loss would comprise a minor proportion (less than 10%) of the overall extent of these habitats within the Project area, and that most of these species would also utilise other undisturbed habitat types, the overall impact of the loss of habitat within the dam footprint is unlikely to be significant for these species.
Erythrotriorchis radiatus Red Goshawk	Occurs in coastal and sub coastal habitats from northern NSW to the Kimberley. (Possibly occurs on site)	It is unlikely that progressive removal of Darwin Stringybark open forest for mining would significantly adversely affect any potentially occurring populations with respect to the availability of foraging areas as it is a highly mobile species that could access other habitat areas. Also, the probability of a nest intersecting with proposed mining areas is low. However, additional mitigation measures to avoid nest disturbance are proposed. Targeted surveys for Red Goshawk nests would be conducted prior to vegetation clearing. If any active Red Goshawk nests are found within the survey areas, a 200m buffer around the nesting tree would be established and the nest monitored until the completion of the breeding season.	
Lophoictinia isura Square-tailed Kite	Recorded from throughout Australia apart from the arid centre and Nullarbor region. (Likely to occur on site).	The Square-tailed Kite is a highly mobile species that would be able to access un-mined areas to compensate for any lost Darwin Stringybark open forest foraging habitat within the mine area. Therefore, it is unlikely that the Square-tailed Kite nesting areas would be adversely affected by mining area development.	
Tyto novaehollandiae kimberli Masked Owl	The northern race of the Masked Owl occurs between Townsville and the Kimberley region with other races extending down the east coast to Tasmania. (Possibly occurs on site)	None of the key habitats would be affected by mining and consequently impacts on the species related to development of the mining area are not anticipated.	
Dasyurus hallucatus Northern Quoll	Distributed from south east Queensland across northern Australia to the Pilbara but has declined in many parts of this range. (Possibly occurs on site)	The Northern Quoll, Chestnut Dunnart, Bare-rumped Sheathtail Bat, Papuan Sheath-tail bat and Burrowing Snake were not confirmed to be present within the Project area during surveys, but if present, are likely to utilise Darwin Stringybark open forest. However these species are known to utilise other habitats such as riparian gallery forest, alluvial/colluvial	

Species **Common name**	**Distribution and Likelihood of Occurrence within the Project Area**	**Potential SoE Project Impact from Mining**	**Potential SoE Project Impact from Infrastructure Construction**
Bare-rumped Sheathtail Bat *Saccolaimus saccolaimus nudicluniatus*	The extent and geographic location of current populations is poorly known. Has been recorded near Cardwell, a narrow coastal region between Ayr and Cooktown, at Coen, Iron Range area, as well as the Northern Territory. (Possibly occurs on site)	woodland, and vine forest and consequently would not be confined to habitat within the mining area. While approximately 32% of Darwin Stringybark open forest would be disturbed by mining within the Project area (refer **Table 7-19**) other habitats used by the species occur outside of the mining area and would be largely unaffected by the Project. Consequently it is unlikely that development of the mining area would have a substantial adverse affect on the species.	
Saccolaimus mixtus Papuan Sheath-tail Bat	Known from northern Cape York Peninsula in the Weipa and Iron Range areas and on Torres Strait islands and New Guinea. (Likely to occur on site).		
Sminthopsis archeri Chestnut Dunnart	Known only from a few specimens from the lower Archer River, Iron Range and Mapoon areas on northern Cape York Peninsula and in New Guinea. Appears to be sparsely and patchily distributed, potentially over a wide area of open forest and woodland throughout the bioregion. (Possibly occurs on site)		
Antaioserpens warro Burrowing Snake	Occurs between Townsville and the Jardine River on northern Cape York Peninsula. (Likely to occur on site).		
Probosciger aterrimus macgillivrayi Palm Cockatoo	The range of the Palm Cockatoo comprises northern Cape York Peninsula north of Pompuraaw and Princes Charlotte Bay. (Confirmed on site)	For the Palm Cockatoo, Rufous Owl and Masked Owl, Darwin Stringybark open forest habitat represents only peripheral habitat to the main habitat areas for these species which comprise riparian, wetland and vine forest habitats. The environmental buffer system would retain peripheral areas of Darwin Stringybark open forest habitat adjacent to these key habitat areas. None of the key habitats would be affected by mining and consequently	Given the loss of a known breeding location within Dam C there is likely be a short term impact on the breeding success of some pairs of Palm Cockatoos when this area is disturbed for dam construction. However, given the availability of other habitats likely to support suitable nesting trees, and the occurrence of foraging habitat elsewhere throughout the Project area, a long term impact on the species is unlikely.

Species **Common name**	**Distribution and Likelihood of Occurrence within the Project Area**	**Potential SoE Project Impact from Mining**	**Potential SoE Project Impact from Infrastructure Construction**
Ninox rufa meesi Rufous Owl	Occurs along the east coast of Cape York Peninsula and in the Weipa region. The eastern race of the species extends down the east coast to Rockhampton. (Confirmed on site)	impacts on the species related to the development of the mining area are not anticipated.	With respect to foraging habitat, the habitat complex within the Dam C footprint includes the largest (7.2ha) patch of riparian gallery rainforest within the Project area and is regarded as prime habitat for the species. The loss of this area is not insignificant in terms of habitat availability for the Rufous Owl, however, other areas of suitable habitat occur throughout the Project area in association with wetland, mangrove, riparian and vine forest habitats. Overall it is not anticipated that there would be a significant impact on this species.
Spilocuscus maculatus nudicaudatus Common Spotted Cuscus	Occurs on northern Cape York Peninsula north of the Coen and Archer River areas. (Possibly occurs on site)	Areas to be disturbed for mining are not considered suitable habitat for this species.	The Dam C area provides suitable habitat for the Common Spotted Cuscus, although intensive survey of this area failed to locate the species. Other suitable habitat for this species occurs within areas that would not be disturbed by the Project including similar riparian gallery forest habitat on the other main arms of Norman Creek and along Winda Winda Creek, riparian gallery forest along the Ward River (Coconut Creek), and mangrove and Melaleuca wetland complexes occurring along the estuarine reaches of Norman Creek and the Ward River. The impoundment of Dam C may represent a partial barrier to movement by the Common Spotted Cuscus as the riparian gallery forest corridor would be removed for a distance of approximately 6.7km. This would curtail day to day feeding movements. However, given that the species is known to occupy eucalypt woodland adjacent to its prime habitats, long term genetic connectivity between individuals that may be present upstream and downstream of the impoundment would unlikely to be substantially affected. Furthermore, observation of the Ely Dam situated in similar habitats near Weipa indicate that at least a rudimentary gallery forest comprised of Melaleuca and Swamp Mahogany (*Lophostemon suaveolens*) is likely to re-establish at the periphery of the full supply level and provide some level of densely vegetated corridor.
Crocodylus porosus Estuarine Crocodile	Occurs in coastal and sub coastal areas in northern Australia between Maryborough in Queensland and Broome WA. (Confirmed on site)	Areas to be disturbed for mining are not considered suitable habitat for this species.	Overall, the availability of potential freshwater nesting habitat for the Estuarine Crocodile would be reduced as a result of dam C development. While this may have a local effect on reproductive rates of the species, it is not anticipated that total breeding effort within the Project area would be significantly affected.

Proposed measures for mitigating impacts on fauna are described in detail in **Section 7.17, Section 7.18,** and **Section 7.19**. Protection of riparian and wetland areas habitats is important to limiting the effects of the Project on fauna biodiversity and would be achieved by development of an environmental buffer system (refer **Section 7.9.2**). The network of habitat preserved within environmental buffers and located outside of the proposed mining area provides a substantial system of habitat corridors between all minor and major drainage tributaries and isolated habitat types within the Project area. Of particular functionality is the band of habitat within the proposed environmental buffer that extends along the western coastline of the Project area, providing a linkage between the lower sections of the Gulf drainage systems and coastal habitats. This network of retained habitat would, to a large extent, maintain habitat functionality and the pre-disturbance fauna movement regime.

Whilst there would be some short term and/or localised impacts on some species of conservation significance, long-term or significant impacts are not expected from the construction and operation of the Project. The proposed mitigation strategies for the Project, in particular the environmental buffer system, would minimise impacts.

There is no publicly available information on the potential impacts of the Pisolite Hills Project and Aurukun Bauxite Project on riparian zone fauna habitats, so it is not possible to assess cumulative impacts of these projects. However, if impacts of these projects are proportional in extent to potential SoE Project impacts, then the cumulative impacts are unlikely to be significant at a regional scale.

20.8 Aquatic Ecology

Other than the proposed water supply storage (Dam C), the direct impact of proposed mining and infrastructure development within the Project area, defined in terms of native vegetation clearing, would primarily occur within terrestrial ecosystems (refer **Section 7**). Implementation of an environmental buffer system, as outlined in **Section 7.9.2**, would ensure that riparian, wetland and estuarine habitats are buffered from direct impacts associated with vegetation clearing, other than where they occur within narrow infrastructure and access corridors that cross drainage lines or in the proposed Dam C impoundment**.** Other indirect potential impacts that commonly affect terrestrial as well as riparian, wetland and estuarine vegetation, including altered fire regime, weed invasion and feral animal disturbance, have been identified along with mitigation measures in **Section 7.10**.

All development that would alter catchment conditions to the extent that the behaviour or quality of water within the Project area's catchments would be modified has some potential to generate indirect impacts on receiving aquatic ecosystems. The greatest potential for impact to the behaviour or quality of water within the Project area's catchments would be associated with vegetation clearing for mining, infrastructure development (including some infrastructure constructed within or across drainage lines i.e. stream road crossings), and the construction of Dam C.

Potential impacts on aquatic ecosystems associated with the Project development could be via:

- changes in catchment hydrology;
- elevated sediment and other contaminant loads in catchment run off; and
- losses of aquatic habitat connectivity.

These three primary sources of potential impact to aquatic ecosystems within the Project area and proposed mitigation measures are discussed below.

Potential catchment hydrological changes due to mining, construction and operation of Dam C, and the Ward River pumping are discussed in **Section 8.14.1**. Mitigation measures to minimise hydrological impacts of these activities are detailed in **Section 8.14.2** and summarised below.

The extent to which catchment disturbance due to mining generates downstream hydrological impacts would be mitigated by the commitment that mine development and rehabilitation approaches are based on information on the hydrological behaviour and requirements of the

catchment's surface and groundwater systems. The principal mitigation commitment is that mining operations and post-mine rehabilitation strategies ensure that developed catchments would still deliver the groundwater recharge and surface run off needed to sustain downstream aquatic ecosystems.

Mitigation measures for the potential impacts associated with catchment hydrological changes generated by the construction and operation of the proposed Dam C impoundment are summarised below.

- Construction of a dam wall that would be keyed into impermeable basement and batter foundations and would provide the best opportunity to mitigate the water quality and hydrological impacts that could be associated with dam seepage to downstream reaches.
- The design of outlet works would allow for the future retro-fitting of a variable higher level off-take, should dam stratification emerge to be a significant management issue.
- Dedicated environmental flow releases, in addition to spillway overflows, which has been identified as a mitigation measure for a range of potential impacts associated with the proposed Dam C impoundment.
- Further monitoring and characterisation of the receiving reaches downstream of the proposed water infrastructure is recommended to support a responsive, adaptive management capacity for potential impacts.

With regard to pumping from the Ward River, potential impacts associated with the extraction of stream flows would be mitigated by restricting pumping to (a) 1% of mean annual flow in any one year, (b) less than 20% of river flow at any time, and (c) times when flow is >1000L/s. The primary focus of this pumping regime would be to ensure maintenance of seasonal salinity regimes in upper estuarine/tidally influence freshwater reaches.

The operation of the Aurukun Bauxite Project and the SoE Project simultaneously could result in cumulative impacts on catchment hydrology and river flows in the Ward River catchment (refer **Section 20.3**). Mining disturbance associated with the Aurukun Bauxite Project would have a very minor change on the annual discharge from the overall Ward River system (refer **Section 20.3.3**) and the proposed dam on a tributary of the Ward River for the Aurukun Bauxite Project would result in only a marginal cumulative decline in mean discharge to the Ward River estuary (refer **Section 20.3.1**). Given the proposed mitigation strategies outlined above, there are unlikely to be significant cumulative impacts on aquatic ecology from impacts on catchment hydrology and river flows in the Ward River catchment.

Elevated catchment sediment loads and contaminants derived from mining, processing and handling operations are discussed in **Section 8.15.1.** Mitigation measures to minimise these impacts are detailed in **Section 8.15.2** and summarised below.

RTA's experience in managing sediment run off risks associated with mining operations in this environment provides the foundation for mitigating the significant risks that would be associated with the inherent vulnerabilities of the Project area's aquatic ecosystems. The persistence of aquatic communities equivalent to the Project area's, in drainage systems of the Weipa Peninsula to the north of the Project area, attests to the impact mitigation capacity of appropriate management approaches for sediment run off. These mitigation measures are outlined below.

- The retention of effective development 'setback' vegetation buffer systems (refer **Section 7.9.2**) around and adjoining surface drainage lines and wetland features represents the frontline in the effective management of elevated sediment load risks confronting aquatic ecosystems.
- Controlled drainage systems - including the retention of surface runoff from mine pits within the pit before it reports to surface drainage networks, and the implementation of sediment control traps to intersect surface run off before it reports to surface drainage systems where haul roads and other infrastructure intersect sensitive environmental areas.

- Clearing and soil stripping would be scheduled in the dry season so that mine pit development is generally underway by the onset of the wet season, providing a basin to capture surface run off which would minimise the risk of runoff from disturbed areas entering stream drainage networks.
- Monthly monitoring of turbidity in receiving waters of the Project area throughout the wet season would be undertaken.

Mitigation options to address aquatic ecosystem risks posed by catchment run-off containing potential contaminants derived from mining, processing and stockpiling are summarised below.

- Leachate analyses of metals in Project crude ore samples show that none are elevated to a degree which would pose a risk to the natural environment (Rio Tinto 2009b). However, if elevated metal levels were to be found in ore, the primary management approach would be the use of internal drainage routes for mine pit run-off. Mitigation measures for other potential contaminants primarily relate to refuelling, fuel/chemical storage and spill response protocols, structures and procedures which are discussed in **Section 19.3.**
- Run-off from industrial plant areas would be controlled via collection to the site water management system. The tailings storage facilities would be located within previously mined and internally draining pit areas and remote from major drainage lines. This would mitigate the potential risks associated with run-off that is potentially high in soluble aluminium to receiving surface waters.
- The locations, parameters and frequency of the proposed surface and groundwater water monitoring are detailed in **Section 5.5.1**. The monitoring program concentrates on pH, EC, dissolved oxygen, turbidity, certain metals and hydrocarbons (in specific locations). If water quality monitoring or other evidence indicates that elevated metal bio-availability has occurred due to mining activities then bio-monitoring of tissue metal concentrations in selected tissue of fish and other aquatic organisms (i.e. crabs, crayfish) would be used to assist identify possible sources.

The proposed Aurukun Bauxite Project is located in the catchment of the Ward River estuary. While there are uncertainties as to whether this project would proceed, the operation of the Aurukun Bauxite Project and the Project simultaneously could result in a cumulative impact on surface water quality in the lower Ward River system. Given the nature of bauxite mining, the design and operation of the Aurukun Bauxite Project mining activities to minimise surface water quality impacts would likely be similar to the Project and the cumulative residual impacts on surface water quality would be expected to be low (refer **Section 20.3.4**). Given the proposed mitigation strategies outlined above, there are unlikely to be significant cumulative impacts on aquatic ecology from impacts on surface water quality in the Ward River catchment.

Infrastructure constructed within or across stream drainage lines, including the proposed impoundment wall (8m for 10.9GL storage capacity, 12m for 29.0GL storage capacity) and more innocuous haul road stream crossings, has the potential to create fish passage barriers and to disrupt the recruitment and movement of species from dry season refugia or downstream estuarine habitats, therefore impacting on the distribution of fish species and the composition of fish communities within the Project area. Altered hydrological and/or geomorphological conditions that may potentially occur at a sub reach scale due to impacts associated with catchment development (e.g. shorter duration stream base flows, less perennial aquatic refugia, sedimentation of stream channels and/or pools) could also potentially impact upon aquatic habitat connectivity and fish passage opportunities in the Project area. These impacts are discussed in **Section 8.16.1.** Strategies to mitigate these impacts are discussed in **Section 8.16.2** and include the following measures.

- Incorporation of a fish way structure into Dam C and other in-stream infrastructure, sensitive management of surface drainage, and implementation of potential hydrological impact mitigation measures.

- Consideration of hydrological aspects in post-mine rehabilitation in the case of altered catchment hydrology and environmental flow strategies for the Dam C impoundment construction and operation.
- Monitoring the potential impacts to aquatic habitat connectivity within the Project area over the mine life. Periodic (three to five years) survey-based monitoring of the freshwater aquatic community within the Project area would be conducted. Specific foci for such monitoring would include community composition within each drainage system, particularly within dry season refugia. Compositions of the fish community above and below the Dam C impoundment wall prior to construction and following commissioning of the spillway incorporating the fish passage structure may also be undertaken to assess fishway effectiveness and to facilitate adaptive design management if required.

The operation of the Aurukun Bauxite Project and the SoE Project simultaneously could result in cumulative impacts on aquatic habitat connectivity in the Ward River catchment. Given the proposed mitigation strategies outlined above, there are unlikely to be significant cumulative impacts on aquatic ecosystems from in-stream infrastructure and altered hydrological and/or geomorphological conditions in the Ward River catchment.

20.9 Air Quality

Dust, particulates, sulphur dioxide (SO_2) and nitrogen dioxide (NO_2) generated at different locations and from different activities within the Project area have the potential to cause cumulative air quality impacts at nearby sensitive receptors (Weipa, Napranum and Aurukun). This type of cumulative impact has been assessed by predicting dust, particulate, and SO_2 and NO_2 concentrations at sensitive receptors based on estimated emission rates from all potential emission sources, at maximum production. Emission sources and air quality modelling are discussed in detail in **Section 9.3** and **Section 9.4**. Modelling outputs and predicted air quality impacts are presented in **Section 9.4.5** and **Section 9.5**.

The cumulative air quality impacts at sensitive receptors, associated with the Project in combination with existing activities, was assessed by adopting conservative ambient air quality levels (to account for emissions from existing activities) and including these in the air quality modelling. Potential emission sources and types of emissions from nearby activities, as well as estimation of ambient air quality levels, are discussed in **Section 9.1**. Air quality modelling outputs, inclusive of ambient air quality levels, are presented in **Section 9.4.5**.

Modelling outputs and predicted air quality impacts are presented in **Section 9.4.5** and **Section 9.5**. In summary, the particulate emissions from the Project (that is, existing activities plus the Project) at maximum production would readily comply with all particulate air quality objectives at the nearest sensitive receptors. The predicted incremental increase to annual average NO_2 and SO_2 concentrations as a result of the Project would be zero at Weipa, Napranum or Aurukun. The predicted NO_2 and SO_2 concentrations at all sensitive receptors (Weipa, Napranum and Aurukun) at maximum production would be much lower than the objectives to protect health and well being.

The Aurukun Bauxite Project and the Urquhart Point Mineral Sands Project are the only other possible future sources of anthropogenic emissions within the local airshed. The predicted levels of dust, particulate, and SO_2 and NO_2 from the SoE Project are much lower than the relevant air quality guidelines (refer **Table 9-7** and **Table 9-8**), even at full production. Hence, the additional emissions from the Aurukun Bauxite Project, if it were to proceed, and the Urquhart Point Mineral Sands Project, would be unlikely to cause an exceedance of air quality guidelines at sensitive receptors.

Local and regional air quality impacts are discussed in **Section 9.5**. The air quality impacts associated with the Project would be entirely local. It is noted that the highest concentrations, as expected, would occur close to the operations and within the mining lease. Dust generally falls out of the air within a few hundred metres of the source. The very fine dust fraction ($PM_{2.5}$) remains aloft for the longest period, yet even this dust quickly becomes less significant

than the estimated regional ambient concentration. Therefore, the cumulative impact of the SoE Project, the Aurukun Bauxite Project and the Urquhart Point Mineral Sands Project on the northern Cape York regional air quality is not expected to be significant, if the Aurukun Bauxite Project was to proceed.

20.10 Greenhouse Gas Emissions

The cumulative impacts of greenhouse gas (GHG) emissions from the Project in combination with existing activities, were assessed by comparing predicted GHG emissions from the Project to existing emissions in Queensland and Australia (refer **Section 9.6**). A summary of the projected GHG emissions is shown in **Table 9-9**. The estimate of emissions from all Project components under the 50Mdptpa production scenario would be 508kt CO_2-e per annum. By comparison, GHG emissions in Australia were estimated to be 553,000kt CO_2-e in 2008 (DCC 2009b) and 181,000kt CO_2-e from Queensland in 2007 (DERM 2009c). The cumulative impact of GHG emissions from the Project on GHG emissions in Queensland and Australia would not be significant.

20.11 Noise

Noise generated at different locations and from different activities within the Project area have the potential to cause cumulative noise impacts at nearby sensitive receptors (Weipa, Napranum and Aurukun). This cumulative impact has been assessed by modelling noise levels for Weipa, Napranum and Aurukun based on all potential significant noise sources and activities within the Project area at maximum production. Noise sources and noise modelling are described in **Sections 10.3** and **10.4**. The results of noise modelling indicate that the existing background noise levels are well above the calculated noise emissions from the Project.

The cumulative noise impacts at sensitive receptors, from the Project in combination with existing activities, was assessed by comparing calculated noise levels from the Project to existing noise levels (refer **Section 10.4**). Adding the calculated Project noise levels to the existing levels would not change the noise levels in the sensitive areas. Furthermore, the noise levels would comply with noise level objectives and therefore health and amenity are unlikely to be adversely affected if there are periods of the year with very low ambient noise levels. There are homesteads on the cattle stations to the east of the mining areas. The separation distances between the Project area and the homesteads are at least 50km. The noise levels at these homesteads associated with the Project are expected to be inaudible under all circumstances.

Given that calculated Project noise levels would not change the existing noise levels in the sensitive areas, and that Project noise emissions at nearby homesteads are expected to be inaudible under all circumstances, the cumulative impact on sensitive receptors and homesteads from the Project in combination with the Aurukun Bauxite Project, if it were to proceed, and the Urquhart Point Mineral Sands Project, is expected to be insignificant.

Cumulative impacts associated with underwater noise emissions due to pile driving activities are not expected, as it is not anticipated that other activities associated with another project in the immediate vicinity, that may impact the underwater noise environment, would be occurring at the same time as pile driving activities associated with the SoE Project.

20.12 Cultural Heritage

20.12.1 Indigenous Cultural Heritage

Potential impacts on Indigenous cultural heritage and mitigation measures are discussed in detail in **Section 11.1.6**. The combined results of the archaeological surveys demonstrate the presence of a range of sites and places of cultural and archaeological value within the Project area. The potential impact of the Project on known archaeological sites has been calculated as a percentage for each site type (refer **Table 11-1**). These results indicate that 82.5% of scarred trees, 88.4% of stone artefacts and 100% of shell middens and ethnographic sites are

located outside of the proposed infrastructure footprint and would not be affected. The remaining sites inside the footprint may be affected during construction of the Project. Measures to mitigate these impacts would be developed in consultation with Traditional Owners through the Western Cape Communities Co-existence Agreement (WCCCA) process. The majority of known places of cultural heritage are well outside of proposed future mining areas, although access to some of these places may be affected by mine development. RTA would take a proactive approach to the management of places of cultural significance and initiate discussions with WCCCA and the Traditional Owners to establish separate heritage action plans for each location and incorporate these into the Community, Heritage and Environment Management Plan (CHEMP). This would ensure that the cultural values of these places are effectively managed over the duration of the Project.

All Indigenous cultural heritage in Queensland is protected under the *Aboriginal Cultural Heritage Act 2003*. To comply with the duty of care provision under section 23 of the Act, proponents are required to have a recognised cultural heritage management plan or other agreement that provides for the management of Aboriginal cultural heritage. The mitigation measures proposed by RTA for the Project and statutory obligations under the *Aboriginal Cultural Heritage Act 2003* for any future projects would minimise the cumulative impacts of the Project and possible future projects on Indigenous cultural heritage.

20.12.2 Non-Indigenous Cultural Heritage

Several non-Indigenous heritage sites have been identified within the Project area. None of the identified non-Indigenous heritage sites, or the Project area as a whole, have been assessed as being of State or National significance, or as being of sufficient significance to warrant the constraint or restriction of any proposed activities (refer **Section 11.2**). Given the lack of significant non-Indigenous heritage sites within the Project area, the Project would not contribute to impacts from future nearby projects to cause a significant cumulative impact on non-Indigenous cultural heritage.

20.13 Visual Amenity

There are no significant or long term residual impacts relating to visual amenity that would interact with other impacts arising from the Project.

Capacity may be provided for third parties at RTA's proposed port, following agreement on suitable commercial terms (refer **Section 1.4**). Such an arrangement would remove the cumulative impacts on visual amenity associated with constructing and operating two ports.

20.14 Transport

Roads

The proposed traffic routes and impacts on road traffic and infrastructure for the Project are described below (refer **Section 14.1** for further details).

During the early construction phase up until the proposed new barge/ferry terminals and the new Mine Access Road to the site are established, road access to the Project site would be from the Peninsula Developmental Road (PDR) via Aurukun Road, Beagle Camp Access Road, Pera Head Access Road, and Amban Access Road (the "access roads"). Subsequently barges and a passenger ferry would travel between a roll-on, roll-off (RORO) barge terminal near the Humbug Wharf and a ferry terminal at Hornibrook Point on the north side of the Embley River, to a combined barge/ferry terminal on the western side of Hey River. A proposed Mine Access Road would link the Hey River Terminal to the Project (refer **Section 2.7.2** for a description of the proposed barge/ferry terminal and road). Use of the current road access is expected to be extremely limited during the operational phases of the Project.

The construction workforce would be based in a camp near the Boyd infrastructure area. When not on roster, construction workers would return to their point of hire. A large majority of these workers would be from the east coast of Australia and would fly in and fly out of Weipa airport

and be transported back and forth to the construction site by RTA in buses. Initially workers would travel via the PDR, Aurukun Road, and the access roads. Once facilities have been constructed, the workers would be transported by either car or bus from Weipa or Weipa airport to the Hornibrook Terminal, by ferry to Hey River and then travel by the Mine Access Road (on-lease) to the construction camp at the beginning and end of each rotation.

During the construction phase, the majority of equipment and materials would be transported by sea, from Cairns to Weipa. Cargo ships and barges would predominantly be unloaded at Evans Landing or Humbug Wharf and cargo would be loaded onto trucks. Initially the trucks would need to travel by road via Kerr Point Drive, the PDR and Aurukun Road to the site, until barge facilities have been constructed at Hey River (approximately six months into the construction period). At this time the loaded trucks would be transported by barge from Humbug Wharf to the Hey River Terminal and then travel along the Mine Access Road (on-lease) to the site. Temporary barge/ferry terminals may be constructed at Hey River as part of the early works program to reduce transportation of cargo by road.

Once the barge facilities and Mine Access Road are established, the primary heavy vehicle usage of roads external to the site during construction would be deliveries of aggregate for concrete from Archer River Quarry to the site. The quarry is located approximately 200km south-east of Weipa and 100km south of the Aurukun Road turn-off via the PDR.

The Project's operations workforce would be based in Weipa. Site-based employees and contractors are likely to be based in Weipa and would commute to the site daily by driving to the Hornibrook ferry terminal where they would leave their vehicle, and then catch the ferry to Hey River where a bus would transport them to the workplace.

During the operations phase, the majority of equipment and materials would continue to be transported by sea from Cairns to Weipa. Cargo ships and barges would predominantly be unloaded at Humbug or Evans Landing wharves and cargo would be loaded onto trucks. The loaded trucks would then be loaded onto barges at the Humbug Terminal and transported to the Hey River Terminal. The trucks would then drive off the barge and travel by the on-lease Mine Access Road to the site. Should any heavy vehicles need to bring supplies by road from Cairns, they would take the Kennedy Highway and the PDR. However, as with existing Weipa mining operations, external road network use would be limited.

Extracted bauxite would be transported using a network of internal haul roads and conveyors to the beneficiation plant prior to being shipped to its final destination from the proposed port.

The proposed development is not expected to have an adverse impact on future yearly or daily operations of the PDR, the Kennedy Highway or Kerr Point Road / John Evans Drive. The traffic increase on Aurukun Road generated by the Project in absolute terms would be minor, and the total daily traffic, inclusive of that generated by the Project, would remain at very low levels. Further detail of traffic impacts are provided in **Section 14.1.6**.

During the construction phase, the proposed development is expected to have a marginal to very low impact (i.e. increases of less than 1%) on annual Equivalent Standard Axles (ESAs) of most roads. The following roads would experience an increase in pavement impacts of greater than 5% during some stages of the Project (refer **Table 14-7**):

- the PDR between the Archer River Quarry and the Aurukun Road turnoff during the delivery of aggregate;
- the PDR between Weipa and the Aurukun Road turnoff prior to the construction of the barge/ferry terminals and Mine Access Road;
- Kerr Point Road and John Evans Drive prior to the construction of the barge/ferry terminals and Mine Access Road, and during operations at 50Mdptpa; and
- Aurukun Road between the PDR and the Access Road turnoff during the construction phase.

RTA would repair any damage caused by Project-related traffic on these roads.

Once construction is completed and production commences, there would be limited impact on the annual ESAs of Aurukun Road, the PDR, and Kennedy Highway as it is unlikely that heavy vehicles would be using roads external to the site. Further details of road pavement impacts are provided in **Section 14.1.6.**

The Pisolite Hills Project area is located approximately 50km north east of Weipa. Ore was proposed to be transported to a barge loading facility on the eastern side of Port Musgrave via a proposed 34km haul road. Facilities would have been built for receiving small barges to supply goods to the mine and camp by sea with vessels being unloaded directly onto a hover-barge to be further transported across the flood plain to a stockpile area for transfer to trucks. Personnel would have been transported to site by light aircraft utilising an on-site airstrip (Cape Alumina 2008). Given the distance of the Pisolite Hills Project site from the SoE Project site, and the proposed transport arrangements, if the Pisolite Hills Project were to proceed and both projects were to operate simultaneously then cumulative impacts on road traffic or infrastructure would be unlikely.

While there are uncertainties as to whether the Aurukun Bauxite Project will proceed, the operation of both projects simultaneously could result in a cumulative impact on roads. There is no publicly available information on the proposed transport of equipment and materials to the Aurukun Bauxite Project site. It is understood that Chalco proposed to accommodate their fly-in fly-out construction and operational workforce on site, and also to construct access roads to/from mine site facilities and Aurukun. For the purposes of this cumulative impact assessment it is assumed that equipment and material for the Aurukun Bauxite Project would have been barged to Aurukun and then transported by road to the project site via new and existing roads, including Aurukun Road, and that heavy vehicles would have needed to bring some supplies by road from Cairns, via the Kennedy Highway and the PDR. Based on these assumptions, if the Aurukun Bauxite Project was to proceed and both projects were to operate simultaneously, then the PDR and a part of the Aurukun Road may receive a cumulative impact. However, this is likely to occur only if the Aurukun Bauxite Project was in the construction or operational phase during the initial construction phase of the SoE Project. Initially trucks transporting material and equipment to the Project site would need to travel by road via the PDR and Aurukun Road to the site. Once barge facilities have been constructed on the Hey River and the Mine Access Road is operating, site access would be via this new route, and the primary heavy vehicle usage of Aurukun Road during the remainder of the construction period would be deliveries of aggregate for concrete from Archer River Quarry to the site. In the absence of detailed traffic data for the Aurukun Bauxite Project the significance of the potential cumulative impact cannot be fully assessed. Cumulative impacts could be mitigated through repair or upgrade of the relevant part of the Aurukun Road. RTA's proposed measures to mitigate impacts related to road use, including Aurukun Road, are discussed in **Section 14.1.6** and **Section 14.1.7** and include repairing any damage to Aurukun Road caused by Project-related traffic.

All plant, equipment and personnel for the Urquhart Point Mineral Sands Project would be barged to site via the Embley River, as there is no road access to the site. Therefore there would be no cumulative impact on roads in the region from the development and/or operation of the Urquhart Point Mineral Sands Project and SoE Project simultaneously.

Airport

The potential impacts of the Project on Weipa airport are discussed in **Section 14.3**. It has been predicted that the potential increase in flight numbers, as a result of the Project, is within the capacity of the existing airport infrastructure and would not require changes to airport infrastructure. Cape Alumina proposed to transport their fly-in fly-out workforce to and from the Pisolite Hills Project in light aircraft utilising an on-site airstrip (Cape Alumina 2008). Chalco also proposed to use a fly-in fly-out construction and operational workforce. There is no publicly available information on where the Aurukun Bauxite Project workforce were proposed be flown to and from, however, it is understood that the workforce were proposed to be flown to and from Aurukun. The other option would be to fly in and out of Weipa airport. In either case there would be no significant cumulative impacts from the operation of both the Project and Aurukun Bauxite Project together that would require significant changes to Weipa airport infrastructure.

Sea Port Facilities

The Aurukun Bauxite Project proposed to construct a second port near Boyd Point designed to accommodate a nominal 70,000 dry weight tonne Panamax vessel. The operation of two ports near Boyd Point may result in cumulative impacts in terms of bulk carrier interactions and vessel interactions with commercial and recreational fishing vessels. In the initial phase of the port, RTA proposes to construct and operate port facilities capable of shipping 30Mdptpa, with provision to enable future expansion up to 63Mdptpa. Capacity may be provided for third parties following agreement on suitable commercial terms. For the initial port development to service RTA's 30Mdptpa production, two berths would be required. Two extra berths would be added if ship loading capacity was increased to 63Mdptpa. Such an arrangement would simplify the management of vessel movements compared to operating two ports and reduce cumulative impacts.

Cape Alumina (2008) proposed to transport ore from the Pisolite Hills Project to a barge loading facility on the eastern side of Port Musgrave, via a proposed 34km haul road. Ore was proposed to be transported by barge for loading onto off-shore moored Panamax or Capesize vessels for export. Facilities were proposed to be built for receiving small barges to supply goods to the mine and camp by sea. Given the Pisolite Hills Project proposed to use a separate port, if the Pisolite Hills Project were to proceed and both projects were to operate simultaneously, then cumulative impacts with respect to interactions with bulk carriers and commercial and recreational vessels would be unlikely.

Providing capacity to third parties at the new port would facilitate increased shipping rates from the port, which may cause additional impacts ("facilitated impacts"). If all Projects were to proceed, the approximate number of ships through the Gulf of Carpentaria would increase (refer **Table 20-2**). Potential impacts from shipping activities on marine fauna are described in **Section 6.9.4** and include boat strike and alienation from habitat, which may affect Dugongs, dolphins and marine turtles**.** There is no Dugong feeding habitat in the vicinity of the proposed wharf and shipping channel, so the risk of strike by bulk carriers at the port and the risk of alienation from habitat would be low. While Dugongs may move through the proposed port area when periodically migrating between feeding areas, the proposed port and port activities do not represent a barrier to migration that is likely to result in any meaningful impact on Dugong populations in the region. Overall, Project-related vessel movements are likely to have a low risk of impact on Dugongs in the vicinity of the proposed port. The potential for boat strike on dolphins would be less than for Dugongs as dolphins are more agile and able to better react to and avoid approaching vessels. There is the possibility of impacts on marine turtles from both boat strike from fast moving vessels and alienation from habitat by boating activity at the new port site. Unlike the Dugong, there is no available information to demonstrate that boating activity alienates marine turtles from their habitat, although this cannot be discounted. However, marine turtles are known to co-exist in areas with very high levels of boating activity. The additional impacts on marine fauna from increased shipping rates from third party use of the port are unlikely to be significant, either on their own or in combination with Project impacts due to the slow movement of these bulk carriers.

Table 20-2 Approximate Cumulative Bulk Carrier Movements

	Minimum Production SoE Project (ships / year)*	**Intermediate Production at SoE Project** (ships / year)*	**Maximum Production at SoE Project** (ships / year)*
SoE Port	150 - 215	300 - 375	410 – 625
Port of Weipa	125 - 150	0	0
Aurukun Project	95	95	95
Pisolite Hills Project	28 - 79	28 - 79	28 - 79
Total	**398 - 539**	**423 - 549**	**533 – 799**

* Number of ships will vary depending on actual production rates and size of vessels.

There is unlikely to be a cumulative impact from boat strike associated with shipping activities in the Hey or Embley Rivers. An assessment of potential vessel movements within the Embley River which takes into consideration existing vessel movements for Weipa is provided in **Section 14.4.5**.

20.15 Social

The cumulative social impacts of the Project and RTA's current operations north of the Embley River have been considered in the social impact assessment for the Project (refer **Section 16**). The Project's construction workforce would be accommodated in an on-site camp and, when not on roster, the construction workers would return to their point of hire. The large majority of these people would be from the east coast of Australia and would fly-in and fly-out of Weipa airport and be transported back and forth to the construction site in buses by RTA. Negligible affects on the local housing market are expected from the construction workforce (refer **Section 17.4.9**). At a Project production rate of 15Mdptpa, RTA's overall workforce (including Andoom) would be marginally smaller than in 2007-2008 and Weipa would have a population of about 3,800, down from just over 4000 reached in 2007-2008 (refer **Section 16.2.1**). Under a production scenario of 30Mdptpa, the overall workforce would reduce slightly (due to greater productivity in Project operations compared to Andoom operations) and Weipa's population is projected to be about 3,300. Future demands on infrastructure and government services as a result of RTA operations are expected to be no higher than in recent years. Project mine production would be capable of increasing when market conditions are suitable. Under the 50Mdptpa production scenario, the population of Weipa is projected rise to approximately 400 above the peak of 2007-2008. Such a population rise would require development of more residential land and housing, and provision of expanded government services. The impact of the Project on housing and property values is discussed in **Section 16.3.11**.

An extensive program of community consultation and stakeholder engagement was undertaken to assist in the preparation of the EIS for the Project. Details of the consultation undertaken with various stakeholder groups and the key issues raised are provided in **Section 15.2**.

There are a number of issues which, while not key issues for local stakeholder groups as identified during the consultation meetings, are issues of importance to indirectly affected stakeholders such as State and Commonwealth government departments and agencies. One of these issues is cumulative impacts, specifically, significant duplication of infrastructure and services between RTA and the other projects proposed for the region and the cumulative social and environmental impacts that would arise should more than one project proceed. It was suggested strongly, particularly by the Aurukun Shire Council, that RTA and Chalco should work together to identify potential cumulative impacts and work out a commercial agreement to minimise duplication. RTA liaised with Chalco during the planning phase for their proposed project to discuss any potential for co-location and/or sharing of certain infrastructure (refer **Section 20.1**).

One matter raised consistently by stakeholders, in relation to cumulative impacts, was concern about the potential for the establishment of a road connection between the Project's Mine Access Road and Chalco's Aurukun Project, thus facilitating the transport of illegal alcohol. A small number of stakeholders identified this as an opportunity for residents in Aurukun to obtain easier access to Weipa-based goods and services.

There are also significant non-Project related cumulative impacts associated with current government services and programs currently being implemented in Aurukun. These include the Alcohol Management Plans (AMP) which imposes alcohol bans and Families Responsibility Commission program designed to encourage parents to take responsibility for their children's school attendance. Although the intentions of these programs are to improve the well-being of the communities, they are another cumulative social change being experienced by this small, isolated community.

As a mitigation strategy, RTA would, by liaising with any other adjacent project proponents, endeavour to identify cumulative impacts and opportunities associated with employment,

training and business development for the local communities. RTA would also seek to co-ordinate its' programs with others, including government programs and services currently being implemented in the region, and, where appropriate, would partner with the relevant Government agencies. Further details of cumulative impact related issues raised by stakeholders, and RTA's proposed mitigations strategies, are set out in **Section 16.3.12**.

The mitigation strategies that RTA proposes would assist in minimising the potential negative social impacts of more than one project operating simultaneously.

20.16 Economy

The cumulative economic benefits of the Project have been assessed by estimating the Project's economic effect at 15Mdptpa as well as its flow-on (or multiplier) effects, and by assessing impacts on the local economy as well as the far north Queensland (FNQ), Queensland and Australian economies. The estimated economic impacts are documented in **Section 17.4** and summarised below:

Construction Phase (for 15Mdptpa installed capacity)

- direct employment averages more than 300 per annum over three years;
- indirect employment of approximately 179 in the local area, 395 in the FNQ region, 632 state-wide and 705 nationally;
- direct financial contribution of $264 million locally, $527.9 million in the FNQ region, $989.9 million in Queensland and $1,319.8 million nationally; and
- indirect financial contribution of $201.7 million locally, $612.2 million in the FNQ region, $1,829.3 million in Queensland and $2,828.2 million nationally.

Operations Phase – 15Mdpta production scenario

- direct employment (including contractors) of approximately 500 in local region;
- indirect employment of approximately 390 locally, 788 in the FNQ region, 1,170 state-wide and 1,771 nationally;
- direct annual financial contribution of $575 million across the local, regional, Queensland and national economies; and
- indirect annual financial contribution of $96 million locally, $182 million in the FNQ region, $257 million in Queensland and $423 million nationally.

The impact of the Project on the local and regional economies is significant:

- The total value of the Project operations under the 15Mdptpa production scenario would be $671 million. The size of the local economy was estimated to be $3.03 billion in 2009, in terms of output. Therefore, the Project at 15Mdptpa would be contributing (directly and indirectly) a significant output, to the value of approximately 22% of the local economy's present output. At this level of production, the Project would be generating approximately $123 million in taxes and royalties, some of which would be injected back into the local economy.
- At 15Mdptpa the total value-added to the local economy is estimated to be $383 million annually which equates to around 81% of the estimated Gross Regional Product (GRP) generated in the local economy in 2009.
- At 15Mdptpa the total value of the Project to the FNQ economy would be $757 million, which is worth approximately 1.5% of the regional economy's estimated output for 2009.
- At 15Mdptpa there would be a total value-added to the FNQ economy of $437 million, which equates to around 3.3% of the total estimated GRP generated in the regional economy ($13.4 billion) for 2009.

The Project would operate with a strong employee to output ratio and would generate significant employment opportunities, both directly as well as through the indirect impacts to

other sectors. At 15Mdptpa, the Project would employ approximately 400 employees and 100 contractors, while another 390 jobs across other sectors would be generated in the local economy indirectly, resulting in 890 jobs generated in total, throughout all industries in Weipa and the surrounds. It is likely, as a result of the direct jobs provided by the Project at 15Mdptpa, that a further 788 jobs would be generated indirectly across other sectors of the FNQ economy resulting in 1,288 jobs being supported throughout FNQ, inclusive of contractors.

The operation of the Aurukun Bauxite Project, Pisolite Hills Project and the Urquhart Point Mineral Sands Project would add to the economic benefits to the local economy as well as the FNQ, Queensland and Australian economies. The economic impacts of the Aurukun Bauxite Project and Pisolite Hills Project, if they were to proceed, would be likely to be roughly proportional to their respective proposed production capacity. Based on this assumption, the Aurukun Bauxite Project and Pisolite Hills Project would have each generated about 40% of the economic benefits of the Project under the 15Mdpta production scenario, which are described above. The impacts of the SoE Project and the other possible future projects together on the local and regional economies, would be expected to be significant.

In addition to direct employment, opportunities are likely to arise as a result of the Project supporting existing local businesses and providing opportunities for new business development. Business development opportunities are discussed in further detail in **Section 16.3.7**, along with mitigation strategies including:

- proactively considering tenders that involve local Indigenous people and/or local Indigenous enterprises;
- working collaboratively with key regional stakeholders to identify and support the ongoing development of Indigenous and non-Indigenous businesses;
- examining applicable contracts for local and Indigenous business opportunities; and
- identifying opportunities to support the implementation of a range of business development programs and support services, in collaboration with key local and regional stakeholders.

The Aurukun Bauxite Project, Pisolite Hills Project and the Urquhart Point Mineral Sands Project would be likely to add to the employment and local and Indigenous business development opportunities, if they were to proceed. Given the proximity of the Aurukun Bauxite Project to Aurukun, this project would have been expected to add to the economic benefits, employment benefits and local and Indigenous business opportunities for the Aurukun community in particular.

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Environmental Impact Statement

for South of Embley Project

Section 21

Environmental Management Plan

Environmental Impact Statement for South of Embley Project

DRAFT

Rio Tinto Alcan

Draft Environmental Management Plan

ML7024 and ML6024

RTA Weipa Pty Ltd

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1 INTRODUCTION

1.1 The Project

The name of the Project is the South of Embley (SoE) Project. The project number is RTA701. RTA Weipa Pty Ltd (RTA) is currently mining the East Weipa and Andoom bauxite deposits located on ML 7024 north of the Embley River. A transitional environmental authority (mining activities) is held for the existing operations north of the Embley River. These reserves are gradually depleting and, with continuing demand for bauxite, RTA have identified significant bauxite reserves on the portion of ML 7024 that lies south of the Embley River, which could sustain a mining operation for about 40 years, depending on annual production rates.

The Project consists of the construction and operation of a bauxite mine and associated processing facilities, a barge/ferry terminal and a port on mining leases held by RTA. The mine would be capable of producing a maximum of 50 million dry product tonnes per annum (Mdptpa). The initial production capacity is subject to ongoing feasibility studies but is likely to be either 15Mdptpa or 22.5Mdptpa. Actual production rates and the timing and size of capacity expansions would depend on market conditions.

In addition, a ferry terminal would be located at Hornibrook Point and a barge terminal at Humbug Point, however these facilities are not on the mining lease. Both locations are on Strategic Port Land within the Port of Weipa and administered by the North Queensland Bulk Ports Corporation Limited (NQBP) and are therefore not covered by this Environmental Management (EM) Plan.

1.2 Location

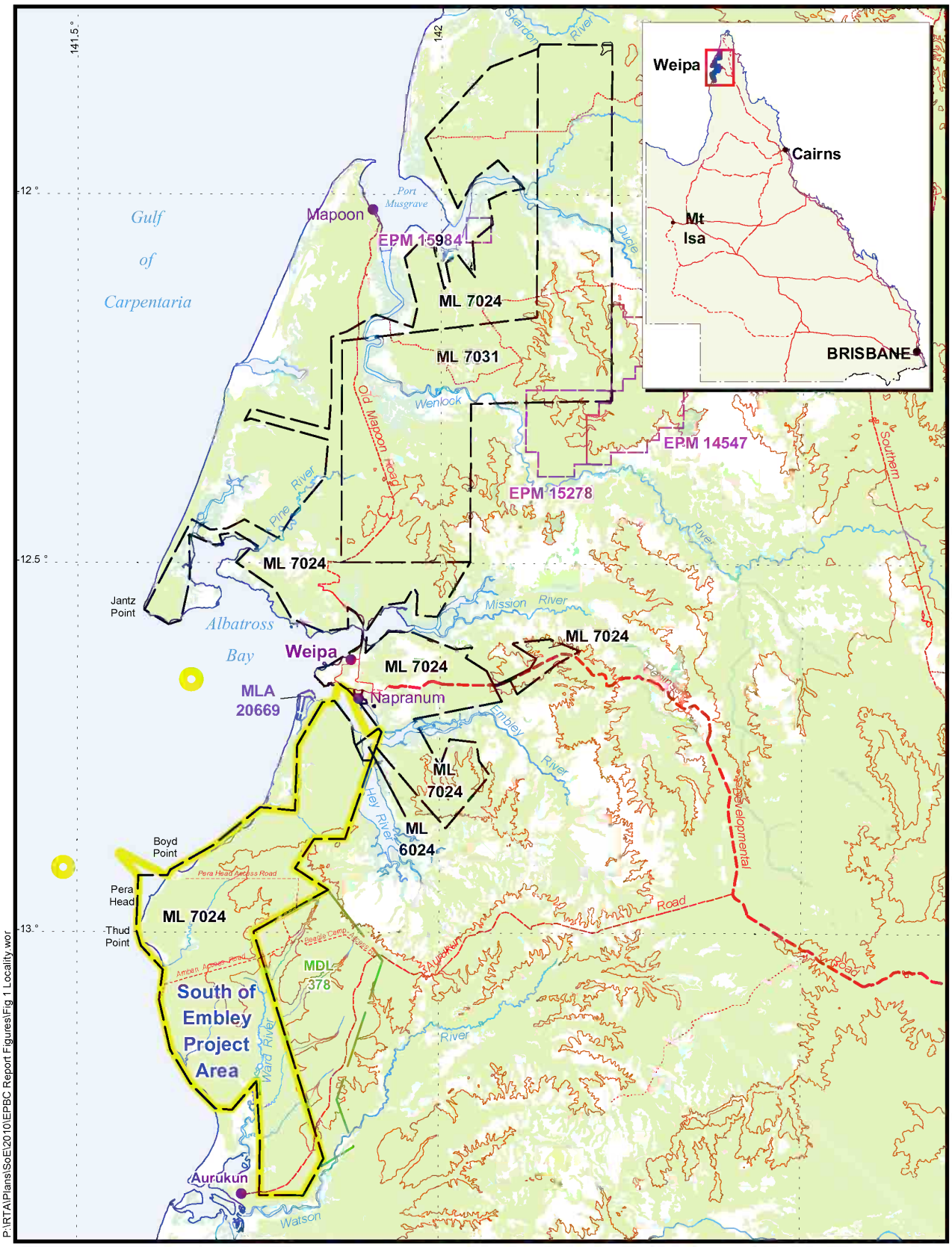
The Project is situated on the western side of Cape York on the Gulf of Carpentaria. The Port and Boyd infrastructure area is approximately 40km south-west of Weipa and 40km north of Aurukun, with the closest mining areas being 4km from Napranum, 15km from Aurukun, and 50km from the nearest cattle station homesteads (refer **Figure 1)**.

The Project is predominately located on the portion of ML 7024 that is south of the Embley River, and on ML 6024. Mining activities would take place on ML 7024. A barge/ferry terminal would be located on the western bank of the Hey River on ML 6024. The northern end of the Project is bounded by the Embley and Hey Rivers and the southern end by the ML 7024 boundary, north of the Watson River. The Gulf of Carpentaria abuts the western boundary of ML 7024, which extends over submerged land between Thud and Boyd Points. The eastern side of ML 7024 adjoins mineral development licence (MDL) 378 (the proposed Aurukun Bauxite Project). The gross extent of the Project area is approximately 106,000ha.

1.3 Project Description

The Project activities covered by this EM Plan consist of construction and operation of the following:

- a bauxite mine;
- two bauxite processing (beneficiation) plants and associated tailings storage facilities;
- product bauxite stockpiles;
- port and ship-loading facilities, and associated dredging;
- ancillary infrastructure – diesel-fuelled power station, workshops, warehouse, administration facilities, package sewage treatment plants, waste storage and disposal facilities, diesel storage, and access roads;
- water infrastructure – a freshwater storage dam on a freshwater tributary of Norman Creek (Dam C) and a pump station on the lower reaches of the Ward River, plus process water and sediment ponds, pipelines and artesian bores;
- an infrastructure corridor for a conveyor, electricity transmission and water pipelines;
- a temporary camp (up to 630 beds) for construction workforce; and
- a barge/ferry terminal on the Hey River.



P:\RTA\Plans\SoE\2010\EPBC Report Figures\Fig 1 Locality.wor

RTA Mining Lease boundary
South of Embley Project Area
Oresome Australia Pty Ltd Mineral Sands Project
Chalco Aurukun Bauxite Project
Cape Alumina Pty Ltd's Pisolite Hills Project
Township
Drainage
Road/track
50m Topographic contour

South of Embley Project

Fig. 1: Locality Map

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Datum/Projection: GDA94/MGA Zone 54 Date: 09/06/2011

Should ore from neighbouring mines operated by others be shipped through the proposed port, such ore would be conveyed by others across ML7024 to the stockpile area. Allowance has been made in the stockpile layout to enable additional stockpile capacity to be added adjacent to RTA's facilities to accommodate, following agreement on suitable commercial terms, product from third parties producing at a rate of up to 13Mdptpa.

The conceptual 40-year mine plan and the main infrastructure components are shown in **Figure 2**. Mining would commence in the Boyd Point/Pera Head area, and would later be extended to the Norman Creek area. The conceptual mine plan shows two mining phases: years 1-13 (based on a production rate of 15Mdptpa) and years 14-40 (based on a production rate of 30Mdptpa and above).

1.4 Project Proponent

The Project would be developed and operated by RTA Weipa Pty Ltd (RTA), which is a wholly-owned subsidiary of Rio Tinto Aluminium Limited. These companies are in the Rio Tinto Alcan product group. Rio Tinto Alcan is one of five product groups operated by the global mining group, Rio Tinto.

Rio Tinto Alcan supplies bauxite, alumina and primary aluminium to Australia, New Zealand and export markets. About 37% of Australia's total production of bauxite, 36% of its alumina and 40% of its primary aluminium is provided by Rio Tinto Alcan.

Rio Tinto Alcan's Australian head office for bauxite and alumina is based in Brisbane. Bauxite and alumina interests in Queensland include the existing Weipa mine, and the Yarwun and Queensland Alumina Limited alumina refineries at Gladstone. Rio Tinto Alcan also operates the Boyne Smelters Limited aluminium smelter in Gladstone.

1.5 Mining Leases

RTA is the holder of ML 7024 granted on 1 January 1958 pursuant to the *Commonwealth Aluminium Corporation Limited Agreement Act 1957* (Comalco Agreement Act), a Queensland 'Special Agreement Act'. ML 6024 (granted 25 July 1985 and affirmed 26 August 2002) was granted pursuant to the Comalco Agreement Act and the *Mineral Resources Act 1989* (Qld) for the purposes of providing transport access to ML 7024. The current term of ML 7024 and ML 6024 is until 31 December 2041; however, there is a right of renewal until 31 December 2062. Following the extended term, the lease of ML 7024 is terminable by either RTA or the State of Queensland giving two years notice of termination. The location of ML 7024 and ML 6024 are shown on **Figure 3**.

The Comalco Agreement Act confers certain rights and obligations relating to the development of bauxite resources, including provisions relating to the taking of water and harbour works.

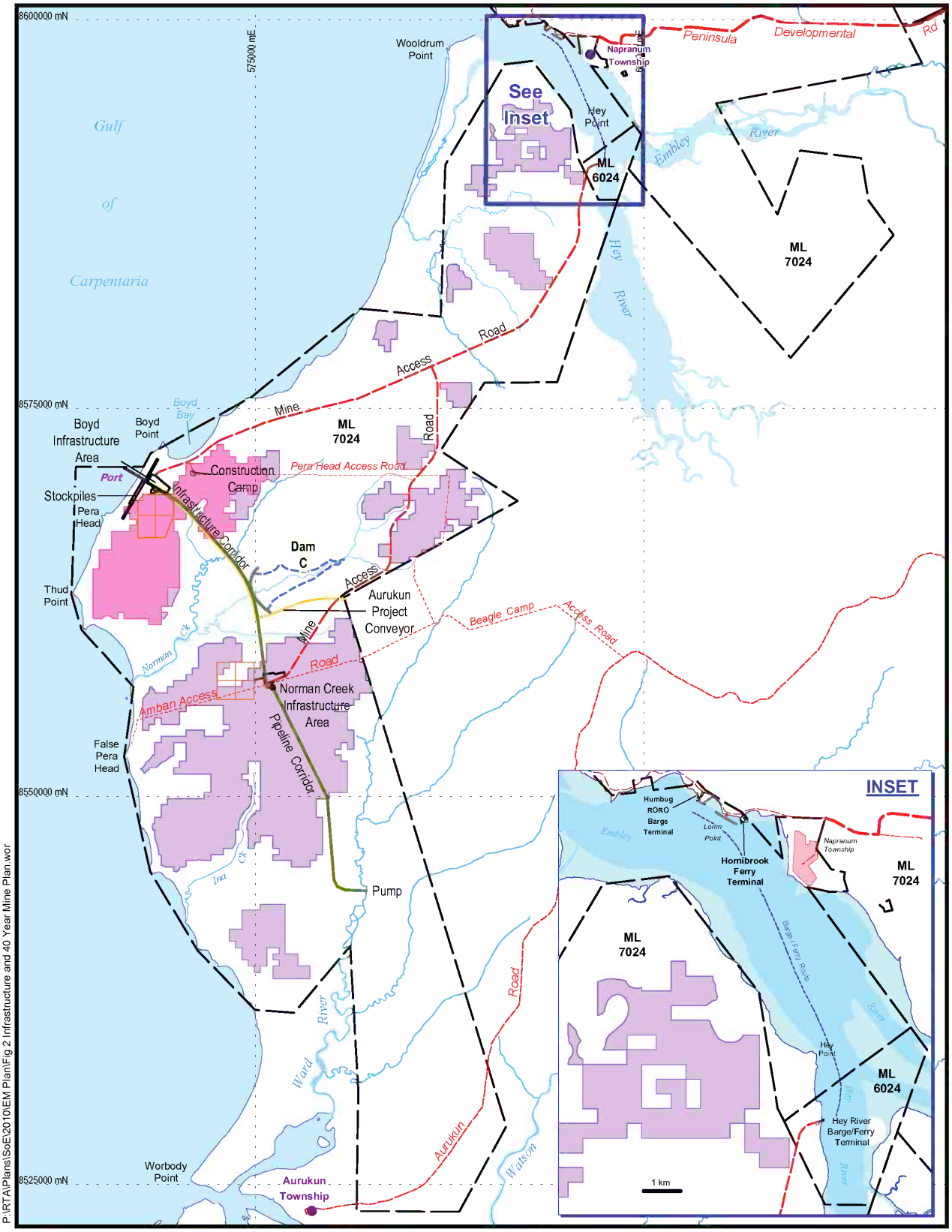
Another company within the Rio Tinto Group, Alcan South Pacific Pty Ltd, is the holder of ML 7031 pursuant to the *Alcan Queensland Pty Limited Act 1965* (which is also a 'Special Agreement Act'). While RTA mines ore for Alcan South Pacific Pty Ltd from ML 7031 (known as the Ely mining lease), activities on ML7031 are not the subject of the Project or this EM Plan.

The Federal Court of Australia determined on 29 July 2009 (FCA 789) that the Wik and Wik Way people have Native Title over the land covered by the Project area. The Western Cape Communities Coexistence Agreement (WCCCA) is a registered Indigenous Land Use Agreement (ILUA) (QIA2001/002) under the Commonwealth *Native Title Act 1993* between RTA, the State of Queensland and relevant Aboriginal parties. Where any proposed activities are outside the ILUA area, to the extent Native Title has not been extinguished in relation to those areas, RTA would comply with the applicable process under the *Native Title Act*. RTA does not expect this to arise.

1.6 Real Property Descriptions

The land parcels and tenure within the Project area are summarised in **Table 1-1** and shown in **Figure 3**.

ML 7024 lies within the Cook Shire Local Government area and ML 6024 lies within the Napranum Shire.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of
Carpentaria
Wooldrum Point
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Napranum Township
Peninsula Developmental Rd
Hey Point
Embley River
ML 6024
ML 7024
Hey River
Road
Access
Mine
8575000 mN
Boyd Bay
Boyd Point
Boyd Infrastructure Area
Port
Stockpiles
Pera Head
Construction Camp
Pera Head Access Road
Infrastructure Corridor
Dam C
Thud Point
Aurukun Project Conveyor
Beagle Camp Access Road
Norman Ck
Norman Creek Infrastructure Area
Amban Access
False Pera Head
Pipeline Corridor
8550000 mN
Ira Ck
Pump
Ward River
Aurukun
Watson
Worbody Point
8525000 mN
Aurukun Township
INSET
Humbug RORO Barge Terminal
Lorim Point
Hornibrook Ferry Terminal
Barge / Ferry Route
Hey River Barge/Ferry Terminal
1 km
P:\RTA\Plans\SoE\2010\EM Plan\Fig 2 Infrastructure and 40 Year Mine Plan.wor
RTA Mining Lease boundary
Township
Road/track
Freshwater dam
Tailings storage facility
Barge / Ferry route
Mining Years 1 -13
Mining Years 14 - 40
South of Embley Project
Fig. 2: Infrastructure and Conceptual 40 Year Mine Plan
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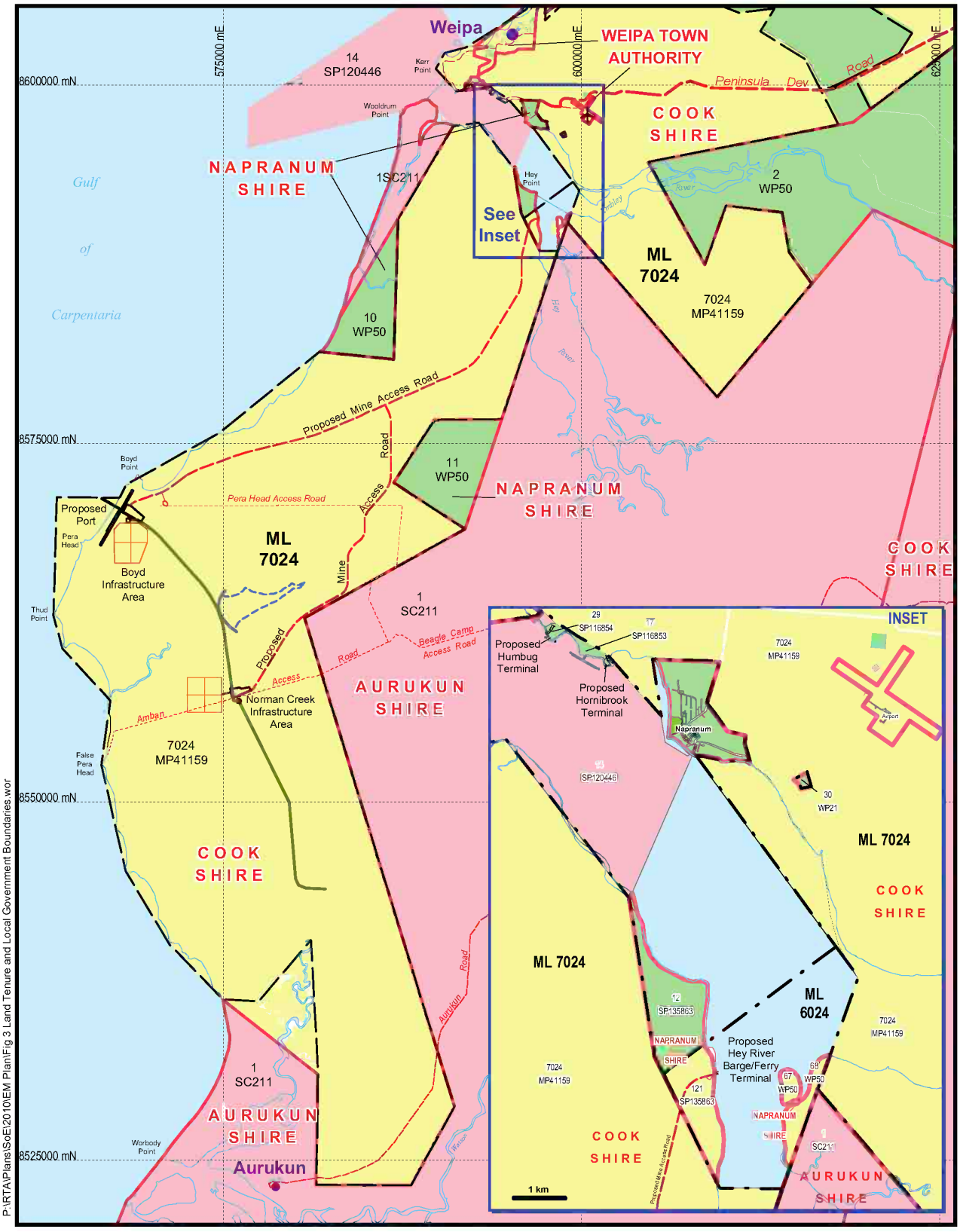
Date: 16/07/2010



P:\RTA\Plans\SoE\2010\EM Plan\Fig 3 Land Tenure and Local Government Boundaries.wor

RTA Mining Lease boundary

Shire Boundary

Weipa Airport

Road/track

Tenure

Freehold

Lands Lease

State Land

South of Embley Project

Fig. 3: Land Tenure and Local Government Boundaries

N

5 0 5km

Datum/Projection: GDA94/MGA Zone 54 Date: 09/06/2011

Table 1–1 Land Parcels and Tenure

Aspect	Mining Tenement	Land Parcel	Background Tenure	Ownership
Mine, Port and Infrastructure	ML7024 (RTA)	Lot 7024 MP41159	State land	The State of Queensland
Hey River Barge/Ferry Terminal	ML6024 (RTA)	Lot 121 SP135863	State land	The State of Queensland
		Lot 67 WP50	State land	The State of Queensland
		Lot 68 WP50	State land	The State of Queensland
Humbug Barge Terminal	Not applicable. Located within Strategic Port Land	Lot 29 SP116854	Freehold	North Queensland Bulk Ports Corporation Limited
		Lot 14 SP120446	Perpetual Lease	North Queensland Bulk Ports Corporation Limited
Hornibrook Ferry Terminal	Not applicable. Located within Strategic Port Land	Lot 17 SP116853	Freehold	North Queensland Bulk Ports Corporation Limited
		Lot 14 SP120446	Perpetual Lease	North Queensland Bulk Ports Corporation Limited
Adjacent Properties	MDL378	1 SC211	Deed of Grant in Trust (DOGIT)	DOGIT to Aurukun Aboriginal Council
	Not Applicable.	11 WP50	Freehold	Napranum Aboriginal Shire Council
		10 WP50	Freehold	Napranum Aboriginal Shire Council
		Lot 15 SP116851	Perpetual Lease	North Queensland Bulk Ports Corporation Limited
		2 SP161882	State Land	The State of Queensland

1.7 Structure of the EM Plan

The EM Plan is structured in accordance with Queensland Department of Environment and Resource Management (DERM) Guideline 8 "Preparing an environmental management overview strategy (EMOS) for non-standard mining projects" and describes the following:

- description of mining activity and mining tenements and the land on which the mining activities are carried out **(Section 1)**;
- all relevant mining activities **(Section 2)**;
- the environmental values likely to be affected by mining activities and the potential adverse and beneficial impacts the mining activities has on environmental values, as well as the environmental protection objectives, conditions and measurable indicators **(Section 3)**;
- details of monitoring programs **(Section 3)**; and
- strategies for reporting, continuous improvement, staff training, and environmental auditing **(Section 4)**.

1.8 Purpose of the EM Plan

The purposes of this EM Plan and proposed conditions are to:

- provide management programs and control strategies to protect and manage environmental values affected by SoE mining and mining-related activities;
- provide for an amendment of the environmental authority (mining activities) consistent with both (i) the authorities granted under the *Commonwealth Aluminium Corporation Pty Limited Agreement Act 1957* (a Special Agreement Act) and (ii) the DERM Guideline Number 8 "Preparing an environmental management overview strategy for non-standard mining projects"; and
- provide a document setting out the conditions for undertaking environmental activities on ML 7024 and ML 6024 such that DERM may issue the required amended environmental authority (mining activities) under the *Environmental Protection Act 1994* (Qld) (EP Act) for operations on ML 7024 and ML 6024.

1.9 Relevant Stakeholders

An extensive program of community consultation and stakeholder engagement was undertaken prior to the commencement of the Project. A program of consultation would continue to be undertaken by RTA to address community issues throughout all phases of the Project. The objectives of the community consultation and stakeholder engagement are:

- to identify stakeholders who have an interest in the Project;
- facilitate two-way engagement with stakeholders, providing accurate, timely and relevant information on the Project;
- identify any concerns or potential issues stakeholders may have with the Project;
- explore areas of the Project with the potential to have a positive impact on communities;
- develop appropriate strategies to mitigate any concerns; and
- address stakeholder issues and concerns.

For the purposes of community consultation, the local community area has been defined as the communities and surrounding areas of the Western Cape region, including Aurukun, Napranum, Weipa and Mapoon. This region encompasses the members of the general public and the organisations (including government, industry, service providers, regional landholders and community groups) likely to be adversely or positively affected by the Project. The relevant stakeholders for the Project have been identified as:

- Federal, State and Local government agencies and services providers including the Weipa Town Authority (WTA);
- Community groups and non-government organisations;
- Traditional Owners and other Aboriginal groups;
- Industry, local businesses and service providers operating throughout the Western Cape region;
- Recreational and professional fishing groups;
- General public and residents of local communities in Aurukun, Napranum, Weipa and Mapoon;
- Regional pastoral lease holders and managers; and
- RTA and local contractor employees based on the Western Cape.

The ongoing consultation and engagement process will also continue to actively involve Traditional Owners in a range of activities to:

- increase knowledge and awareness of the mining processes;
- provide accurate, timely and relevant information on the Project;
- identify any concerns or potential issues Traditional Owners may have with the Project;
- explore areas of the Project with the potential to have a positive impact on communities; and
- develop and pursue appropriate strategies to mitigate any issues and concerns during the environmental approval process, and during the construction and operational phases.

The Western Cape Communities Coordinating Committee (WCCCC) and the relevant WCCCC Sub-committee would continue to provide the consultative mechanism for coordination of these activities.

2 PROJECT DESCRIPTION

2.1 Significant Project

The relevant mining leases are included in a Project that was declared a "significant project" by the Queensland Coordinator-General on 21 November 2008. An EIS under Part 4 of the *State Development and Public Works Act 1971* (Qld) (SDPWO Act) has been prepared for the Project (RTA 2011).

2.2 Project Overview

The Project involves establishment of a new bauxite mine capable of producing up to 50Mdptpa along an incremental expansion pathway. The environmental impacts of the Project have been assessed at several different levels of production along this pathway: a minimum rate of 15Mdptpa, a maximum rate of 50Mdptpa, and a nominal intermediate rate of 30Mdptpa. However, the actual rates and the timing of production increases are subject to market conditions. The initial production capacity is subject to ongoing feasibility studies but is likely to be either 15Mdptpa or 22.5Mdptpa.

The initial phase of mining operations involves production to replace depleted East Weipa production as well as developing third party markets. Production capacity would expand to replace Andoom production once those reserves are depleted. Production capacity will thereafter be expanded to 50Mdptpa when market conditions are suitable. The Project has bauxite reserves capable of sustaining a mine life of approximately 40 years, depending on annual production rate.

2.3 Description of the Mine

The term "mining activities" is defined in Section 147 of the EP Act, and this Project will, in summary, involve the following types of mining activities defined in that section:

- prospecting, exploring and mining under the *Mineral Resources Act 1989* (Qld);
- processing those materials;
- a number of activities directly associated with, or facilitating or supporting, the mining and processing activities (see **Section 2.9** for details);
- rehabilitation/remediation; and
- actions taken to prevent environmental harm.

Certain changes may occur in the layout of facilities, associated infrastructure, and the mining areas as the mine develops. Should any such change be likely to lead to a significant increase in environmental harm, an amendment to the environmental authority (mining activities) would be required.

2.4 Exploration Activities

Exploration activities are conducted throughout ML 7024 from time to time and involve prospecting; the establishment of access tracks; drilling; test pits; use of instruments and equipment for mineral detection; sampling and digging to extract test material; ore samples to determine mineral content; land clearance, and trucking of ore and test samples extracted. The transport corridor within ML 6024 is also required for this purpose, along with associated port and town infrastructure north of the Embley River.

2.5 Mining Process

Vegetation is cleared by bulldozers following the wet season when the ground is sufficiently moist to allow tree roots to pull clear of the ground rather than breaking. Consideration is given to the selective extraction of structural grade timber in the Project area prior to mining, where practicable

and where the timber can be beneficially used. The cleared vegetation will be pushed into windrows and burnt.

Approximately 600mm of soil is salvaged and returned by scraper or haul truck directly to mined-out areas undergoing rehabilitation, where possible, or stockpiled for later re-spreading. The overburden above the bauxite is then removed by front-end loader and returned to mined-out pits by trucks.

The top of the bauxite strata is generally less than 1m below the natural ground surface. The average ore thickness across the Project area is approximately 3.4m.

A shallow open pit is developed whereby bauxite is mined by front-end loader or excavator. Bauxite is relatively easy to dig and does not require blasting. The ore is loaded into 180t dump trucks and transported via dedicated haul roads to a truck dump station adjacent to the beneficiation plant.

2.6 Rehabilitation

Rehabilitation is undertaken progressively during the life of the mine. Mined areas are likely to be rehabilitated to native woodland. However, the final land use options will be developed and discussed with the Traditional Owners, as required under the WCCCA, and relevant Government stakeholders. The overall objective is to return the land to a post-mining land use that is stable, self-sustaining, requires minimal maintenance, and protects downstream water quality. Details of rehabilitation objectives and strategies are described in **Section 3.7.3**.

2.7 Bauxite Processing

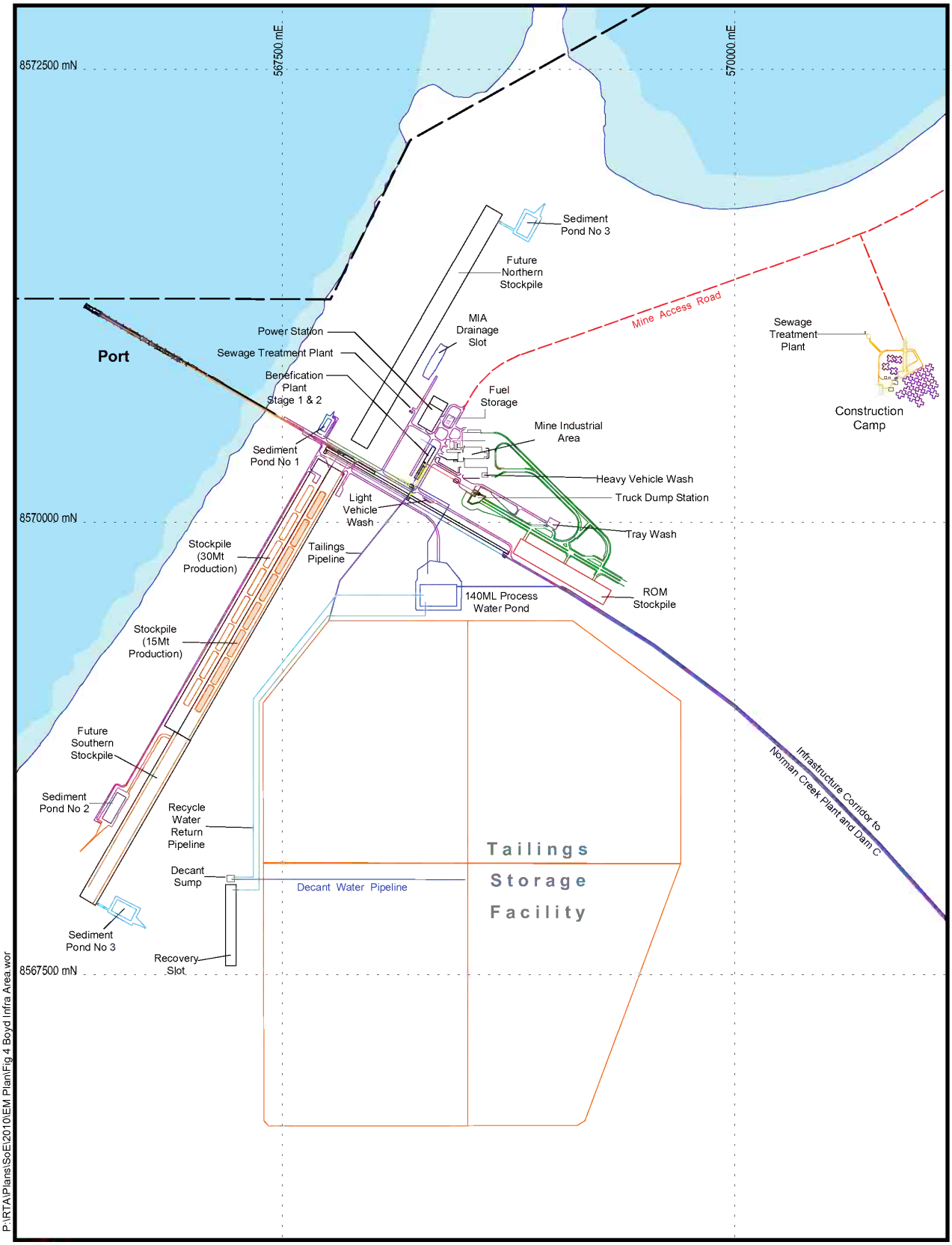
The location of the Boyd and Norman Creek beneficiation plants is shown in **Figures 4** and **5** respectively.

Product grade bauxite is processed by beneficiation, a process where oversized particles are removed by screening and fine particles are removed by washing. No chemicals are used in the beneficiation process. Overall bauxite product recovery from crude ore averages approximately 70%.

The initial Boyd and Norman Creek beneficiation plants are similar "low dispersion energy" plants designed to process approximately 3400 wet crude tonnes per hour, and each plant uses approximately one tonne of water to produce one tonne of product bauxite. Each plant would be designed so it can be expanded in the future. Some of the crude ore in the Norman Creek mining area has elevated fines content that requires "high dispersion energy" beneficiation. This ore would be processed through a "high dispersion energy" module that would be added to the Norman Creek plant. This module uses approximately 1.9 tonnes of water to produce one tonne of product bauxite.

The beneficiation process generates tailings, which are pumped to tailings storage facilities where water is decanted and recycled back to the plant. The process involves:

- crude ore is transported to a truck dump station and dumped into a hopper;
- the ore is sized to <300mm in a primary crusher and then <90mm in a secondary crusher;
- ore is conveyed to the beneficiation plant;
- crushed ore and dispersion water is fed to single-deck scalping screens. Water sprays over the screen decks complete the dispersion of the crude ore. The decks of the scalping screens classify and separate oversize rejects (+25mm) from the crude bauxite feed;
- the oversize rejects are conveyed to a nominal 4000t stockpile adjacent to the plant. A 100,000t stockpile is located between the plant and the tailings storage facility. This material is reprocessed in a tertiary crusher and blended with the product stream, used for construction (e.g. roads, tailings storage facility walls) or returned to mined-out pits;
- the underflow slurry (–25mm) from each scalping screen flows by gravity onto a dedicated product screen for de-watering of the product (+0.6mm);



P:\RTA\Plans\SoE\2010\EM Plan\Fig 4 Boyd Infra Area.wor

Lease boundary

South of Embley Project

Fig. 4: Boyd Infrastructure Area

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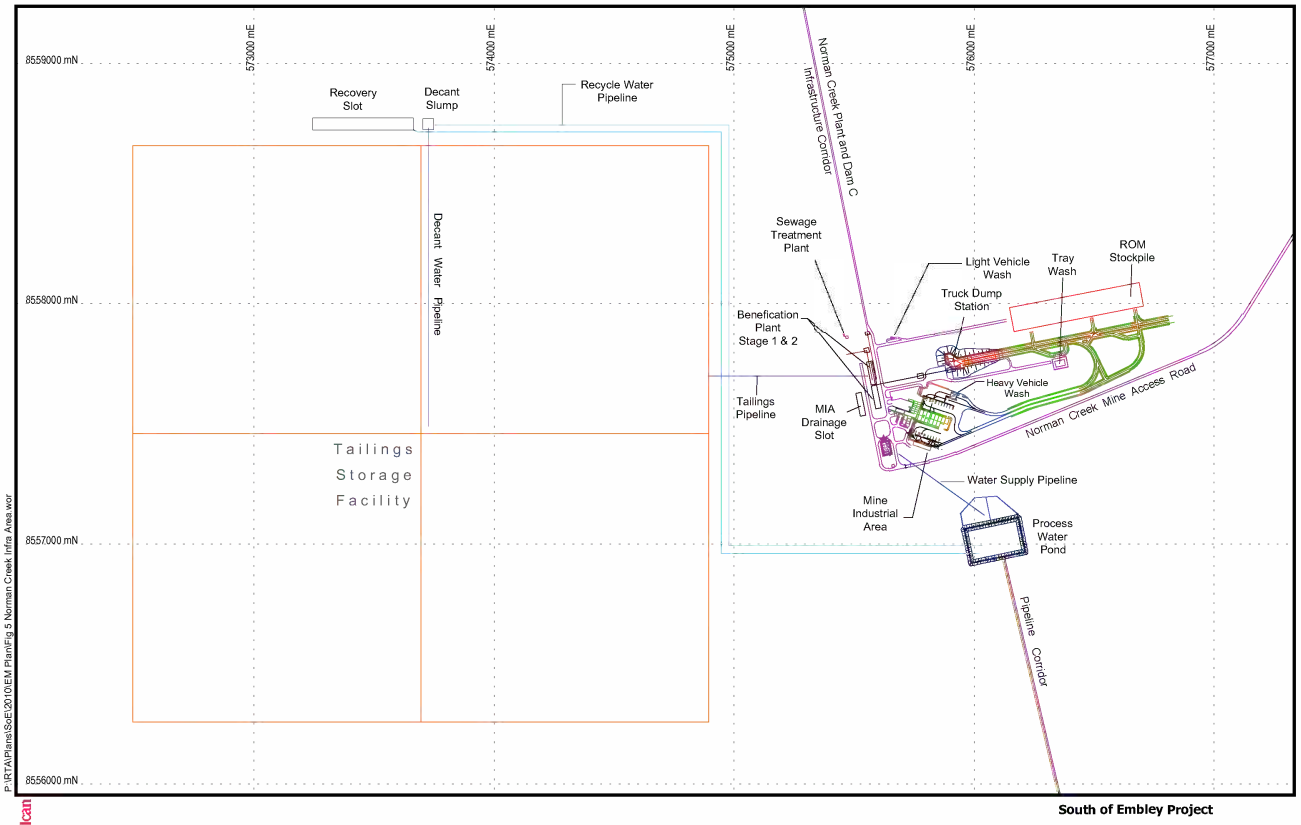
0 500 1000m

Datum/Projection: GDA94/MGA Zone 54 Date: 16/07/2010


573000 mE
574000 mE
575000 mE
576000 mE
577000 mE
8559000 mN
8558000 mN
8557000 mN
8556000 mN
Recovery Slot
Decant Slump
Recycle Water Pipeline
Decant Water Pipeline
Tailings Storage Facility
Norman Creek Plant and Dam C Infrastructure Corridor
Sewage Treatment Plant
Light Vehicle Wash
Tray Wash
ROM Stockpile
Truck Dump Station
Benefication Plant Stage 1 & 2
Heavy Vehicle Wash
Tailings Pipeline
MIA Drainage Slot
Norman Creek Mine Access Road
Water Supply Pipeline
Mine Industrial Area
Process Water Pond
Pipeline Corridor
P:\RTA\Plans\SoE\2010\EM Plan\Fig 5 Norman Creek Infra Area.wor
Rio Tinto Alcan
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500m
South of Embley Project
Fig 5: Norman Creek Infrastructure Area
Datum/Projection: GDA94/MGA Zone 54
Date: 16/07/2010

- the underflow slurry (<0.6mm) from the secondary screen, made up of water, fine bauxite pisolites, sands and clays, is directed to a tailings storage facility via the tailings pumping system. Approximately 0.4Mt of tailings is produced for every 1Mdpt of bauxite. The Boyd tailings storage facility has a capacity of approximately 182Mt, covers an area up to 580ha, and would be about 22m high upon completion. The Norman Creek tailings storage facility has a capacity of approximately 204Mt, covers an area of approximately 580ha, and would be about 25m high upon completion;
- the tailings storage facilities are divided into cells to facilitate the cycling of tailings perimeter deposition within a cell and between cells, to enhance formation of a broad tailings beach adjacent to the perimeter walls that dries quickly to a consistent density over its full depth;
- the dewatered product bauxite is conveyed to a stacking feed conveyor, which supplies a travelling stacker, which deposits bauxite onto a stockpile pad. The stacker operates at a nominal rate of 2500 dry product tonnes per hour (dptph). A bucket wheel reclaimer withdraws stockpile material at a nominal rate of 9000dptph and feeds the bauxite onto a reclaim conveyor which, in turn, feeds a load-out conveyor to the wharf; and
- the stockpile area will be expanded in stages as production increases. At a production capacity of 15Mdptpa, the stockpile capacity is 680,000dpt and occupies 17ha. At a production capacity of 30Mdptpa, the stockpile capacity would be 1.36Mdpt and would occupy 34ha. At an RTA production capacity of 50Mdptpa, and assuming 13Mdptpa production from third parties as well, the stockpile capacity would be 2.55Mdpt and it would occupy 59ha.

2.8 Port Facility and Shipping

RTA proposes to construct and operate a port located between Boyd Point and Pera Head. The port would include an approach jetty, wharf, berths and ship-loader. The berth pockets and departure areas would need to be dredged. The port is capable of shipping 30Mdptpa and is designed to allow expansion to ship up to 63Mdptpa. Capacity may be provided for third parties following agreement on suitable commercial terms.

The port includes an approach jetty approximately 568m long and a wharf with two berths. A further two berths will be operated when production is greater than 30Mdptpa. The four-berth wharf would be approximately 696m long. The port is capable of accepting bulk carrier vessels of up to 185,000 deadweight tonnage (dwt) and 18.1m draft. Separate berths are provided for tugs and line boats.

The approach jetty supports the product load-out conveyor and a vehicle access roadway from the Boyd infrastructure area. The wharf supports a rail-mounted travelling ship loader capable of loading at a rate of 9,000t per hour. Ships are not refuelled at the SoE port.

Initially, approximately 6,500,000m^3 of marine sediments will be dredged to establish the berth pockets and departure areas over a period of about three hundred days. For the purposes of evaluation studies, it has conservatively been assumed that vessel departures are unrestricted by tides and hence the depth of dredging required has been matched to this assumption. The dredging will be carried out by a cutter suction dredger re-depositing material on the sea bottom and retrieved by a trailing suction hopper dredge (TSHD). Dredged spoil would be transported by the TSHD to a new off-shore spoil disposal ground located approximately 17km west of Boyd Point (refer **Figure 2-9** for location). Annual maintenance dredging of approximately 890,000m^3 is expected to be required to maintain under keel clearance for ships.

When the wharf is extended in a second stage to expand capacity to at least 50Mdptpa, a further 2,400,000m^3 of dredged spoil would be generated and disposed of at the same off-shore spoil ground.

The port is designed for continuous hours of operation. The estimated shipping frequencies under each production scenario are summarised below:

- 15Mdptpa – up to 215 ships/annum (4-5 ships/week);
- 30Mdptpa – up to 430 ships/annum (8-9 ships/week); and
- 50Mdptpa – up to 700 ships/annum (14 ships/week).

2.9 Associated Infrastructure

This section describes infrastructure that will be constructed as part of the SoE Project to support the mining, processing and shipping activities.

2.9.1 Transport

During the initial construction period, access to the Project area is from the Peninsula Developmental Road (PDR) via the Aurukun Road, Beagle Camp Access Road, Pera Head Access Road and Amban Access Road (the "access roads") that traverse MDL 378. Once the ferry terminals and Mine Access Road are constructed, workers will be transported from the Hornibrook ferry terminal by high-speed ferry to the Hey River barge/ferry terminal and then by bus to the site at the beginning and end of each roster.

The following transport infrastructure is located on the mining lease:

- The Hey River barge/ferry terminal – includes a roll-on roll-off (RORO) barge facility, vehicle parking, covered waiting area and walkway, pontoon and floating ramp for the ferry terminal. Approximately 17,300m^3 of material will be dredged during the initial construction phase and disposed of at the Albatross Bay spoil ground, which is currently used by the Port of Weipa. An area of about 4,400m^2 will be reclaimed and supported by rock revetment and/or sheet piles. A thin band of mangroves will be cleared.
- All weather sealed 38km Mine Access Road from the Hey River barge/ferry terminal to the Boyd infrastructure area (see **Figure 1**) and a 24km spur road from the Mine Access Road to the Norman Creek infrastructure area. Box culvert causeways are used for some watercourse crossing points.

Plant, equipment and materials transported by barge from Cairns is offloaded at Humbug Wharf and transferred via RORO barge from the Humbug barge terminal to the Hey River barge/ferry terminal. Barges may also deliver to Evans Landing wharf or direct to the Hey River barge/ferry terminal (depending on the draft of the barge).

2.9.2 Water Supply and Management

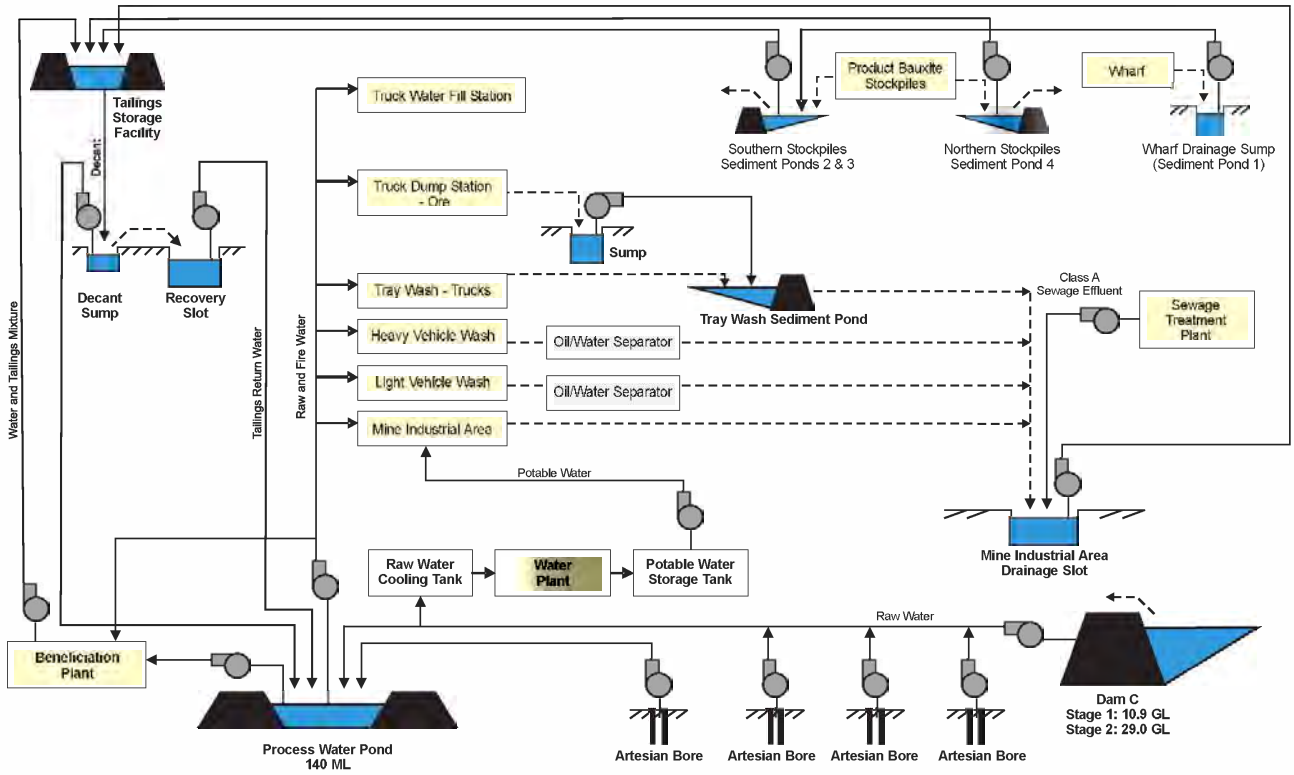
The locations of water management infrastructure are shown in **Figure 4** and **Figure 5**. Schematic diagrams of the proposed water management systems are shown in **Figure 6** and **Figure 7**.

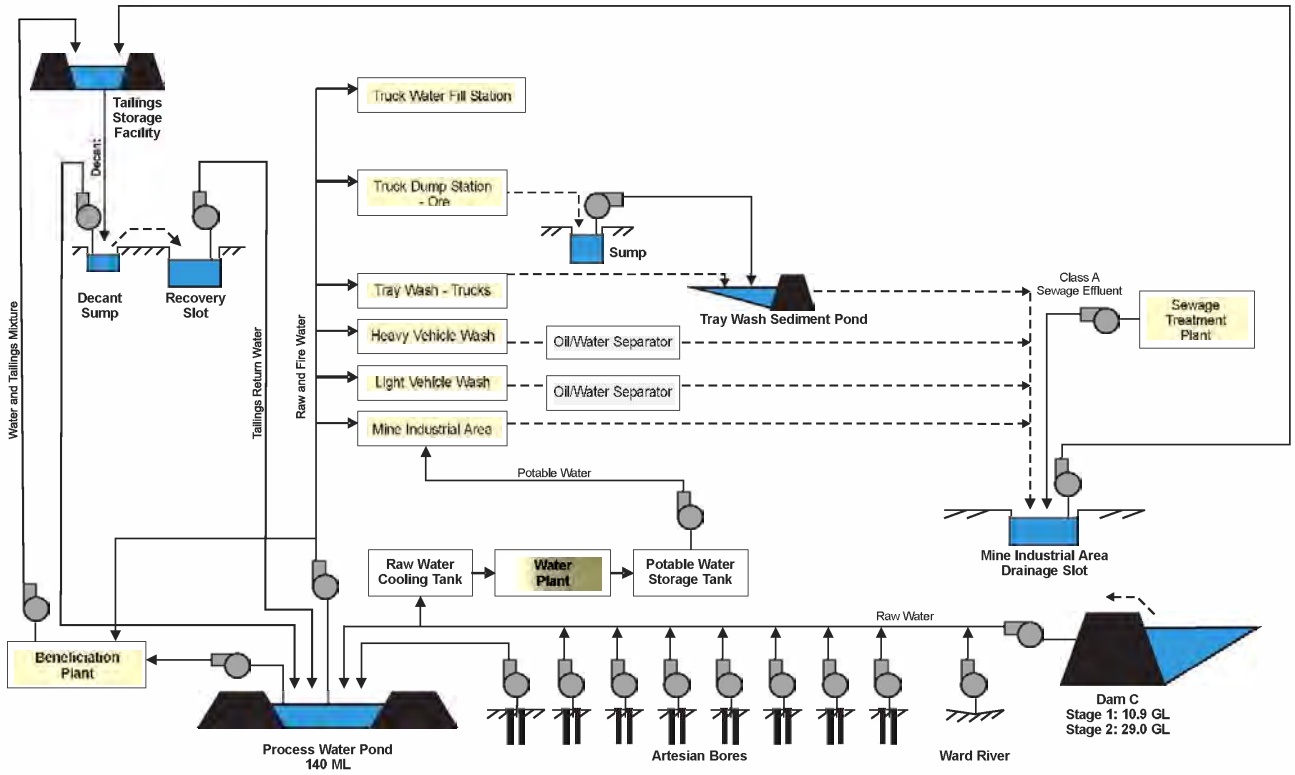
The Project's principal water requirements are for process water, haul-road watering, vehicle wash-down, dust suppression, and potable supplies. Typically, water would be drawn in order of preference from tailings recycle, recovery slots, surface water dam (Dam C), and artesian bores. Some supplementary surface water will be drawn directly from the Ward River to minimise the risk of inadequate supply from Dam C. The overall water balance for the Project is summarised in **Table 2–1.**

Table 2–1 Average Annual Water Balance

Production Scenario	Average Annual Demand (GL)	Average Annual Supply (GL)				
		Recycle from tailings	Artesian	Dam	Recovery Slots*	Total Supply
15Mdptpa	16.4	4.7	3.1 (5.2 peak)	7.8	0.8	16.4
30Mdptpa	33.0	9.4	6.0 (10.6 peak)	13.8	1.6	33.1
50Mdptpa	63.7	22.1	11.9 (15 peak)	25.4	1.6	63.6

* Trenches dug adjacent to tailings storage facilities to recover water.


Tailings Storage Facility
Decant
Decant Sump
Recovery Slot
Water and Tailings Mixture
Tailings Return Water
Raw and Fire Water
Truck Water Fill Station
Truck Dump Station - Ore
Sump
Tray Wash - Trucks
Heavy Vehicle Wash
Light Vehicle Wash
Mine Industrial Area
Oil/Water Separator
Oil/Water Separator
Tray Wash Sediment Pond
Southern Stockpiles Sediment Ponds 2 & 3
Product Bauxite Stockpiles
Northern Stockpiles Sediment Pond 4
Wharf
Wharf Drainage Sump (Sediment Pond 1)
Class A Sewage Effluent
Sewage Treatment Plant
Mine Industrial Area Drainage Slot
Potable Water
Raw Water Cooling Tank
Water Plant
Potable Water Storage Tank
Raw Water
Beneficiation Plant
Process Water Pond 140 ML
Artesian Bore
Artesian Bore
Artesian Bore
Artesian Bore
Dam C
Stage 1: 10.9 GL
Stage 2: 29.0 GL
Gravity flow
Pipeline
RioTinto Alcan
South of Embley Project
Fig. 6: Boyd
Water Management System
Date: 12/07/2010



RioTinto Alcan

Gravity flow

Pipeline

South of Embley Project

Fig. 7: Norman Creek Water Management System

Date: 12/07/2010

A water supply dam (Dam C) is on a freshwater tributary of Norman Creek and has a catchment area of 259km^2. Dam C is a conventional earth-fill dam with a maximum capacity of 29GL, which would be constructed either in two stages or a single stage. If constructed in two stages, the first stage would provide 10.9GL storage capacity and, later, the wall would be raised to provide 29GL storage capacity. The dam would be constructed in a single stage (29GL capacity) should expansion of production above 15Mdptpa be anticipated to occur quickly, or should an initial production capacity of 22.5Mdptpa be adopted. This is the subject of ongoing feasibility studies.

In order to maintain the reliability of the overall surface water supply at production levels of 30Mdptpa and above, some water would be pumped directly from the lower reaches of the Ward River to supplement the Dam C supply.

A reverse osmosis potable water treatment plant treats raw water from Dam C to a standard that meets the *Australian Drinking Water Guidelines* (NHMRC 2004).

Stormwater runoff generated within active mine areas is mostly captured within the internally draining mine pits. The post-mining landscape effectively provides internally draining sumps that contain stormwater runoff, which then infiltrates through the pit floor and walls. In the event that the post-mining topography is not an internally draining pit, stormwater runoff is directed via a sediment pond. Sediment traps are also included as part of the drainage designs at points where haul roads cross watercourses.

No watercourses are diverted as part of the Project.

2.9.3 Sewage

During the initial construction phase, prior to a sewage treatment plant (STP) being commissioned, the construction areas will be serviced by portable ablution facilities. Sewage will be stored in holding tanks and regularly trucked by a licensed regulated waste transporter back to Weipa for treatment in an existing licensed STP. This method would also be utilised if temporary mobile construction camps were used for the Mine Access Road construction or an accommodation barge was used during dredging of the Port.

The construction camp, and Boyd and Norman Creek infrastructure areas are serviced by separate gravity-fed package STPs. The effluent is treated to Class A standard (as defined in Schedule 3D of the *Public Health Regulation 2005)* and recycled for use in the dust suppression, landscape watering or other appropriate uses on-site that are suitable for the quality of water.

2.9.4 Power Generation and Supply

Electricity for the Project is generated by a diesel-fuelled power station located at the Boyd infrastructure area. The power station would be expanded in stages using multiple generating units in the range of 1.4 to 6MW capacity to meet the following demands:

- 15Mdptpa – 15.4MW;
- 30Mdptpa – 29MW; and
- 50Mdptpa – 54MW

Transmission lines reticulate power to artesian bores, water-supply pumps and the Norman Creek infrastructure area.

2.9.5 Mining-Related Activities

The mining-related activities that will be carried out on the mining leases include:

- Access track and road construction;
- Quarrying of rock and gravel;
- Dam construction;
- Clearing of vegetation;
- Topsoil stripping and stockpiling;
- Overburden removal by front-end loader and truck;

- Bauxite mining by front-end loader or excavator, and haulage by truck;
- Rehabilitation;
- Bauxite crushing and sizing;
- Beneficiation plant operation;
- Transport of bauxite by conveyor;
- Stacking and reclaiming product bauxite from a stockpile;
- Loading ships and operating a port;
- Dredging;
- Operation of barge and ferry;
- Disposal of bauxite tailings;
- Stockpiling of oversize bauxite;
- Disposal of overburden;
- Operation of diesel-fuelled power station;
- Water management system operation;
- Borefield operation;
- Haul-road watering;
- Sewage treatment plant operation;
- Operation of potable water treatment plant;
- Operation of construction workforce accommodation;
- Temporary storage of general and regulated wastes;
- Heavy equipment workshop and service bay;
- Fixed-plant workshop;
- Operation of warehouse;
- Diesel, oil and other hydrocarbon storage;
- Lube-truck operation;
- Chemical storage;
- Heavy equipment and light vehicle refuelling;
- Heavy vehicle and light vehicle wash-down areas;
- Tyre store and change bay;
- Offices and crib room; and
- Emergency service centre.

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The Boyd and Norman Creek infrastructure areas are linked by a 15km infrastructure corridor, approximately 64m wide. The corridor contains an overland conveyor, access road, transmission line, water supply pipeline, and telecommunications. A second, 16km-long, 50m-wide corridor links the Norman Creek infrastructure area with the pumping station on the Ward River and provides space for an access road, transmission line and water supply pipeline (see **Figure 1**).

Notifiable Activities are activities defined in Schedule 3 of the EP Act. The Notifiable Activities that will occur in the Project area are shown in **Table 2-2**.

Table 2-2 Notifiable Activities

Notifiable Activity	Description	Location
14	Engine reconditioning works	Boyd infrastructure area Norman Creek infrastructure area
25	Mineral processing	Boyd beneficiation plant Norman Creek beneficiation plant
29	Petroleum product or oil storage: b)(iii) petroleum products that are combustible liquids in class C1 or C2 in *AS 1940:2004 The storage and handling of flammable and combustible liquids* – more than 25,000L capacity	Boyd infrastructure area Norman Creek infrastructure area
37	Waste storage, treatment or disposal	Temporary storage of regulated waste in mining infrastructure areas and Boyd and Norman Creek infrastructure areas (e.g. batteries, tyres, waste oil).

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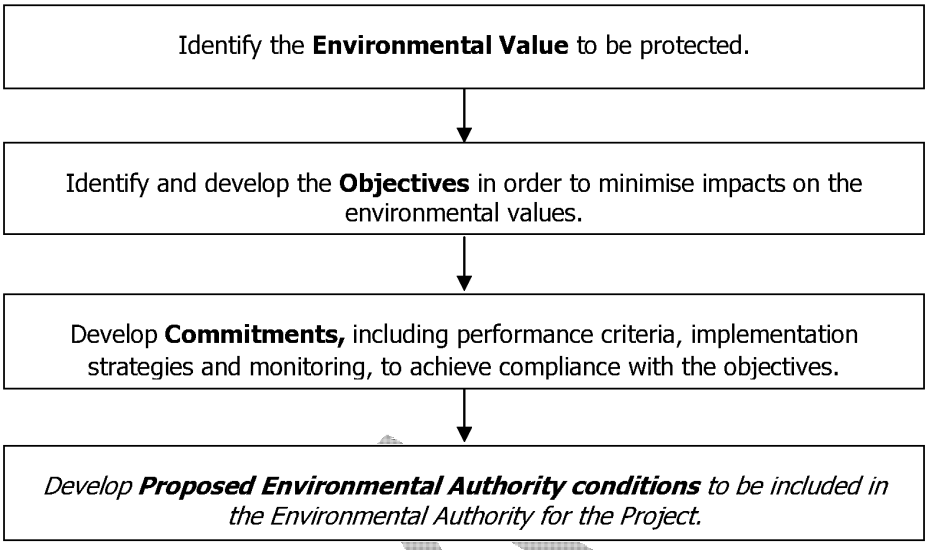
3 ENVIRONMENTAL VALUES, POTENTIAL IMPACTS, COMMITMENTS, PROPOSED DRAFT CONDITIONS AND SUPPORTING INFORMATION

3.1 Content of the Section

This document has been designed incorporating the framework for drafting an Environmental Management Overview Strategy (EMOS), as outlined in the Queensland Environmental Protection Agency's "Guideline 8 – Preparing an Environmental Overview Strategy (EMOS) for Non-Standard Mining Projects". This document has been prepared in accordance with the following stages:



The guiding definitions for the terms used throughout this EM Plan are:

Environmental values: those qualities or physical characteristics of the environment conducive to ecological health, public amenity or safety.

Section 9 of the EP Act describes an "environmental value" as:

(a) "a quality or physical characteristic of the environment that is conducive to ecological health or public amenity or safety; or

(b) another quality of the environment identified and declared to be an environmental value under an environmental protection policy or regulation."

Objectives: Describes the key elements of the environment and the outcomes to be protected in order to minimise impacts on the environmental values.

Commitments: Defines the performance criteria and describes the implementation strategies (including technological and design elements together with management plans and strategies), and monitoring proposed to be undertaken to meet the objectives and achieve the performance criteria.

Proposed environmental authority conditions: Draft conditions containing measurable indicators and standards proposed to be included in the environmental authority to protect identified environmental values that may be affected by the Project.

Indicators: The indicators by which the level of achievement of the environmental protection objectives can be determined, in a measurable and auditable way.

Performance criteria: Numerical standards or measurable outcomes for each of the indicators by which adequate levels of achievement of the environmental protection objectives and protection of the environmental values can be determined.

Words and phrases used throughout this EM Plan are defined in **Section 5**, except where identified in the EP Act or subordinate legislation. Where a word or term is not defined, the ordinary English meaning applies, and regard should be given to the Macquarie Dictionary.

3.2 Proposed Environmental Authority Conditions: Schedule A – General Conditions

Note: The draft conditions in this Schedule are subject to change due to the pending approval of the ML7024 Environmental Authority for the existing Weipa mining operations.

Activity

A1 This environmental authority authorises environmental harm referred to herein. The environmental authority does not authorise environmental harm unless a condition contained within this authority explicitly authorises that harm. Where there is no condition or the authority is silent on a matter, the lack of a condition or silence shall not be construed as authorising harm.

A2 The activities to be carried out under this environmental authority are the mining activities authorised under the Commonwealth Aluminium Corporation Pty Limited Agreement Act 1957 including those defined within Table A1 – Mining Activities and identified in **Figure 2**.

Table A1 Mining Activities – South of Embley

Mining Activities*	Mine Feature	Tenure	Maximum Surface Area of Disturbance (ha)
Exploration	South of Embley Project area	ML7024	40
	Transport	ML6024	2
Extraction Areas	Mining areas	ML7024	27,300
Processing Areas	Boyd infrastructure area	ML7024	900
	Norman Creek infrastructure area	ML7024	500
Regulated Dams	Boyd Tailings Storage Facility	ML7024	5*
	Norman Creek Tailings Storage Facility	ML7024	275*
	Dam C (water supply dam)	ML7024	700
Electricity Generation	Boyd Power Station	ML7024	0*
Chemical Storage	Boyd infrastructure area	ML7024	#
	Norman Creek infrastructure area	ML7024	#
Motor Vehicle Workshops	Boyd infrastructure area	ML7024	#
	Norman Creek infrastructure area	ML7024	#
Construction camp	Construction camp (South of Embley Project)	ML7024	0*
Barge/ferry terminal	Hey River terminal	ML6024	2

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Port and ship loading	Port (South of Embley Project)	ML7024	TBA
Water Treatment	Construction camp sewage treatment plant	ML7024	0*
	Boyd infrastructure area sewage treatment plant	ML7024	#
	Norman Creek infrastructure area sewage treatment plant	ML7024	#

^ Mining activities include vegetation clearing

* Area of clearing in addition to that which would have been previously cleared for mining prior to construction of infrastructure.

Area of disturbance included in total infrastructure area under "Processing areas"

A3 Access to the mining project via land authorised for that purpose by the *Mineral Resources Act 1989* (Qld) is subject to the conditions of this environmental authority.

Maintenance of Measures, Plant and Equipment

A4 The holder of this environmental authority must:

(a) install reasonable and practicable measures, plant and equipment necessary to ensure compliance with the conditions of this environmental authority; and,

(b) maintain such measures, plant and equipment in a proper condition; and,

(c) operate such measures, plant and equipment in a proper manner.

A5 No change, replacement or alteration of any plant or equipment is permitted if the change, replacement or alteration substantially increases, or is likely to substantially increase the risk of environmental harm caused by the mining activities.

Monitoring & Reporting

A6 The holder of this environmental authority must record, compile, evaluate and keep all monitoring results, records and documents required by this environmental authority and any complaints received about the mining activities, and make available for inspection all or any of these records upon request by the administering authority for a period of five (5) years.

A7 All monitoring referred to in this environmental authority shall be undertaken by a suitably competent person using monitoring equipment that is accurately calibrated and maintained in good working order and condition.

A8 All analyses and tests required to be conducted under this environmental authority must be carried out by a laboratory that has NATA certification for such analyses and tests, except as otherwise authorised by the administering authority.

Financial Assurance

A9 The Environmental Authority holder must provide a financial assurance of an amount determined by the administering authority in accordance with the Department of Environment and Resource Management's Guideline – Financial Assurance for Mining Activities, and in a form acceptable to the administering authority. The financial assurance must remain in force until the administering authority is satisfied no claim on the assurance will be required.

Risk Management

A10 The holder of this environmental authority must develop and implement a risk management system for mining activities by 1 January 2012 which conforms to the Australian Standard for Risk Management (AS/NZ 4360:2004) or the latest edition of Australian Standard for Risk Management.

Emergency Response / Contingency

A11 An emergency response / contingency plan must be developed and implemented to respond to emergency events and incidents. This plan is to be provided upon request to the administering authority.

A12 The emergency response / contingency plan must address, without limitation, the following matters:

(a) timely and accurate reporting of the circumstance and nature of incidents to the administering authority; and,

(b) procedures for accessing monitoring points during incidents; and,

(c) procedures to notify any person who may be affected by the event within 24 hours or as soon as reasonably practicable thereafter, with the following information to be provided at a minimum:

i. the location of the release; and,

ii. the date and time of the release; and,

iii. the estimated quantity and type of any substances (if in available concentrations) involved in the incident; and,

iv. the potential impacts to environmental values, livestock and public health caused by the release.

Notification of Emergencies, Incidents and Exceptions

A13 The holder of this environmental authority must notify the administering authority by telephone, email or facsimile, as soon as reasonably possible (no later than 24hrs) after becoming aware of:

(a) any emergency or incident which results in the release of contaminants not in accordance with, or reasonably expected to be not in accordance with the conditions of this environmental authority, or,

(b) any monitoring result that indicates an exceedance of any environmental authority limit.

A14 The notification must include but not be limited to the following:

(a) the environmental authority number and name of the holder; and,

(b) the name and telephone number of the designated contact person; and,

(c) the location of the emergency or incident; and,

(d) the date and time of the incident; and,

(e) the time the holder of this environmental authority became aware of the incident; and,

(f) the estimated quantity and type of substances involved in the incident, if known; and,

(g) the cause of the incident if known; and,

(h) a description of the nature and effects of the incident including risks to the environment, public health or live stock, if known; and,

(i) immediate actions taken to prevent or mitigate any further environmental harm caused by the release; and,

(j) details of any notification of persons who may be affected by the event.

A15 Within fourteen (14) days or as otherwise agreed, following the initial notification of an emergency, incident or exceedance, further written advice must be provided to the administering authority including the following:

(a) results and interpretation of any samples taken and analysed; and,

(b) outcomes of actions taken at the time to prevent or minimise unlawful environmental harm; and,

(c) proposed actions to prevent a recurrence of the emergency or incident.

Transition to New Standards

A16 Where a condition requires compliance with a standard published externally to this environmental authority and the standard is amended or changed subsequent to issue, the holder of this environmental authority must:

(a) comply with the amended or changed standard within 2 years, unless a different period is specified in the amended standard or relevant legislation; and

(b) until compliance with the amended or changed standard can be achieved, continue to remain in compliance with the standard that was current immediately prior to the relevant amendment or change.

Complaints

A17 Records must be kept of all environmental complaints received about the mining activities including the following details and must be made available for inspection by the administering authority on request:

(a) name, address and contact number for complainant, if known; and,

(b) time and date of complaint; and,

(c) reasons for the complaint; and,

(d) investigations undertaken; and,

(e) conclusions formed; and,

(f) actions taken to resolve complaint; and,

(g) any abatement measures implemented; and,

(h) person responsible for resolving the complaint.

A18 When requested by the administering authority, the holder of this environmental authority must undertake relevant specified monitoring within a timeframe agreed to by the administering authority to investigate any complaint of environmental harm considered in the opinion of an authorised officer not to be vexatious and frivolous. The results of the investigation (including an analysis and interpretation of the monitoring results) and abatement measures implemented must be provided to the administering authority within fourteen (14) days of completion of the investigation.

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Third Party Auditing

A19 Compliance with the conditions of this environmental authority must be audited within one year of the commencement of this environmental authority by a suitably qualified third party auditor and then at regular intervals not exceeding once every three years. A copy of the final audit report will be submitted to the administrating authority upon request.

A20 The holder of this environmental authority must promptly take necessary action to ensure compliance with the conditions of the environmental authority in the event that the audit finds non-compliance.

END OF CONDITIONS FOR SCHEDULE A

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3.3 Air Quality

3.3.1 Value/Background

The relevant environmental values to be enhanced or protected are defined by the *Environmental Protection (Air) Policy 2008* (Qld) (EPP (Air)) as:

- the qualities of the air environment that are conducive to protecting the health and biodiversity of ecosystems; and
- the qualities of the air environment that are conducive to human health and wellbeing.

The Project area is situated in a mostly undeveloped and remote part of Cape York. Bushfires are common and result in particulate and greenhouse gas emissions. To the north of the Project area are the townships of Weipa and Napranum, and to the south the township of Aurukun (see **Figure 1**). There are several homesteads on the remote cattle stations to the east of the Project area. The nearest sensitive receptors are shown on **Figure 8**.

Particulate Matter (Dust)

The air environment of the Project area is described in detail in RTA (2010). The ambient dust levels for Weipa, Napranum and Aurukun that have been adopted are based on Pacific Air and Environment (PAE 2004) data and are summarised in **Table 3-1**. The levels for $PM_{2.5}$ were derived based on the *Queensland 2007 Air Monitoring Report* (EPA 2008), which showed the ratio of $PM_{2.5}$ to PM_{10} in ambient air is approximately 1:2.4 for urban areas where motor vehicles are a large source of $PM_{2.5}$ emissions. For rural areas a ratio of 1:3 was adopted. The ambient air quality values for total suspended particulate (TSP) and deposited dust were based upon the consultant's knowledge of monitoring in north Queensland, and are shown in **Table 3-1**.

Table 3–1 Ambient Air Quality

Indicator	Ambient Air Quality	Averaging Period
$PM_{2.5}$	7 µg/m^3	24 hours
PM_{10}	22 µg/m^3	24 hours
TSP	23 µg/m^3	Annual average
Deposited dust	50 mg/m^2/day	30 days ± 2 days

The ambient levels for Napranum and Aurukun will be likely to be lower than Weipa due to the increased distance from existing dust sources. However, as air quality criteria are based on health protection criteria rather than ambient levels, the higher the ambient level assumed for the modelling, the more conservative the approach. Therefore, the ambient levels are assumed to be the same across Weipa, Napranum and Aurukun.

SOx and NOx

There have not been any measurements of existing levels of NO_x or SO_2 in Weipa. The existing power station and vehicle fleet in the region would be the main contributors. The *Queensland 2007 Air Monitoring Report* (EPA 2008) states the annual mean for NO_2 is between four parts per billion (ppb) and 8ppb for various industrial locations in Queensland. For SO_2, the annual mean is reported to be between one and 2ppb. The maximum one-hour NO_2 level is typically 40ppb. For SO_2 the level is typically 5ppb for the maximum one-hour and 3ppb for the maximum 24-hour average. These values have been adopted as ambient concentrations for the Project area. Given they mostly relate to industrial areas (Townsville, Gladstone, etc) they are likely to be elevated compared to existing levels in Weipa. As for particulates, this is a conservative approach to the modelling given that air quality criteria are based on health protection criteria rather than ambient levels.

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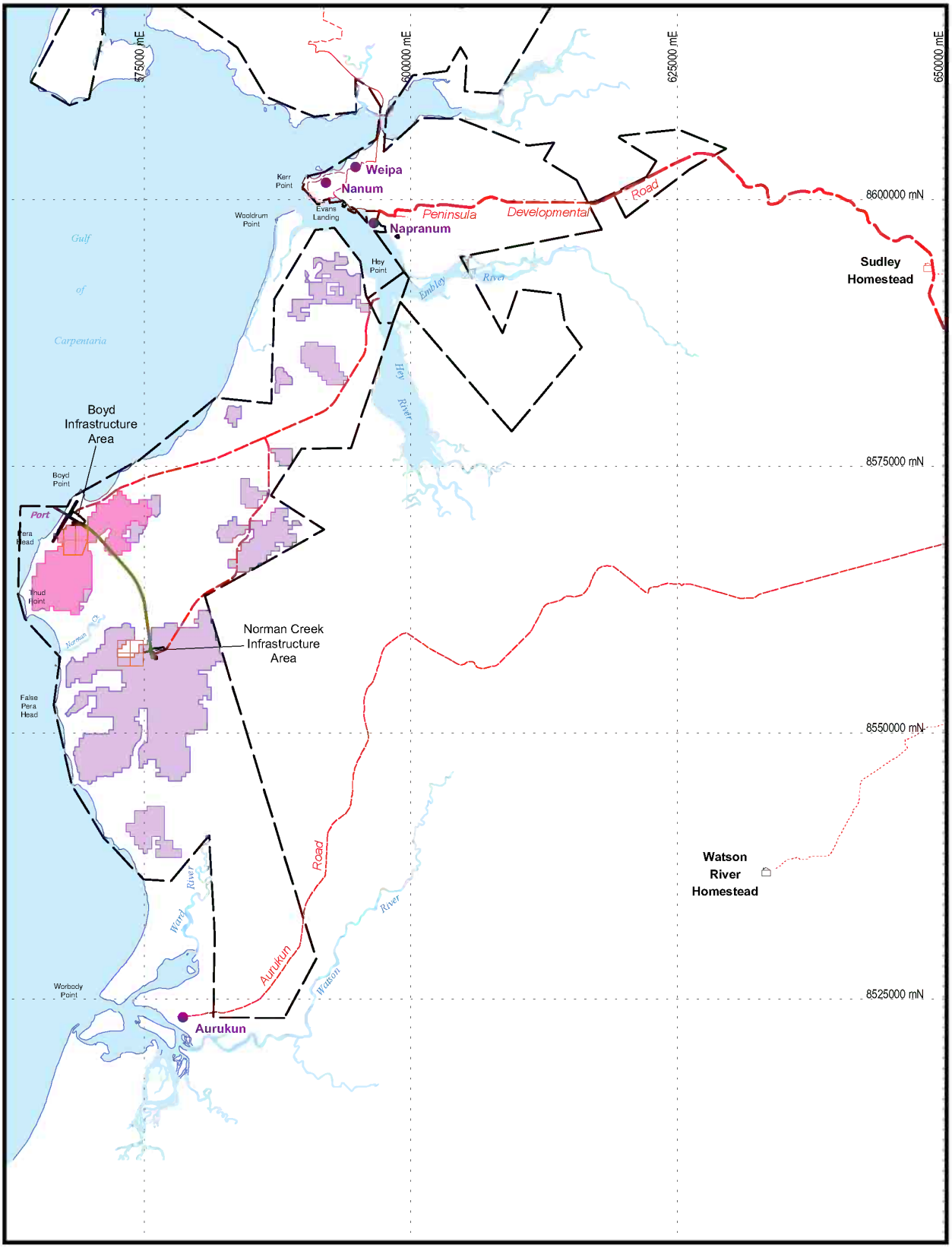

P:\RTA\Plans\SoE\2010\EM Plan\Fig 8 Sensitive Receptor Locations.wor

Rio Tinto Alcan

- RTA Mining Lease boundary
- Township (Sensitive Receptor)
- Homestead (Sensitive Receptor)
- Road/track
- Tailings storage facility
- Mining Years 1 -13
- Mining Years 14 - 40

South of Embley Project

Fig 8: Sensitive Receptor Locations

N

5 0 5 10km

Datum/Projection: GDA94/MGA Zone 54 Date: 01/04/2011

Visual Amenity and Light

Due to the remote location of the site there are currently no permanent lighting sources in the Project area.

There are no permanent residences in the Project area. The nearest residential areas are in Weipa and Napranum, located north of the Project area, and Aurukun located to the south. These communities are located away from the main Project components. There are no gazetted public roads that traverse the Project area and hence no viewpoints accessible from public roads. However, the general public do use various tracks in the Project area. Members of the general public wishing to access the lands covered by the Project area require a permit from the Aurukun Shire Council.

Traditional Owners regularly visit outstations in the Project area, including Amban (False Pera Head), Waterfall (near Ina Creek), and Six Ti-Tree (located a short distance south of Ina Creek) during the dry season to go camping, fishing and undertake other activities. The major Project components are not visible from these locations, however they may be visible from roads accessing these areas.

The barge/ferry terminals involve minor developments on the shoreline of the Embley and Hey Rivers that have low impact on visual amenity. The Humbug and Hornibrook terminals are located among existing lighting sources and the changes will have low impact. The Hey River terminal is located within an undeveloped section of the Hey River and is not directly visible from Napranum. A low glow from lighting at the terminal may be visible, however it is expected this would have low impact.

Altered light regimes can affect nesting adult female turtles and hatchlings, therefore the environmental value of the visual environment to be enhanced or protected near the port are the qualities that make the area suitable for turtle breeding.

3.3.2 Objectives

The environmental protection objective for air quality is to minimise the impacts of mine-derived air pollutants on sensitive receptors beyond the boundaries of the SoE Project.

The environmental protection objective for lighting is to minimise the impacts of lighting on marine turtles.

3.3.3 Commitments

Performance Criteria

The performance criteria for air quality are:

- Compliance with the requirements of the environmental authority (including proposed limits shown in **Table 3-2**); and
- The number of air quality complaints in relation to SoE operations.

Table 3–2 Proposed SoE Air Quality Criteria

Indicator	Receptor	Air Quality Objective	Units	Averaging Period	Comment	Source
PM_{10}	Residences	50	$\mu g/m^3$	24 hours	Not to be exceeded on more than five days per year	EPP(Air)
TSP	Residences	90	$\mu g/m^3$	one year		EPP(Air)

The performance criteria for lighting are:

- Monitoring carried out for turtles in accordance with monitoring plan; and
- The number of lighting complaints in relation to SoE operations.

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Implementation Strategy

Particulate Matter

The predicted particulate concentrations at the sensitive places closest to the Project are shown in **Table 3-3**. The ground level concentrations at the sensitive places include the ambient background concentrations.

Table 3–3 Predicted Particulates at Sensitive Residential Receptors at 50Mdptpa

Receptor	Predicted Particulate Levels For Sensitive Receptors (including ambient levels)				
	Maximum PM_{10} (24 hour) – Fifth highest in a year [µg/m^3]	Maximum $PM_{2.5}$ (24 hour) [µg/m^3]	$PM_{2.5}$ (annual average) [µg/m^3]	Total Suspended Particulate (TSP) (annual average) [µg/m^3]	Dust deposition (highest month) [mg/m^2/day]
Proposed Criteria	**50**	**25**	**8**	**90**	**120**
Existing Ambient	**22**	**8**	**2**	**23**	**50**
Weipa	24	10	2	23	51
Napranum	27	9	2	23	51
Aurukun	27	10	2	23	52

The model incorporates standard dust-suppression techniques, such as haul-road watering. The particulate emissions from the Project are expected to readily comply with all particulate air quality objectives at the nearest sensitive places. Apart from the conventional haul-road watering and water sprays on chutes where trucks dump crude ore into the beneficiation plant, which was incorporated into the modelling, no further mitigating measures are required.

SOx and NOx

SO_2 and NO_2 concentrations at the sensitive places closest to the Project are shown in **Table 3-4**. The ground level concentrations at the sensitive places include the ambient background concentrations.

Table 3–4 Predicted NO_2 and SO_2 Concentrations at Sensitive Residential Receptors at 50Mdptpa

Receptor	Predicted Concentrations for Sensitive Receptors				
	Maximum NO_2 (one hour) [ppb]	Annual Average NO_2 [ppb]	Maximum SO_2 (one hour) [ppb]	Maximum SO_2 (one day) [ppb]	Annual Average SO_2 [ppb]
Proposed Criteria	**120**	**30**	**200**	**80**	**20**
Existing Ambient	**40**	**6**	**5**	**3**	**1.5**
Weipa	52	6	6	3	1.5
Napranum	51	6	6	3	1.5
Aurukun	51	6	5	3	1.5

The NO_2 and SO_2 concentrations from the Project are expected to comply with all air quality objectives at the nearest sensitive places. There is no need for any mitigating measures.

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Lighting

A lighting plan has been developed to minimise impact to turtles, which will include the following:

- Ensuring lighting is minimised overall to that which is essential for safe and efficient operation of the facility;
- Installation of timer switches or movement sensors where applicable;
- Shielding and/or recessing of lights to minimise light spill;
- Installation of long wavelength lights; and
- Any other lighting options that further reduce impacts to marine turtles while allowing for the safe and efficient operation of the port facility.

Monitoring

Weipa operations currently conduct PM_{10} monitoring at four locations, including Weipa and Napranum. No further monitoring is proposed, due to the low risk of impact.

A monitoring program would be developed for turtle-nesting activities (number, type, predation, success), behaviour (hatchling activity), and incident reporting.

3.3.4 Proposed Environmental Authority Conditions: Schedule B – Air

Note: The draft conditions in this Schedule are subject to change due to the pending approval of the ML7024 Environmental Authority for the existing Weipa mining operations.

General

B1 The release of dust, noxious or offensive odour or any other airborne contaminants resulting from the mining activities must not cause unauthorised environmental harm at any sensitive place or commercial place.

B2 The holder of this environmental authority must ensure that vehicles (including trains) used for transporting bulk materials from the mining lease, leave the mining lease with appropriate load preparation to minimise the spillage and/or loss of particulate matter and/or windblown dust during transport.

B3 In the event of a complaint made to the administering authority (which in the opinion of an authorised officer is considered neither frivolous nor vexatious) about airborne contaminants generated in carrying out the authorised activity in the South of Embley Project area must not exceed the following levels when measured at any sensitive or commercial place:

(a) Dust deposition of 120 milligrams per square metre per day, averaged over one month, when monitored in accordance with the most recent version of Australian Standard AS3580.10.1 *Methods for sampling and analysis of ambient air – Determination of particulate matter – Deposited matter – Gravimetric method.*

(b) A concentration of particulate matter with an aerodynamic diameter of less than 10 micrometres (PM_{10}) suspended in the atmosphere of 50 micrograms per cubic metre over a 24 hour averaging time*, when monitored in accordance with the most recent version of the relevant Australian Standard for measuring 10 micrometres (PM_{10}) suspended . (*5 days exceedance allowed each year including natural causes)

(c) A concentration of particulate matter suspended in the atmosphere (TSP) of 90 micrograms per cubic metre over a one (1) year averaging time, when monitored in accordance with the most recent version of the relevant Australian Standard for measuring TSP.

B4 If monitoring indicates the airborne contaminants specified in Condition (B3) have been exceeded, the holder of this environmental authority must compare the results of the impacted site to that of the reference monitoring site. If the level of airborne contaminants at the impacted site does not

exceed the reference monitoring site, then no action is to be taken and the contaminants will be regarded as not having been generated in the carrying out of the authorised activity.

Ambient Air Quality Monitoring

B5 Prior to commencement of construction for the South of Embley Project, the holder of this environmental authority must review the existing Weipa Ambient Air Quality Monitoring Program to ensure adequacy for the South of Embley Project or prepare a new Ambient Air Quality Monitoring Plan for the South of Embley Project for monitoring particulate emissions at the locations identified in Table B1 – Location of Ambient Air Quality Monitoring Stations.

Table B1 – Location of Particulate Monitoring Stations

Site	Latitude (GDA94)	Longitude (GDA94)	Location
Compliance			
1	8602161	593928	Nanum
2	8599189	597145	Napranum
3	8604509	596646	Rocky Point
Reference			
4	8604828	618016	Scherger RAAF Base

Light

B6 In the event of a complaint about light emissions from any mining activity that, after investigation is in the opinion of an authorised person causing a nuisance at a sensitive place, the administering authority may request the holder of this environmental authority to take appropriate action to mitigate the nuisance and the holder must take appropriate action (e.g. by screening or directing the light away from the sensitive place) within a time set by the administering authority.

Point Source Releases to Air – South of Embley Power Stations

B7 Power station emissions must only be released to the atmosphere from the release points specified in Table B2 – Release Points.

Table B2 - Release Points – South of Embley

Release Point / Monitoring Location	Source Description	Minimum Release Height (m)	Minimum Exit Gas Temperature (^{0}C)	Minimum Efflux Velocity (m/s)
SoE power station	Boyd infrastructure area	6	300	15

B8 Except during engine start up, maintenance and engine shut down, the release of contaminants at the locations specified in Table B2 – Release Points must be:

(a) directed vertically upwards with no impedance; and
(b) in accordance with the criteria listed in Table B2 – Release Points.

B9 Prior to commissioning the South of Embley Power Station, the holder of this environmental authority must review the existing Weipa Stack Emission Monitoring Program (SEMP) to ensure adequacy for the South of Embley Project or develop a new Stack Emission Monitoring Program

(SEMP) for the South of Embley Project. The SEMP must be implemented within three months of commissioning to monitor and record the release of contaminants from the South of Embley Power Station. A copy of the draft SEMP must be provided to the administering authority prior to its implementation and due consideration given to any comments made on the SEMP by the administering authority.

B10 The holder of this environmental authority must develop and implement and keep records of a monitoring program of contaminant releases to the atmosphere at the release points identified in Table B2 – Release Points at a frequency and for the contaminants specified in Table B3 – Monitoring of Contaminant and which complies with the following:

(a) monitoring provisions for the release points must comply with the most recent edition of Australian Standard *AS4323.1 Stationary source emissions method 1: Selection of sampling provisions*; and,

(b) all determinations of contaminant releases to the atmosphere must be made in accordance with methods prescribed in the most recent version of the Department of Environment and Resource Management *Air Quality Sampling Manual*. If monitoring requirements for specific contaminants are not described in the *Air Quality Sampling Manual*, monitoring protocols must be in accordance with a method as approved by New South Wales DEC/EPA, Victorian EPA or United States EPA; and,

(c) the following tests must be performed for each sample taken at each release point specified in Table B2 - Release points:
(i) gas velocity, volume and mass flow rate; and,
(ii) temperature and oxygen content; and,
(iii) water vapour concentration (for non-continuous sampling).

(d) samples taken must be representative of the contaminants discharged when operating under maximum operating conditions; and,

(d) during the sampling period the following additional information must be gathered:
(i) plants throughput rate at the time of sampling; and,

(ii) fuel type and consumption rate; and,

(iii) any factors that may influence odour and particulates emissions; and,

(iv) the odour and particulates treatment system operating, system status and rate; and,

(v) reference to actual test methods and accuracies.

Table B3 – Monitoring of Contaminants

Contaminant	Minimum Monitoring Frequency
Oxides of Nitrogen (expressed as NO_2)	All stacks must be monitored within three months of commissioning and annually thereafter.
Carbon Monoxide	

Meteorological Monitoring

B11 Under circumstances where relevant wind, temperature and rainfall data cannot be provided to the holder of this environmental authority from the Weipa meteorological station operated by the Bureau of Meteorology, the holder must deploy, as soon as reasonably practicable, a portable automatic meteorological station to continuously measure and record wind speed and direction, temperature and rainfall data when and where these data measurements are required.

B12 The portable meteorological station must be installed in accordance with the latest edition of the Bureau of Meteorology - Observation Specification No.2013.1 - Guidelines for the siting and exposure of meteorological instruments and observing facilities.

B13 The holder of this environmental authority must record, compile, evaluate and keep all monitoring records obtained from the portable automatic meteorological station.

END OF CONDITIONS FOR SCHEDULE B

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3.4 Greenhouse Gas Emissions

3.4.1 Value/Background

The environmental values of the air environment to be enhanced or protected are the qualities that make the air environment suitable for the life, health and well-being of humans.

A summary of the projected greenhouse gas (GHG) emissions is shown in **Table 3-5**. The estimate of emissions from all Project components under the 50Mdptpa production scenario is 508kt CO_2-e per annum. By comparison, GHG emissions in Australia were estimated to be 537,000kt CO_2-e in 2009 (DCCEE 2010a) and 181,000kt CO_2-e from Queensland in 2007 (DERM 2009a).

Similar to current Weipa operations, land clearing is the main source of GHG emissions. At higher mining rates there is greater operational efficiency as the intensity of GHG emissions are predicted to decrease from 0.0121t CO_2-e/t bauxite under the 15Mdptpa production scenario to 0.0102t CO_2-e/t bauxite under the 50Mdptpa production scenario. The estimate of diesel used for power generation includes electricity supply to Weipa township.

Table 3–5 Predicted Energy Use and Greenhouse Gas Emissions at 15, 30 and 50Mdptpa

Production Rate		Units	15Mdptpa	30Mdptpa	50Mdptpa
Input Data	Diesel used for power generation*	kL	26,100	46,100	70,100
	Diesel used for transport	kL	11,700	23,100	38,400
	Cleared land	ha	500	580	1,360
	Rehabilitated land	ha	290	850	1,360
Greenhouse Gas Emissions	Power generation	t CO_2-e	69,740	121,100	187,400
	Transport	t CO_2-e	31,600	62,300	103,500
	Vegetation cleared	t CO_2-e	81,700	138,800	222,100
	Less vegetation sink (rehab)	t CO_2-e	1,100	3,300	5,300
	Total	t CO_2-e	181,840	318,900	507,700
	Intensity	t CO_2-e / t bauxite	0.0121	0.0106	0.0102

* Includes electricity supply for Weipa which would be supplied from the existing East Weipa power station.

Conversion factors and methodology described in DCCEE (2010b).

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3.4.2 Objectives

The environmental protection objective for GHG is to minimise GHG emissions.

3.4.3 Commitments

Performance Criteria

Greenhouse gas performance will be measured as emissions of greenhouse gases (CO_2 equivalents) per tonne of bauxite produced.

Overall efficiencies will be gained as production increases, as shown in **Table 3-5**. However, within each production scenario, greenhouse gas emissions will vary considerably from year to year, depending on production levels and activities. For example, areas close to the beneficiation plants are likely to be mined first, which means haul distances will increase over time, decreasing the greenhouse gas efficiency of production.

Implementation Strategy

To ensure greenhouse gas generation from the Project is minimised to the extent practicable, the following actions will be undertaken:

Engineering and design

- diesel efficiency considerations will be included in assessments of new mobile and fixed equipment to optimise diesel use and reduce GHG emissions from combustion; and
- electrical efficiency considerations will be included in assessments of fixed plant and equipment to reduce on-site electricity and hence diesel use.

Training

- greenhouse gas awareness training will occur at induction to make employees aware of the science of climate change and efforts to minimise emissions.

Operations and maintenance

- equipment will be regularly maintained to retain high levels of diesel and electrical efficiency;
- a process for regular review of new technologies to identify opportunities to increase diesel and electrical efficiency will be adopted;
- vegetation clearing will be minimised to that essential for the Project;
- progressive rehabilitation will be undertaken; and
- mine plans will be optimised to ensure haul routes are planned efficiently.

RTA will participate in relevant research, development and improvement programs to identify energy efficiency and greenhouse abatement opportunities. RTA will also continue to participate in the Australian Government Energy Efficiency Opportunities (EEO) program, which encourages large, energy-using businesses to improve their energy efficiency.

Monitoring

The following monitoring will be undertaken:

- regular energy audits will be conducted to identify inefficient equipment or operating procedures;
- diesel use will be measured;
- an inventory of GHG emissions and sinks will be developed and maintained; and
- GHG emissions from all relevant activities will be reported externally in accordance with the Commonwealth Government's *National Greenhouse and Energy Reporting Act 2007*.

Environmental authority conditions are not applicable for greenhouse gas as greenhouse gas emissions are managed under legislation other than the EP Act.

3.5 Water Resources

3.5.1 Value/Background

The environmental values of waters to be protected are defined by the *Environmental Protection (Water) Policy 2009* (Qld) (EPP Water) as:

- biological integrity of a slightly modified aquatic ecosystem;
- suitability for recreational use;
- suitability for minimal treatment before supply as drinking water;
- suitability for agricultural use; and
- suitability for industrial use.

Surface Water

There are no pre-existing surface water dams or weirs in the Project area. The surface waters of the Project area are used by Traditional Owners and visitors for fishing, camping and recreation. RTA uses very small amounts of surface water during mineral exploration activities. There are no cattle in the Project area.

Detailed baseline surface water resource studies are described in RTA (2010). The principal catchments in the Project area are presented in **Table 3-6**.

Table 3–6 Catchment Areas

Project Area Catchments	**Area (km^2)**
Hey River	756
Triluck Creek	108.4
Winda Winda Creek	93.9
Norman Creek (all tributaries)	259.0
Ina Creek	65.4
Ward River sub-catchment	186.9
Coconut Creek	119.2
Tappelbang Creek	126.9
Sandy Creek	105.2
Possum Creek	130.5
Ward River (all tributaries)	665.8
Adjacent Catchments	**Area (km^2)**
Embley River	1000
Watson River	2872

The Watson River drains a relatively small area in southern extremity of ML 7024.

The proportion of surface runoff (<1%) is unusually small and reflects the flat topography and the very high infiltration rates of the soils and lateritic strata. The consequence of this is streamflow does not respond quickly to incident runoff until after the catchment is "wetted up" and there is no "first-flush" response to rainfall at the start of the wet season. Wet-season rainfall typically commences in November but it is usually not until January, after soil moisture stores are filled, that streams show appreciable flow. Thereafter, flows rise until March or April in response to wet-season rainfall and then decline once rainfall ceases. In lower catchment locations within the Project area, flows may persist until late in the dry season.

Proposed mining activities may result in impacts to surface water hydrology and quality. The Project area is not grazed and no rural homesteads are located near the Project area, therefore dams within the Project area are not accessible to stock.

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Groundwater

The hydrogeology and groundwater quality of the Project area are described in detail in RTA (2010).

The groundwater bodies in the area have been differentiated as shallow aquifer and artesian aquifer resources. The artesian resources are hosted within the Gilbert River formation and Garraway Beds, and the shallow aquifer resources are those occurring within the formations above the Rolling Downs Group.

Proposed mining activities may result in impacts to groundwater hydrology and quality.

3.5.2 Objectives

The environmental protection objectives for water resources are to:

- minimise impact on water quality and biological characteristics of surface and groundwaters;
- maintain surface water amenity values for the local community; and
- maintain suitability of surface and groundwaters for potable, agricultural and industrial use.

3.5.3 Commitments

Performance Criteria

The performance criteria for water resources are:

- compliance with the requirements of the environmental authority;
- compliance with the requirements of the existing groundwater licence; and
- groundwater and surface water monitoring in accordance with the monitoring program.

Implementation Strategy

Water Supply

The Project's principal water requirements are for process water, haul-road watering, vehicle wash-down, dust suppression and potable supplies. Typically, water would be drawn in order of preference from tailings recycle, recovery slots, surface water dam (Dam C), and artesian bores. Some supplementary surface water will be drawn directly from the Ward River to minimise the risk of inadequate supply from Dam C. A detailed water balance is provided in RTA (2010) and the overall water balance for the Project is summarised in **Table 2-1**.

The locations of water management infrastructure are shown in **Figure 4** and **Figure 5**. Schematic diagrams of the proposed Boyd and Norman Creek water management systems are shown in **Figure 6** and **Figure 7** respectively.

A water supply dam (Dam C) is on a freshwater tributary of Norman Creek (refer **Table 3-7**). If constructed in two stages, the first stage would provide 10.9GL storage capacity and, later, the wall would be raised to provide 29GL storage capacity. The dam would be constructed in a single stage (29GL capacity) should expansion of production above 15Mdptpa be anticipated to occur quickly, or should an initial production capacity of 22.5Mdptpa be adopted. This is the subject of ongoing feasibility studies.

In order to maintain the reliability of the overall surface water supply at production levels of 30Mdptpa and above, some water would be pumped directly from the lower reaches of the Ward River to supplement the Dam C supply.

Process water ponds in each of the mine infrastructure areas have been designed to contain three days supply of water for the beneficiation plants, dust suppression, and other industrial uses.

Table 3–7 Water Supply Dam Summary

	Dam C	
	At 10.9 capacity	At 29.0GL capacity
Total catchment area (km^2)	259.0	
Dam catchment area (km^2)	77.3	
Dam catchment as % of total catchment	29.8%	
Maximum dam volume (GL)	10.9	29.0
Dam surface area (km^2) (at spillway)	3.6	6.5
Dam wall height (m) (at spillway)	8.0	12.0
Freeboard above spillway (m)	2.75	2.75

The artesian demand will fluctuate depending on whether there is above or below average rainfall runoff into the water supply dam. RTA has an existing artesian water licence for 9GL per annum which allows abstraction of underground water from the Gilbert River Formation and from the Garraway Beds from bores located on ML 7024. RTA proposes to apply to increase the artesian allocation to cover the fluctuations in artesian demand. It is proposed that a three-year moving average of 12GL per annum be established, with a peak abstraction of 15GL in any one year. The impact of abstraction on the artesian aquifer has been modelled and is discussed in RTA (2010).

RTA also has an existing shallow aquifer water licence for 15.77GL per annum, which allows abstraction of underground water from Weipa Tertiary Sediments under ML 7024.

Treated effluent from the construction camp would be recycled for dust suppression, landscape watering or other appropriate uses on-site suitable for the quality of water. Treated effluent from the Boyd and Norman Creek sewage treatment plants would be recycled and used as process water. Refer to **Section 3.9** for further discussion of the management of sewage.

The Project potable water requirements are small, 15ML per annum under the 15Mdptpa production scenario rising to 30ML per annum under the 50Mdptpa production scenario. A reverse osmosis potable water treatment plant is used to treat raw water to a standard that meets the *Australian Drinking Water Guidelines* (NHMRC 2004).

Dam Design Criteria

The dams in the Project area have been assessed against the DME/DEH (1995) *Site Water Management* guidelines and a summary is shown in **Table 3-8**.

Table 3–8 Dam Hazard Assessment

	Wall height >8m?	Exceeds contaminant concentration trigger?	Hazard Category Assessment (DME/DEH 1995)	Design Storage Allowance requirement?
Dam C (water storage)	Yes	No	Not applicable to water supply dams	No
Tailings storage facilities	Yes	No	Significant (for dam break) Significant (for discharge)*	Yes
Process water ponds	No	No	Low	No
Sediment ponds	No	No	Low	No
Industrial area drainage slots	No	No	Low	No
Recovery slots	No	No	Low	No

*** Even though the tailings have low-toxicity, a conservative approach has been adopted and a "significant" hazard category assigned for discharge. The design criteria would be reviewed whenever the guidelines are updated by DERM.**

The Australian National Committee on Large Dams (ANCOLD 2000) provides hydrologic design criteria for spillways based on downstream flood hazard. Dam C represents a low to significant incremental flood hazard category and, as such, the spillway should be designed to pass a 1:1000 Annual Recurrence Interval (ARI) storm event as a minimum. A 1:1000 ARI storm event is considered a rare event (IEA 2001). The dam spillway will be designed to pass the peak flow from a 1:2,000 ARI flood event. The spillway will be at a low gradient (<3%) and be designed to facilitate fish passage during spillway flow events.

The process water ponds and tailings storage facilities are constructed as "turkey's nest" dams, meaning they only capture the rainfall that falls directly on the dam impoundment. None of these dams contain contaminants in concentrations that are hazardous.

The hazard category of the tailings storage facilities has been rated as "significant" for a dam break scenario in accordance with the DME/DEH (1995) *Site Water Management* guidelines. For the purposes of determining a design storage allowance, a conservative approach has been adopted and a "significant" hazard category assigned for discharge due to the presence downstream of listed threatened flora and fauna, even though the tailings are low toxicity. The design criteria would be reviewed whenever guidelines are updated by the Department of Environment and Resource Management.

The process water ponds are "low" hazard category (DME/DEH 1995) and therefore will be designed for a spillway critical design storm of 1:100 year ARI. The process water ponds will be designed to operate a freeboard equivalent to a 24-hour 1:100 year ARI rainfall event.

The mine industrial area drainage slots and the stockpile sediment ponds receive stormwater runoff. These ponds will be sized to a volume equivalent to the runoff volume from a 1:10 ARI 24-hour rainfall event, plus 20% for sediment storage. The water from these ponds will be pumped to either the process water pond or the tailings storage facility.

Stormwater runoff generated within active mine areas is predominantly contained within the internally draining mine pits. The post-mining landscape effectively provides internally draining sumps that contain stormwater runoff, which then infiltrates through the pit floor and walls. In the event the active pit or post-mining topography is not an internally draining pit, stormwater runoff would be directed via a sediment pond.

The Mine Access Road alignment follows elevated portions of the landscape wherever possible to enable all weather access; however, box culvert causeways would be required at certain watercourses. The Norman Creek access road and certain internal mine haul roads will also require box culvert causeways for a number of watercourse crossings. Sediment traps would be included as part of the drainage designs at points where haul roads cross watercourses.

Catchment Hydrology

Modelling described in RTA (2010) indicates the overall impact of mining on catchment discharge is very much less than the normal year-to-year variation driven by rainfall variation. This is consistent with the calibrated rainfall-runoff model, which shows surface runoff is extremely low and hence changes to surface drainage patterns have little impact on overall discharge into streams.

The impact of Dam C on downstream flow was modelled using a daily rainfall-runoff model (Boughton's Australian Water Balance Model (AWBM)) embedded in a GoldSim model that takes into account inputs (catchment runoff, direct rainfall) and outputs (pumped withdrawals, evaporation, evaporation, seepage, spillway overflow and environmental releases) (RTA 2010). Dam C leads to an appreciable annual decline (>20%) in flows immediately downstream on that particular branch of the Norman Creek. However, when the catchment is considered as a whole, the overall decline is (<15%) well within the range of normal year-to-year variation.

Dam C is fitted with a low-level outlet pipe, which permits the controlled release of environmental flows when required. Sufficient water is reserved for environmental flows to enable continued releases in the driest months (August to October) of a volume equivalent to 25% of dam inflows. The pipe is sized to enable peak discharge of up to 1000L/s, if required. When dam inflows cease, environmental flow releases cease. Once the dam is full following the onset of the wet season, the spillway would typically overflow on a regular basis. If environmental flow releases are required during the wet season, they would commence after the dam is full.

The GoldSim daily water balance model was also used to estimate Ward River flow at the pump station and the pumped volumes (RTA 2010). The overall impact of pumping on the Ward River hydrological regime is minor. The annual volume of water pumped from the Ward River would be capped at 1% of mean annual river flow at the pump station (2.67GL). In addition, no pumping would occur when Ward River flow was less than 1000L/s and the rate of pumping at all times would be less than 20% of the river flow rate.

Erosion and Sedimentation

Erosion rates from active mining areas are higher than from un-mined areas. In the wet season, increased erosion is expected to occur during mining operations from activities such as soil stripping, mining, and haul-road construction. However, due to pit layout and topography, rainfall runoff will be predominantly retained within the mined areas.

Some elevated sediment concentrations are also expected to occur in storm water runoff from ore processing and stockpile areas. Runoff and sediment collected from catch trays, belt scrapings, and the sealed maintenance area on the wharf will be pumped back to the wharf drainage sump on shore.

The following principles will be applied in the management of stormwater discharge:

- the *Engineering Guidelines for Queensland for Soil Erosion and Sediment Control* (IE Aust 1996) will be followed;
- land disturbance will be restricted to that necessary for the works;
- topsoil will be salvaged for use in rehabilitation;
- outflow will be passed from the sediment dams via engineered spillways to adjacent waterways;
- stormwater and runoff from upstream catchments will be diverted away from active mining and disturbed areas;
- drains will be protected to prevent scouring if necessary;
- sediment dams will be de-silted and cleaned periodically;
- hazardous materials will be stored in bunded areas or stored such that contaminated runoff is not generated; and
- traffic will be confined to maintained tracks and roads.

Erosion and sedimentation control program will be included in site environmental procedures.

The water quality of natural surface drainage systems would be maintained by preserving riparian vegetation corridors. The buffer system will exceed the minimum requirements of the Queensland Government's *Regional Vegetation Management Codes* as they relate to clearing set-back distances from watercourses and wetlands (DERM 2009b). The retention of vegetation buffers around and adjoining surface drainage lines and wetland features provides effective management of elevated sediment load risks that would otherwise impact aquatic ecosystems. Areas that are disturbed by mining activities and infrastructure are to be rehabilitated to a stable landform with a self-sustaining vegetation cover.

Groundwater

The hydrogeology and groundwater quality of the Project area is described in detail in RTA (2010).

The existing water licence requires that drawdown does not exceed five metres at Bramwell Station, Batavia Downs and Weipa Crossroads monitoring bores. The modelling results (RTA 2010) indicate under the proposed licensed abstraction regime the existing water licence condition relating to maximum relative drawdown would be met. The modelling predicted the existing water licence condition relating to maximum relative drawdown would be met for both a 12GL and an 18GL per annum scenario. The results indicate the aquifer could sustainably support abstraction rates greater than the proposed rate of 12GL per annum (five-year moving average).

Section 39 of the *Great Artesian Basin Resource Operations Plan* (GAB-ROP) (DNRW 2007) prescribes conditions that must be met for the chief executive to make a decision about a water licence, if the decision is associated with a management unit connected to a spring, and the water is for purposes

other than domestic and stock watering. A decision associated with abstraction from a management unit connected to a spring is subject to the cumulative spring factor not exceeding 400mm head of water. The GAB-ROP (DNRW 2007) prescribes how the spring factors are to be calculated.

The proposed artesian groundwater abstraction from existing and proposed new bores will take water from the Gilbert River Formation, which is connected to watercourse and recharge springs. The spring factors for the closest recharge and watercourse springs have been calculated to demonstrate the cumulative spring factor limit of 400mm is not exceeded for any of the existing or proposed new bores.

The calculated spring factors represent the highest possible cumulative spring factor for each spring because the spring factors are calculated on the assumption that all 12GL per annum is abstracted from the closest bore. The calculated spring factors presented in **Table 3-9** are all well below the spring factor limit of 400mm head of water, demonstrating the spring factor requirement is met in all cases.

Table 3–9 Spring Factors

Spring Type	Spring ID	Distance from Closest Borefield (km)	Closest Borefield	Spring Factor Multiplier (from Table D-2)	Spring Factor (mm Head of Water) *(Spring Factor x 12,000 MLpa)*
Recharge	V512	110	Andoom	0.0003	3.6
Recharge	V511	107	Andoom	0.0004	4.8
Recharge	V499	113	Andoom	0.0002	2.4
Recharge	V498	112	East Weipa	0.0002	2.4
Recharge	V495	126	SoE	0	0
Recharge	V497	138	SoE	0	0
Watercourse	Palm Creek	84	Andoom	0.008	96
Watercourse	Oliver River	100	Andoom	0.0006	7.2
Watercourse	Wenlock River	87	Andoom	0.007	84
Watercourse	Wenlock River	94	East Weipa	0.004	48
Watercourse	Archer River	129	SoE	0	0
Watercourse	Coen River	154	SoE	0	0

Water Quality

Potential contaminant sources, such as ore, tailings, tailings liquor and stockpile runoff, have been analysed and reported in RTA (2010). The results are summarised below in terms of potential contaminant impacts to surface and groundwater:

- The results suggest bauxite stockpiles are unlikely to be a significant contributor of aluminium to surface water ecosystems via runoff. Tailings liquor and some tailings seepage waters may contain aluminium concentrations greater than 80th percentile calculated for any freshwater site in the Project area, but within the range found in late dry season sampling of site waters;
- The following metals were not detected in tailings liquor at concentrations greater than the reporting limit: arsenic, boron, cobalt, copper, lead, nickel, selenium, zinc and mercury. This, combined with the lack of enrichment in the ore (Geochemical Abundance Index (GAI) less than three, according to Bowen (1979)) indicates these elements are not considered potential constituents of concern for the Project area.
- Tailings solid and ore samples were collected for leach analyses using two analytical methods. Based on these results, leaching from either is not anticipated to have an adverse effect on surface or ground waters.

Water from the heavy and light vehicle wash bays will be treated in oil water separators prior to recycling.

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Aluminium, iron and manganese may be affected by geochemical changes arising from mining impacts or natural causes. In accordance with *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC/ARMCANZ 2000) it is proposed to set Project trigger values for aluminium, iron and manganese based on the 80th percentile of the baseline data set for fresh waters. If, during operations, the median concentration of aluminium, iron or manganese exceeds the Project trigger value, an investigation shall be carried out to determine the possible causes.

Water Management Plan

A Water Management Plan will be developed to address all aspects of water management and potential impacts to receiving environments. It will consist of:

(a) Contaminant Source Study;

(b) Site Water Balance and Model;

(c) Water Management System;

(d) Emergency and Contingency Planning; and

(e) Monitoring and Review.

Monitoring

Streamflow gauging stations will be installed upstream and downstream of Dam C, as well as in two Norman Creek sub-catchments (one to be mined and one non-mined "control"). When the Ward River pump station is installed, a stream gauging station will be installed on the river in the vicinity of the pump.

Surface water will be monitored for relevant physico-chemical parameters at monitoring points located in each of the major tributaries, upstream and downstream of mining activity, where possible, on a monthly basis until a statistical baseline is established (consistent with ANZECC requirements), and then quarterly.

Groundwater levels and relevant quality parameters will be monitored at locations upgradient and downgradient of the mine industrial areas and tailings storage facilities. Groundwater levels will also be monitored at eight locations upgradient, downgradient or within mining areas.

Treated sewage effluent will be monitored for *E. coli* as described in **Section 3.9**.

3.5.4 Proposed Environmental Authority Conditions: Schedule C – Water

Note: The draft conditions in this Schedule are subject to change due to the pending approval of the ML7024 Environmental Authority for the existing Weipa mining operations.

General

C1 Contaminants that will, or have the potential to, cause environmental harm must not be released directly or indirectly to any waters except as permitted under the conditions of this environmental authority.

C2 The maintenance and cleaning of vehicles and any other equipment or plant must not be carried out in areas from which contaminants can be released into any waters, roadside gutter or stormwater drainage system.

C3 All determinations of water quality must be:

(a) made in accordance with methods prescribed in the latest edition of the administering authorities *Monitoring and Sampling Manual*.

(b) carried out on representative samples.

C4 The following information must be recorded in relation to all water monitoring required under the conditions of this environmental authority and submitted to the administering authority in the specified format when requested:

(a) the date and time upon which the sample was taken; and,

(b) the monitoring point at which the sample was taken; and,

(c) the measured or estimated daily quantity of the contaminants released from all release points; and,

(d) the release flow rate at the time of sampling for each release point; and,

(e) the results of all monitoring and details of any exceedances with the conditions of this environmental authority; and,

(f) water quality monitoring data provided electronically in the specified format.

C5 The release of contaminants to waters must only occur from the sources specified in Table C1 and depicted in Figure 1 attached to this environmental authority.

Table C1 Release Points (point source release – SoE)

Latitude or Northing (GDA94)	Longitude or Easting (GDA94)	Potential Contaminant Source and Location	
8568100	568520	Boyd Tailings Storage Facility	
8557460	573700	Norman Creek Tailings Storage Facility	
8569590	568360	Boyd Process Water Pond	
8557020	576080	Norman Creek Process Water Pond	
8567760	567210	Boyd Tailings Recovery Slot	
8,558,470	572,360	Norman Creek Recovery Slot	
8570890	568340	Boyd MIA Drainage Slot	
8570260	568620	Boyd truck tray wash pond	
8,557,580	575,530	Norman Creek MIA Drainage Slot	
8,557,750	576,360	Norman Creek truck tray wash pond	
Various	Various	Sediment ponds throughout mining areas	
8571040	570720	Construction Camp Sewage Treatment Plant Sludge-Drying Bed	
8570610	568210	Boyd Sewage Treatment Plant Sludge-Drying Bed	
8,557,860	575,470	Norman Creek Sewage Treatment Plant Sludge-Drying Bed	

Water Supply Dam (South of Embley)

C6 Water may be stored in the dam specified in Table C2, which must be constructed with a spillway design specified in Table C2.

Table C2 Water Storage Dam Design Criteria (SoE)

Latitude or Northing (GDA94)	Longitude or Easting (GDA94)	Dam	Spillway Design
8,563,380	575,790	Dam C	Peak flow from a 1:2000 year Annual Recurrence Interval flood event.

C7 Water may be released from the release points specified in Table C3 and depicted in Figure 1 attached to this environmental authority.

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Table C3 Water Release Points, Sources and Receiving Waters (SoE)

Release Point (RP)	Latitude or Northing (GDA94)	Longitude or Easting (GDA94)	Release Point	Flow in Receiving Water Required for a Release Event	Receiving Waters Description
1	8,562,650	574,420	Dam C valve	Natural flow measured at upstream monitoring point.	Freshwater tributary of Norman Creek

C8 Releases to waters must be undertaken so as not to cause erosion of the bed and banks of the receiving waters, or cause a material build-up of sediment in such waters.

Direct Pumping from Stream (South of Embley)

C9 Water may be pumped from the stream specified in Table C4, in accordance with parameters specified in Table C4.

Table C4 Water Pumping Design Criteria (SoE)

Latitude or Northing (GDA94) 1	Longitude or Easting (GDA94) 1	Stream	Annual Volume of Water	Rate of Pumping
TBA	TBA	Ward River	≤1% mean annual river flow	<20% of river flow rate if river flow rate is ≥1000L/s

1. Coordinates would be included in the Water Management Plan and would be based on cultural heritage surveys prior to development.

Streamflow Monitoring (South of Embley)

C10 The holder must install, operate and maintain stream flow gauging stations to determine and record stream flows at the locations specified in Table C5.

Table C5 Water Flow Monitoring Points (SoE)

Latitude or Northing (GDA94)[1]	Longitude or Easting (GDA94) [1]	Gauging Station Description	Flow Recording Frequency
TBA	TBA	GS1 (Upstream Dam C)	Continuous[2]
TBA	TBA	GS2 (Downstream Dam C)	Continuous[2]
TBA[#]	TBA	GS3 (Norman Creek sub catchment - to be mined)	Continuous[2]
TBA	TBA	GS4 (Norman Creek sub catchment - non-mined)	Continuous[2]
TBA	TBA	GS5 (in vicinity of Ward River pump station)[3]	Continuous[2]

1. Coordinates would be included in the Water Management Plan and would be based on safe access points, which are to be determined.

2. Continuous measurement refers to 90% data availability over any 12-month period to allow for downtime during maintenance and repair.

3. GS5 would be installed when the pump station is installed.

Receiving Environment Monitoring and Contaminant Trigger Levels (South of Embley)

C11 The quality of the receiving surface waters must be monitored at the locations specified in Table C6 for each quality characteristic and at the monitoring frequency stated in Table C6.

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Table C6 Receiving Surface Water Monitoring Points (SoE)

Latitude or Northing (GDA94)	**Longitude or Easting (GDA94)**	**Monitoring Points** (Point number)	**Type**	**Parameters**	**Frequency**
8,563,524#	571,226#	Norman Creek estuary (10A)	Estuarine	EC, turbidity, Al, Cr, Cu, Fe, Pb, Mn, Ni, Zn.	Monthly until statistical baseline established and then quarterly.
8,570,157#	576,488#	Norman Creek (4)	Freshwater	EC, turbidity, Al, Cr, Cu, Fe, Pb, Mn, Ni, Zn.	Monthly until statistical baseline established and then quarterly.
8,567,264#	574,554#	Norman Creek (2A)	Freshwater	EC, turbidity, Al, Cr, Cu, Fe, Pb, Mn, Ni, Zn.	Monthly until statistical baseline established and then quarterly.
8,566,987#	570,509#	Norman Creek (1)	Freshwater	pH, EC, turbidity, Al, Cr, Cu, Fe, Pb, Mn, Ni, Zn.	Monthly until statistical baseline established and then quarterly.
8,566,531#	581,323#	Norman Creek upstream Dam C (5A)	Freshwater	pH, EC, temperature, dissolved oxygen, turbidity, Al, Cr, Cu, Fe, Pb, Mn, Ni, Zn.	Monthly until statistical baseline established and then quarterly.
8562780#	574,225#	Norman Creek downstream Dam C (1B)	Freshwater	pH, EC, temperature, dissolved oxygen, turbidity, Al, Cr, Cu, Fe, Pb, Mn, Ni, Zn.	Monthly until statistical baseline established and then quarterly.
8,561,748#	587,060#	Coconut Creek (14A)	Freshwater	EC, turbidity, Al, Cr, Cu, Fe, Pb, Mn, Ni, Zn.	Monthly until statistical baseline established and then quarterly.
8,555,380#	583,310#	Ward River Catchment – lease boundary. (22)	Freshwater	pH, EC, temperature, dissolved oxygen, turbidity, Al, Cr, Cu, Fe, Pb, Mn, Ni, Zn.	Monthly until statistical baseline established and then quarterly.
8,548,340#	581,468#	Ward River Catchment – down gradient of mining (25A)	Freshwater	pH, EC, temperature, dissolved oxygen, turbidity, Al, Cr, Cu, Fe, Pb, Mn, Ni, Zn.	Monthly until statistical baseline established and then quarterly.
TBA	TBA	Ward River at Pump Station (23)	Freshwater	pH, EC, temperature, dissolved oxygen, turbidity, Al, Cr, Cu, Fe, Pb, Mn, Ni, Zn.	Monthly until statistical baseline established and then quarterly.
8,587,121#	584,589#	Winda Winda/Triluck Creek estuary (21)	Estuarine	EC, turbidity, Al, Cr, Cu, Fe, Pb, Mn, Ni, Zn.	Monthly until statistical baseline established and then quarterly.
8,588,864#	592,138#	Triluck Creek (19)	Freshwater	EC, turbidity, Al, Cr, Cu, Fe, Pb, Mn, Ni, Zn.	Monthly until statistical baseline established and then quarterly.
8,578,825#	588,762#	Winda Winda Creek (9a)	Freshwater	EC, turbidity, Al, Cr, Cu, Fe, Pb, Mn, Ni, Zn.	Monthly until statistical baseline established and then quarterly.
8,550,284#	575,012#	Ina Creek (26A)	Freshwater	EC, turbidity, Al, Cr, Cu, Fe, Pb, Mn, Ni, Zn.	Monthly until statistical baseline established and then quarterly.

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Latitude or Northing (GDA94)	**Longitude or Easting (GDA94)**	**Monitoring Points** (Point number)	**Type**	**Parameters**	**Frequency**
8,543,390#	570,466#	Ina Creek (31)	Freshwater	EC, turbidity, Al, Cr, Cu, Fe, Pb, Mn, Ni, Zn.	Monthly until statistical baseline established and then quarterly.
8,572,700#	567,710#	Boyd Point (Marine1)	Marine	Hydrocarbons, turbidity.	Monthly until statistical baseline established and then quarterly.
8,569,040#	565,210#	Pera Head (Marine2)	Marine	Hydrocarbons, turbidity.	Monthly until statistical baseline established and then quarterly.

Notes:

Draft coordinates only. Coordinates will be confirmed in the Water Management Plan and will be based on safe access points to be determined during the first round of monitoring.

1. All metals and metalloids must be measured as total (unfiltered) and dissolved (filtered). Trigger levels for metal/metalloids apply if dissolved results exceed trigger.

2. The list of quality characteristics required to be monitored will be reviewed once baseline monitoring data is gathered over 24 months or an earlier date if the data is, or becomes, available and if it's is determined there is no need to monitor for certain individual quality characteristics these can be removed.

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C12 If quality characteristics of the receiving surface waters downstream of mining activities exceed any of the trigger levels specified in Table C7 (for estuarine waters), Table C8 (for freshwater), or Table C9 (for marine waters), the environmental authority holder must compare the results of the downstream site to the data from background monitoring sites and;

(a) if the result is less than the background monitoring site data, then no action is to be taken, or

(b) if the result is greater than the background monitoring site data, complete an investigation in accordance with the ANZECC & ARMCANZ 2000 methodology, into the potential for environmental harm and provide a written report to the administering authority in the next annual return, outlining:

(i) details of the investigations carried out, and

(ii) actions taken to prevent environmental harm.

Note: Where an exceedance of a trigger level has occurred and is being investigated, in accordance with C12 (b)(ii) of this condition, no further reporting is required for subsequent trigger events for that quality characteristic.

Table C7 Receiving Estuarine Trigger Investigation Levels (SoE)

Quality Characteristic	**Trigger Levels**
Turbidity	Baseline 80th percentile as per ANZECC
Aluminium	Baseline 80th percentile as per ANZECC

Table C8 Receiving Freshwater Stream Trigger Investigation Levels (SoE)

Quality Characteristic	**Trigger Levels**
Turbidity	Baseline 80th percentile as per ANZECC
Aluminium	Baseline 80th percentile as per ANZECC
Iron	Baseline 80th percentile as per ANZECC
Manganese	Baseline 80th percentile as per ANZECC

Table C9 Receiving Marine Trigger Investigation Levels (SoE)

Quality Characteristic	**Trigger Levels**
Hydrocarbons	Visible oil

C13 The quality of the receiving groundwaters must be monitored at the locations specified in Table C10 for each physical and quality characteristic and at the monitoring frequency stated in Table C10.

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Table C10 Groundwater Monitoring Points (SoE)

Latitude or Northing (GDA94)	Longitude or Easting (GDA94)	Monitoring Points	Parameters	Frequency*
TBA#	TBA#	GM1 (Boyd MIA upgradient)	Level	Monthly
			pH, EC, Al, Total Petroleum Hydrocarbons (TPH)	Quarterly
TBA#	TBA#	GM2 (Boyd MIA downgradient)	Level	Monthly
			pH, EC, Al, TPH	Quarterly
TBA#	TBA#	GM3 (Norman Creek MIA upgradient)	Level	Monthly
			pH, EC, Al, TPH	Quarterly
TBA#	TBA#	GM4 (Norman Creek MIA downgradient)	Level	Monthly
			pH, EC, Al, TPH	Quarterly
TBA#	TBA#	GM5 (Boyd tailings storage facility north)	Level	Monthly
			pH, EC, Al	Quarterly
TBA#	TBA#	GM6 (Boyd tailings storage facility east)	Level	Monthly
			pH, EC, Al	Quarterly
TBA#	TBA#	GM7 (Boyd tailings storage facility south)	Level	Monthly
			pH, EC, Al	Quarterly
TBA#	TBA#	GM8 (Boyd tailings storage facility west)	Level	Monthly
			pH, EC, Al	Quarterly
TBA#	TBA#	GM9 (Norman Creek tailings storage facility north)	Level	Monthly
			pH, EC, Al	Quarterly
TBA#	TBA#	GM10 (Norman Creek tailings storage facility east)	Level	Monthly
			pH, EC, Al	Quarterly
TBA#	TBA#	GM11 (Norman Creek tailings storage facility south)	Level	Monthly
			pH, EC, Al	Quarterly
TBA#	TBA#	GM12 (Norman Creek tailings storage facility west)	Level	Monthly

Latitude or Northing (GDA94)	Longitude or Easting (GDA94)	Monitoring Points	Parameters	Frequency*
			pH, EC, Al	Quarterly
TBA#	TBA#	Groundwater bores upgradient, downgradient or within mining areas	Level	Monthly
TBA#	TBA#	Groundwater bores upgradient, downgradient or within mining areas	Level	Monthly
TBA#	TBA#	Groundwater bores upgradient, downgradient or within mining areas	Level	Monthly
TBA#	TBA#	Groundwater bores upgradient, downgradient or within mining areas	Level	Monthly
TBA#	TBA#	Groundwater bores upgradient, downgradient or within mining areas	Level	Monthly
TBA#	TBA#	Groundwater bores upgradient, downgradient or within mining areas	Level	Monthly
TBA#	TBA#	Groundwater bores upgradient, downgradient or within mining areas	Level	Monthly
TBA#	TBA#	Groundwater bores upgradient, downgradient or within mining areas	Level	Monthly

Coordinates would be included in the Water Management Plan once the detailed mine plan is developed.

* Subject to safe access.

Groundwater

C14 Groundwater monitoring bores constructed after the date of issue of this environmental authority must be constructed and operated in accordance with methods prescribed in the latest edition of the Agriculture and Resource Management Council of Australia and New Zealand manual titled *Minimum Construction Requirements for Water Bores in Australia*.

C15 Annual groundwater monitoring reports analysing groundwater chemistry and hydro-geological status of all groundwater bores and groundwater conditions must be prepared and submitted to the administering authority on request.

Stormwater and Water Sediment Controls

C16 An Erosion and Sediment Control Plan must be developed by an appropriately qualified person and implemented prior to commencement of construction for the South of Embley Project for all stages of the mining activities on the site to minimise erosion and the release of sediment to receiving waters and contamination of storm water.

C17 The Erosion and Sediment Control Plan must provide for at least the following stormwater management functions and be made available to the administering authority upon request:

(a) prevent or minimise the contamination of stormwater; and,

(b) diverting uncontaminated stormwater run-off around areas disturbed by mining activities or where contaminants or wastes are stored or handled; and,

(c) contaminated stormwater runoff, incident rainfall and leachate is collected; and treated, reused, or released in accordance with the conditions of this environmental authority; and,

(d) where practicable, roofing or minimising the size of areas where contaminants or wastes are stored or handled; and,

(e) using alternate materials and or processes (such as dry absorbents) to clean up spills that will minimise the generation of contaminated waters; and,

(f) erosion and sediment control structures are placed to minimise erosion of disturbed areas and prevent the contamination of any waters; and,

(g) procedures to ensure that erosion and sediment control structures are maintained and adequate storage is available in sediment dams in accordance with design criteria; and,

(h) training of staff that will be responsible for maintenance and operations of erosion and sediment control structures.

C18 Erosion protection and sediment control measures must be implemented and maintained to minimise erosion and the release of sediment and contamination of stormwater as described in the Erosion and Sediment Control Plan.

C19 Any spillage of wastes, contaminants or other materials must be cleaned up as quickly as practicable to minimise the release of wastes, contaminants or materials to any stormwater drainage system or receiving waters.

C20 Stormwater may be released from mining and infrastructure areas and the points specified in Table C11 and C12, in accordance with the Erosion and Sediment Control Plan.

C21 The dams in Table C11 are designed with a volume equivalent to the runoff volume from a 1:10 ARI 24-hour rainfall event, plus 20% for sediment storage.

Table C11 Stormwater Ponds

Latitude or Northing* (GDA94)	**Longitude or Easting* (GDA94)**	**Stormwater Pond Location**
8,567,760	567,210	Boyd Tailings Recovery Slot
8,558,467	572,363	Norman Creek Tailings Recovery Slot
8,570,890	568,344	Boyd Industrial Area Drainage Slot
8570260	568620	Boyd truck tray wash pond
8,557,581	575,529	Norman Creek Industrial Area Drainage Slot
8,557,749	576,360	Norman Creek truck tray wash pond
8,571,640	568,844	Sediment Pond 1 (Wharf Drainage Sump)
8,570,533	567,749	Sediment Pond 2 (Southern Stockpile)
8,568,419	566,568	Sediment Pond 3 (Southern Stockpile)
8,567,853	566,620	Sediment Pond 4 (Northern Stockpile)

C22 The dams in Table C12 are designed to operate a freeboard equivalent to a 1:10 ARI 24-hour rainfall event.

Table C12 Sewage Treatment Plant Sludge Drying Beds

Latitude or Northing* (GDA94)	**Longitude or Easting* (GDA94)**	**Sewage Treatment Plant Sludge Drying Bed Location**
8,571,044	570,717	Construction Camp Sewage Treatment Plant Sludge-Drying Bed
8,570,610	568,210	Boyd Sewage Treatment Plant Sludge-Drying Bed
8,557,861	575,469	Norman Creek Sewage Treatment Plant Sludge-Drying Bed

Interference with waterways

C23 Destroying native vegetation, excavating, or placing fill in a watercourse, lake or spring necessary for and associated with mining operations, may be undertaken for the purposes of mining and associated activities in accordance with the Plan of Operations.

Water Management Plan

C24 Prior to commissioning the South of Embley Project the Weipa Water Management Plan must be reviewed to ensure adequacy for the South of Embley Project or a new Water Management Plan developed and implemented for the South of Embley Project. The Water Management Plan shall provide proper and effective management of the actual and potential environmental impacts resulting from the mining activity and to ensure compliance with the conditions of this environmental authority.

C25 The Water Management Plan must be developed in accordance with the latest version of the Department of Environment and Resource Management Guideline for Preparing a Water Management Plan 2009 and must include at least the following components:

(a) contaminant source study;

(b) site water balance and model;

(c) water management system;

(d) saline drainage prevention and management measures;

(e) emergency and contingency planning, and

(f) monitoring and review.

C26 Each year the holder of the environmental authority must undertake a review of the Water Management Plan prior no later than 1 November to ensure that proper and effective measures, practices or procedures are in place so the mine is operated in accordance with the conditions of this environmental authority and that environmental harm is prevented or minimised.

C27 A copy of the Water Management Plan and/or a copy of the final review document of the Water Management Plan must be provided to the administering authority on request.

END OF CONDITIONS FOR SCHEDULE C

3.5.5 Proposed Environmental Authority Conditions: Schedule D – Regulated Dams

Note: The draft conditions in this Schedule are subject to change due to the pending approval of the ML7024 Environmental Authority for the existing Weipa mining operations.

Regulated Dams

D1 The hazard category of each regulated dam must be assessed by a suitably qualified and experienced person at least once every two (2) years, based on documented evidence sufficient to define or confirm the current nature and extent of environmental consequences for potential failure of that regulated dam.

D2 The holder of this environmental authority must not commence construction of any regulated dam (i.e. dams determined to be in the significant or high hazard category) unless the location, hydraulic performance, size and purpose of that dam are specifically referenced in accordance with this environmental authority in the form of tabulated details as identified in Conditions D3, D4 and D15.

D3 Water and tailings may be stored at the locations and within the parameters described in Table D1 – Location of Regulated Dams and Table D2 – Size and Purpose of Regulated Dams. This does not exclude the storage of water or tailings in accordance with any other condition of this environmental authority.

Location of Regulated Dams

D4 The construction and operation of regulated dams listed in Table D1 - Location of Regulated Dams, must be located on the mining lease(s) within the polygonal area defined by the co-ordinates listed in Table D1.

Table D1 - Location of Regulated Dams (South of Embley)

Name of Regulated Dams	Latitude (MGA 94)	Longitude (MGA 94)
Boyd Tailings Storage Facility	see Figure 4	
Norman Creek Tailings Storage Facility	see Figure 5	

D5 The construction and operation of regulated dams must comply with Table D2 - Size and Purpose of Regulated Dams.

Table D2 - Size and Purpose of Regulated Dams (South of Embley)

Regulated Dam	Hazard Category	Maximum Surface Area (Ha)	Maximum Volume	Maximum Depth (m)	Purpose
Boyd Tailings Storage Facility	Significant	580	182Mt	22	Storage of tailings
Norman Creek Tailings Storage Facility	Significant	580	204Mt	25	

Regulated Dams – Certification and Operation

D6 Every regulated dam must be constructed in accordance with a certified design plan that has been submitted to the administering authority and developed so that the resulting dam will deliver the performance identified in the submitted design plan and is compliant with this environmental authority.

D7 The holder of this environmental authority must not commence construction of a regulated dam unless:

(a) the holder has submitted to the administering authority two electronic copies (one locked copy and one working copy) of a design plan together with the certification of a suitably qualified and experienced person that the design of the regulated dam will deliver the performance stated in that submitted design plan and that dam is compliant with this environmental authority; and,

(b) at least 20 business days has passed since the receipt of those documents or the administering authority notifies the holder that a design plan and certification has been submitted for that dam.

D8 When construction or modification of any regulated dam is complete the holder must submit to the administering authority two electronic copies (one locked copy and one working copy) of a set of 'as constructed' drawings, together with the certification of a suitably qualified and experienced

person that the dam 'as constructed' will deliver the performance stated in the submitted design plan and that the dam is compliant with this environmental authority.

D9 Each regulated dam must be maintained and operated in a manner that is consistent with the design plan and the certified "as constructed" drawings for the duration of its operational life and until decommissioned and rehabilitated.

Annual Inspection of Regulated Dams

D10A suitably qualified and experienced person must inspect all regulated dams annually before 1 November each year.

D11At each annual inspection, the condition and adequacy of each regulated dam must be assessed for dam safety and in terms of the necessary structural, geotechnical and hydraulic performance criteria.

D12An assessment of the adequacy of available storage in each regulated dam must be based on a dam level observed within the month of October and result in an estimate of the level in that dam as at 1 November.

D13For each annual inspection, a copy of a report on the condition and adequacy of each regulated dam, certified by the suitably qualified and experienced person and including any recommended actions to be taken to ensure the integrity of each regulated dam, must be provided to the administering authority upon request.

D14The holder of this environmental authority must, upon receipt of the final annual inspection report, consider the report and its recommendations and within one month of receipt of the final annual inspection report, formulate actions to ensure that each regulated dam safely performs to its intended functions.

Taking into account the weather conditions at the time, the holder of this environmental authority must promptly implement the formulated actions.

Note: Weather conditions include the commencement of the wet season. Accordingly, it may not be practicable to implement formulated actions until the end of the wet season.

Hydraulic performance criteria

D15Regulated dams constructed on the licensed place must comply with the hydraulic performance criteria shown in Table D3 - Hydraulic Performance Criteria for Regulated Dams.

Table D3 - Hydraulic Performance Criteria for Regulated Dams (South of Embley)

Name of Regulated Dam	Design Storage Allowance	Spillway Design	Mandatory Reporting Level[2]
Boyd Tailings Storage Facility	0.02 AEP[1], 2 month wet season, to be available on 1st November each year	0.001 AEP	0.01 AEP, 72 hour duration rainfall event or wave allowance
Norman Creek Tailings Storage Facility	0.02 AEP[1], 2 month wet season, to be available on 1st November each year	0.001 AEP	0.01 AEP, 72 hour duration rainfall event or wave allowance

1 AEP means the Annual Exceedance Probability, which is the probability that at least one event in excess of a particular magnitude will occur in any given year.

2 Refers to the level below the spillway crest, required to contain either the AEP (design risk) 72hr storm or the AEP (design risk) wave allowance, whichever is lower.

D16The spillway for any regulated dam constructed within the operational land must be designed and maintained to withstand the peak flow from the critical design storm in Table D3 - Hydraulic Performance Criteria for Regulated Dams.

D17 The holder of this environmental authority must notify the administering authority as soon as possible, but within 24 hours, of the level in any regulated dam reaching the mandatory reporting level in Table D3 - Hydraulic Performance Criteria for Regulated Dams; and must immediately act to prevent or minimise the risk of environmental harm.

Decommissioning of Regulated Dams - Objective

D18 Prior to the cessation of mining activities each regulated dam must be decommissioned such that it either:

(a) becomes a stable landform that safely confines flowable substances, if any, or,

(b) is approved or authorised under relevant legislation for a beneficial use or,

(c) is a void authorised by the administering authority to remain after decommissioning or,

(d) is compliant with the rehabilitation requirements of this environmental authority.

END OF CONDITIONS FOR SCHEDULE D

3.5.6 Proposed Environmental Authority Conditions: Schedule E – Sewage Treatment

Note: The draft conditions in this Schedule are subject to change due to the pending approval of the ML7024 Environmental Authority for the existing Weipa mining operations.

Sewage Treatment Plants (South of Embley)

E1 The quality of treated effluent from any operational sewage treatment plants must be monitored at the locations specified in Table E1 for each quality characteristic and at the monitoring frequency stated in Table E2.

Table E1 Sewage Treatment Plants

Latitude or Northing (GDA94)	Longitude or Easting (GDA94)	Sewage Treatment Plant (STP) Name	Monitoring Points
8,571,026	570,737	Construction camp STP	Construction camp STP sludge-drying bed decant point
8,571,025	570,738	Boyd STP	Boyd STP sludge-drying bed decant point
8,557,861	575,469	Norman Creek STP	Norman Creek STP sludge-drying bed decant point

Table E2 Sewage Treatment Plant Effluent Monitoring and Criteria

Quality Characteristic	Criteria (cfu/100mL)	Follow-up Sample Criteria (cfu/100mL)	Annual Rolling Average Criteria (cfu/100mL)	Monitoring Frequency
E. coli	100	10	10 cfu/100mL found in 95% of the samples taken for a 12-month period	Weekly

E2 If quality characteristics of the treated effluent exceed the criteria specified in Table E2, the environmental authority holder must take a follow-up sample, and:

(a) if the quality characteristics of the follow-up sample meets the follow-up sample criteria specified in Table E2 then no action is to be taken, or

(b) the quality characteristics of the follow-up sample exceeds the follow-up sample criteria specified in Table E2, complete an investigation into the potential for environmental harm and provide a written report to the administering authority in the next annual return, outlining:

(i) details of the investigations carried out, and

(ii) actions taken to prevent environmental harm.

Note: Where an exceedance of a trigger level has occurred and is being investigated, in accordance with E2 (b)(ii) of this condition, no further reporting is required for subsequent trigger events for that quality characteristic.

E3 If quality characteristics of the treated effluent meet the Trigger Investigation Level specified in Table E2, the environmental authority holder may irrigate the treated effluent in areas identified as disturbed in the current Plan of Operations for the purposes of dust suppression, landscape watering or other appropriate uses that are suitable for the quality of water.

Waste Management

E4 Screenings, grit, sewage and wastewater treatment plant sludges generated must be stored, managed and utilised so as not to cause environmental harm.

E5 Sewage sludge generated on the licensed place must be monitored at least annually to obtain the following information:

(a) the estimated annual quantity and nature of each sludge produced; and

(b) the current method(s) of pre-treatment or disposal.

END OF CONDITIONS FOR SCHEDULE E

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3.6 Noise and Vibration

3.6.1 Value/Background

The environmental values to be enhanced or protected are:

- the qualities of the acoustic environment that are conducive to protecting the health and biodiversity of ecosystems;
- the qualities of the acoustic environment that are conducive to human health and well-being, including by ensuring a suitable acoustic environment for individuals to sleep, study or learn, and recreate; and
- the qualities of the acoustic environment that are conducive to protecting the amenity of the community.

The acoustic environment of the Project area is described in detail in RTA (2010). The Project lies a considerable distance from sensitive receptors. To the north of the Project area are the townships of Weipa and Napranum, and to the south the township of Aurukun (see **Figure 1**). There are several homesteads on the remote cattle stations to the east of the Project area. The nearest sensitive receptors are shown on **Figure 8**.

An environmental noise survey was conducted in Evans Landing, adjacent to the Department of Primary Industries Fisheries building. This site was considered to be representative of the residential areas along the Embley River, namely Napranum and the accommodation areas in Evans Landing, which would be the nearest sensitive receptors to the Project area. The measured noise levels are shown in **Table 3-10**. The noise levels recorded at Evans Landing included noise from recreational boating and activities in the boat ramp car park. During the night, noise from the Lorim Point ship loader was noted.

By way of comparison, the results of an earlier survey commissioned by RTA at Nanum are presented in **Table 3-10** (Moore and Associates, 2007). Nanum is approximately 3km north of Evans Landing and closer to Weipa.

The results of the noise monitoring for both Nanum and Evans Landing are similar. The background noise levels are almost identical while the $L_{Aeq\ (1\ hour)}$ shows Evans Landing is exposed to slightly higher overall noise levels.

Table 3–10 Environmental Noise Survey at Evans Landing

Date	$L_{A90\ (1\ hour)}$ Background Noise Level [dB(A)]			$L_{Aeq\ (24\ hour)}$ [dB(A)]	$L_{Aeq\ (1\ hour)}$ Noise Level [dB(A)]		
	Day	Evening	Night		Day	Evening	Night
17 September 2008	-	37	37	-		52	47
18 September 2008	41	37	35	51	54	48	45
19 September 2008	40	38	36	48	50	46	48
20 September 2008	40	38	37	50	53	46	45
21 September 2008	43	41	42	53	54	56	49
22 September 2008	41	38	38	53	55	50	47
23 September 2008	42	34	39	51	53	45	48
24 September 2008	39	-	-	49	52	-	-
Median Level	41	38	38	51	53	48	47

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Table 3–11 Environmental Noise Survey at Nanum

Date	$L_{A90\ (1\ hour)}$ Background Noise Level [dB(A)]			$L_{Aeq\ (24\ hour)}$ [dB(A)][#1]	$L_{Aeq\ (1\ hour)}$ Noise Level [dB(A)]		
	Day	Evening	Night		Day	Evening	Night
19 July 2007	42	39	36	47	48	50	42
20 July 2007	38	38	35	45	46	46	41
21 July 2007	38	38	38	47	48	45	42
22 July 2007	37	40	37	44	42	53	42
23 July 2007	41	40	36	49	48	50	42
24 July 2007	40	38	37	46	47	45	43
25 July 2007	40	38	38	48	49	45	43
Median Level	40	38	37	47	48	46	42

Note 1: $L_{Aeq(24\ hour)}$ not provided in data provided by RTA but estimated from results.

There are no designated Marine Parks or Protected areas in the vicinity of the Project area, and therefore the objectives provided by the *Queensland Environmental Protection (Noise) Policy 2008* (EPP (Noise)) for critical habitats (as defined in a conservation plan under the *Nature Conservation Act 1992* (Qld) and marine parks under the *Marine Parks Act 2004* (Qld)) are not relevant to the Project. However, marine turtles and mammals, such as whales, dolphins and dugongs, are known to be sensitive to underwater noises which are louder (greater intensity) than normal background levels. Physical damage to the auditory system of dolphins and whales may occur at noise levels of about 230-240dB re 1 µPa (Gausland 2000). Avoidance behaviour begins to occur at around 110-130dB re 1 µPa (McCauley 1994). As there is no critical breeding or feeding habitat for these species close to the construction areas, an avoidance response is unlikely to have a significant impact.

There is no significant vibration sources associated with the operations. The operations do not require blasting to be carried out. Nor are there any vibration-sensitive receptors within or close to the lease area. As a result vibration issues will not be addressed further.

3.6.2 Objectives

The environmental protection objectives for noise are:

- To avoid significant impact to marine mammals and turtles during construction; and
- To avoid causing nuisance noise levels at sensitive receptors beyond the boundaries of the Project.

3.6.3 Commitments

Performance Criteria

The proposed noise level criteria for the Project have been derived taking into consideration the acoustic quality objectives for health and well-being, as well as the control of background creep, both from the EPP (Noise).

Currently, the existing ambient levels are much higher than the EPP (Noise) Schedule 1 acoustic quality objectives and therefore these objectives are not able to be met.

The objective to control background creep seeks to avoid intrusiveness. When setting limits it is not intended that the acoustic environment be permitted to deteriorate and this is achieved by controlling background creep. The noise from most plant and equipment at the Project varies over a short time period. Furthermore, the noise propagation characteristics over large distances always results in fluctuating noise levels. Since all the noise-sensitive locations are located at large distances from the operations it is reasonable to apply the limits for time-variable noise. The noise level criteria to avoid

background creep have been calculated using the method specified in the EPP (Noise) and is equal to $L_{Aeq,T} = L_{A90,T} + 5$ dB(A). The $L_{A90,T}$ is the median background noise level calculated in **Table 3-10**.

Thus the noise level criteria proposed for the Project are designed to avoid background creep and are shown in **Table 3-12**. It is difficult to model the L_{A10} and the L_{A1} since there is no accurate calculation method available. Since the noise sources are not of very short duration but occur throughout the monitoring period it is expected that if the L_{Aeq} goals are met then the L_{A10} and L_{A1} would be met as well. As a consequence, it is not proposed to model or report either the L_{A10} or L_{A1}.

DERM's Ecoaccess Guideline *Assessment of Low Frequency Noise* recommends overall sound pressure level inside residences should not exceed 50dB(Linear) to avoid complaints from noise that has a proportionally high level of frequency content less than 200 Hz.

Table 3–12 Proposed Noise Level Criteria for Residential Areas

	Noise Level Criteria to Avoid Background Creep [$L_{Aeq,\ 1\ hour}$ dB(A)]			Low Frequency Noise [$L_{eq,\ adj,\ 1\ hr}$ dB(Linear)]
Time Period	**Daytime**	**Evening**	**Night**	**Night**
Measured 4m from residential receptors	46	43	43	50

Implementation Strategy

Modelling carried out by RTA (2010) demonstrates the noise levels from construction and mining are expected to comply with all noise level objectives and criteria in Weipa, Napranum and Aurukun during the day, evening and night.

During construction of the Port, a "soft start" approach will be used to disperse animals in the vicinity prior to normal pile driving. The "soft start" involves commencing pile driving with a partial capacity strike, or giving a warning with an underwater airgun prior to normal pile driving.

During operations it has been predicted the noise from the barge and ferry is likely to be the main source of low frequency noise from the SoE Project at both Napranum and Weipa. The noise from these vessels has been modelled at 50dB(Linear) at Napranum at night with wind, however this is based on conservatively high noise emissions from the ferry and barge. Smaller passenger ferries would be significantly quieter.

The route for the barge and ferry is approximately mid channel and at least 1km from the banks of the Embley River at Napranum.

The manufacturer's sound power level specifications for major equipment items will be used as guidance when purchasing equipment.

Monitoring

Sightings of whales or turtles in the vicinity of pile driving will be recorded.

Baseline noise monitoring will be carried out at Napranum prior to the commencement of construction. A noise monitoring campaign, which will include attended monitoring at Napranum, will be conducted after operation commences to validate the noise model. Where it is determined that actual noise levels exceed applicable noise limits, action will be taken to reduce noise levels.

3.6.4 Proposed Environmental Authority Conditions: Schedule F – Noise

Note: The draft conditions in this Schedule are subject to change due to the pending approval of the ML7024 Environmental Authority for the existing Weipa mining operations.

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General

F1 Subject to Condition F2 noise from any mining activity as defined in Table A1 must not cause unauthorised environmental harm at any sensitive place or commercial place.

F2 In the event of a complaint made to the administering authority (which is neither frivolous or vexatious) about noise generated in carrying out the licensed activity and the noise is unauthorised noise and is considered by the administering authority to be an unreasonable noise, the holder of this environmental authority must take action to ensure that it is no longer an unreasonable noise.

Noise Monitoring

F3 When requested by the administering authority, noise monitoring must be undertaken within a reasonable and practicable timeframe nominated by the administering authority to investigate any complaint related to noise (which is neither frivolous nor vexatious nor based on mistaken belief in the opinion of the authorised officer) at any sensitive or commercial place, and the results must be notified within 14 days to the administering authority following receipt of final monitoring report.

F4 The environmental holder, is authorised to, and will not be considered to be causing environmental harm or environmental nuisance where noise emissions from licensed activities at sensitive places or commercial places are in accordance with the limits in Table F1 at the time periods specified in Table F1.

If monitoring indicates exceedance of the limits in Table F1, then the environmental authority holder must implement noise abatement measures so that emissions of noise from the activity do not exceed the limits in Table F1.

Table F1 - Noise Limits

Noise level dB(A) measured as:	Monday to Saturday			Sundays and Public Holidays		
	7am to 6pm	6pm to 10pm	10pm to 7am	9am to 6pm[1]	6pm to 10pm[2]	10pm to 9am
Weipa township (including Nanum, Rocky Point)						
$L_{Aeq, adj, 1 hour}$	45	43	42	43	42	42
Evans Landing						
$L_{Aeq, adj, 1 hour}$	46	43	42	43	42	42
Napranum						
$L_{Aeq, adj, 1 hour}$	TBD[3]	TBD[3]	TBD[3]	TBD[3]	TBD[3]	TBD[3]

1 assumed same as weekday evening

2 assumed same as weekday night period

3 baseline noise monitoring to be carried out at Napranum prior to commencement of construction.

F5 Subject to Condition F2 the environmental authority holder must develop and implement a noise monitoring program to investigate noise complaints that may exceed the levels identified in Table F1 – Noise Limits.

F6 Noise monitoring and recording must include the following descriptor characteristics and matters:

(a) LAeq,1hr;

(b) background noise $L_{A90,}$ 1hr;

(c) the level and frequency of occurrence of impulsive or tonal noise and any adjustment and penalties to statistical levels;

(d) atmospheric conditions including temperature, relative humidity and wind speed and directions;

(e) effects due to any extraneous factors such as traffic noise;

(f) location, date and time of monitoring;

(g) if the complaint concerns low frequency noise, Max $Lp_{LIN,}$ 1hr; and,

(h) if the complaint concerns low frequency noise, one third octave band measurements in dB(LIN) for centre frequencies in the 10 – 200 Hz range.

F7 The method of measurement and reporting of noise levels must comply with the latest edition of the Department of Environment and Resource Management Noise Measurement Manual or the most recent version of *AS1055 Acoustics – Description and measurement of environmental noise*.

END OF CONDITIONS FOR SCHEDULE F

3.7 Land Management

3.7.1 Value/Background

Land use

Lands within the Project area are not used for agriculture and are relatively undisturbed by development. There are no rural properties within the Project area. Tracks to various parts of the Project area are used by recreational vehicle users, Traditional Owners and for access for exploration. Exploration activities, including drilling and associated road development, have taken place throughout the Project area and on-going activities such as drilling, ore sampling, creation of associated road access, and other exploration activities are continuing. Some cattle grazing took place within the Project area in the early to mid-1900s but has been discontinued. Some limited logging and sawmilling activity also took place during this period and has been discontinued (Venn 2004).

While overall there has been very little direct disturbance and the terrestrial environment is generally in good condition, some areas have been affected by camping and rubbish dumping, and some areas have been significantly affected by the frequent fire regime and damage from feral pigs. The effect of the current fire regime on the *Eucalyptus tetrodonta* ecosystem has been the development of a homogeneous vegetation structure that varies little throughout the Project area.

The topography within the Project area comprises a gently undulating bauxite plateau landform cut by a network of rivers and smaller creeks. Landfall is from the east to the west toward the Gulf of Carpentaria. There are bauxite cliffs along the coastline, particularly between Boyd Point and Thud Point. The highest elevations (95m AHD) within the Project area are along the eastern boundary. A number of semi-perennial watercourses, plus numerous smaller ephemeral creeks traverse the Project area and flow in a westerly direction eventually discharging into the Gulf of Carpentaria. There are large estuaries associated with the Hey, Embley and Ward rivers.

The main bauxite reserves lie in the Pera Head and Boyd Point areas, south of Norman Creek, and the Hey Point area. The areas to be mined comprise *E. tetrodonta* woodlands on bauxite plateaus. Approximately 5307ha of woodland will be cleared for mining over years 1-13 and 21,979ha over years 14-40. The bauxite resource and reserves are located on the bauxite plateau. Bauxite is not usually found in the main drainage lines.

Surrounding land uses include bauxite mining and associated infrastructure to the north and native ecosystems used by Aboriginal people to the east and south. The eastern side of ML 7024 adjoins mineral development licence MDL 378 (for the proposed Aurukun Bauxite Project). Further east there are a number of large cattle stations (see **Figure 8**).

Soils

Most of the area to be disturbed contains Red Kandosol soil type on slightly elevated plains with a level to gently undulating surface. Red Kandosols have a topsoil depth of 100 to 200mm. There are smaller areas of Yellow Kandosols and Yellow Kandosol acid soils in areas of lesser drainage and on lower slopes fringing drainage lines. The Kandosol soils are weathered and extremely infertile, and support vegetation adapted to such conditions. Nutrients such as nitrogen, calcium and potassium are concentrated in the surface 0.1m of soil, due to nutrient recycling in the litter layer. This layer represents the main nutrient storage capacity for tropical soils, and therefore will need to be preserved to facilitate rehabilitation following mining. The majority of seed readily able to germinate is present in the upper 50mm of soil.

The Kandosol soil types in mid to upper landscape positions have low potential to develop accelerated erosion when cleared of vegetation for mining or infrastructure development. The predominantly sandy surface soils, together with the low slopes on the bauxite plateau, facilitate infiltration and reduce the rate of runoff. Redoxic Hydrosols occur in the narrow drainage lines and along their margins and Orthic Tenosols occur on the very coastal margin. The Hydrosol and Tenosol soil types have a higher erosion potential. Any of these areas to be disturbed by the Project have a risk of erosion during the wet season.

Land Suitability

The suitability of each soil type within the Project area for low and medium input pasture and high input pasture was assessed. The Agricultural Land Classification for each soil type was also assessed,

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based on the agricultural land class definitions in the guidelines for the identification of Good Quality Agricultural Land (DPI and DHLGP 1993). The outcome of the land suitability assessment shows none of the soil types within the Project area are suitable for improved pasture land uses. Most of the soils (95% of the Project area) are suitable for low-intensity grazing of native pastures due to their very low fertility status. Soils associated with estuarine areas and near coastal plains within the Project area are not suitable for any improved pasture or native pasture grazing land uses. The Agricultural Land Classification assessment showed there is no Good Quality Agricultural Land within the Project area.

Mining involves removing around one metre of soil and overburden above the bauxite and then excavating the bauxite. The overburden will be returned to mined-out pits and then soil will be re-spread during rehabilitation. The final landform will be at a lower elevation than the original landform due to the removal of the bauxite, but the overall slope of the landform will be similar. Overall, the post-mining land suitability for low-intensity grazing is likely to be the same as the pre-mining suitability. The rehabilitated tailings storage facilities shall be an exception, and will not be suitable for low-intensity grazing.

RTA's objective for the rehabilitation of areas disturbed by Project mining activities is to establish a self-sustaining vegetation community using appropriate local native tree, shrub and grass species. Under the WCCCA and at the request of the WCCCC, RTA may establish post-mining land use options other than those required by regulation, subject to obtaining all necessary government approvals. While it is not currently envisaged that land uses other than native vegetation be established, RTA shall consult with Traditional Owners about rehabilitation objectives and rehabilitated land completion criteria and objectives.

Contaminated Land

Lands south of the Embley River are relatively undisturbed by development. Some cattle grazing took place within the Project area in the early to mid-1900's and some limited logging and sawmilling activity also took place during this period and has been discontinued (Venn 2004). Exploration activities have taken place throughout the Project area. While there has been domestic rubbish dumping at some camping locations, there is no known historic land contamination south of the Embley River.

Searches of the Environmental Management Register (EMR) and Contaminated Land Register (CLR) were undertaken to identify land parcels that will be disturbed by the Project and that may be contaminated from past and current Notifiable Activities, and/or that are known to be contaminated. No land parcels that will be disturbed by the Project are currently registered as contaminated land on the CLR.

Mineral Waste

The subsoil and overburden above the bauxite are benign. Generally, the subsoil and overburden stripped from a new mining area are taken directly to an existing mined-out area awaiting rehabilitation. The final landform will not have any out-of-pit dumps of excavated wastes. Therefore, there is no risk of soil or water contamination from excavated subsoil and overburden.

The principal mineral waste at the site will be tailings from the processing of the bauxite, known as beneficiation. Beneficiation involves separation of the bauxite and waste materials through screening, crushing, grinding, washing and dewatering. No chemicals are added to the process. This process produces tailings consisting of water, fine bauxite pisolite, sands and clays.

Bauxite tailings are benign. Representative tailings solid and liquor samples were collected from the existing East Weipa and Andoom tailings storage facilities and analysed for the specified tailings constituents used to define a hazardous dam (EPA 2003). The tailings samples were also analysed for metals and evaluated in terms of enrichment. The results show:

- the concentrations of all constituents in tailings solids and liquor are at least an order of magnitude less than the specified criteria (EPA 2003) for hazardous waste and therefore the tailings are not hazardous;
- the concentration of all measured constituents in tailings water is less than the ANZECC (2000) freshwater guidelines with the exception of aluminium;

- bauxite tailings do not trigger the EPA environmental investigation limit (EIL) for contaminated land in Queensland;
- bauxite tailings are not significantly enriched in any metal when compared to average crustal abundance using the GAI (Bowen 1979). The DME/DEH (1995) guideline entitled *Assessment and Management of Acid Drainage* states "*a GAI of greater than three indicates significant enrichment to a level that warrants further examination*". None of the metals have a GAI greater than three; and
- bauxite tailings are not enriched in any metal when compared to crude bauxite ore.

An earlier assessment of fine tailings from Andoom by the National Research Centre for Environmental Toxicology (Noller 2002) concluded:

"The chemical properties of Andoom ultrafine tailings, being essentially soil, suggest that there is unlikely to be any hazard associated with leaching by tropical rainwater as the material is already highly leached".

Given the GAI of one for aluminium in tailings, the assessment by Noller (2002) and the concentration of aluminium in recovery slots; aluminium in tailings is not expected to significantly impact on the environment.

Acid Sulphate Soils

The Hey River barge terminal has been identified as potentially containing Potential Acid Sulphate Soils (PASS), based on elevation and soil type.

ASS investigations were undertaken of soil at the Hey River barge/ferry terminal. The results showed if material represented by the samples tested was to be placed on land, the addition of lime to manage acid generation is not required.

Summary of Environmental Values

The environmental values of the land that are to be protected or enhanced are:

- The integrity of topsoil as a resource to be used in rehabilitation;
- The maintenance of a stable, non-polluting landform, and
- The suitability of land for beneficial post-mining land use.

3.7.2 Objectives

The objectives to protect the environmental values of the mined land are:

- The land disturbed by mining activities will be rehabilitated and made safe for humans and wildlife, non-polluting, stable and able to sustain the proposed post-mining land use, and
- The post-mining land use will be appropriate native vegetation ecosystems. At the request of the WCCCC, RTA may establish post-mining land use options other than those required by regulation, subject to obtaining all necessary government approvals.

3.7.3 Commitments

Performance Criteria

The performance criteria for land management are:

- Compliance with the requirements of the environmental authority, and
- Rehabilitation of areas disturbed by mining activities and infrastructure to a stable landform with a self-sustaining vegetation cover able to sustain the proposed post-mining land use.

Implementation Strategy

Erosion and sediment control

The proposed erosion and sediment control measures to be employed throughout the life of the Project are summarised below:

- The *Engineering Guidelines for Queensland for Soil Erosion and Sediment Control* (IE Aust 1996) will be followed;
- Restrict clearing to areas essential for mining to minimise length of time soil is exposed;
- Traffic will be confined to maintained tracks and roads;
- Vegetation clearing will occur following the wet season;
- Vegetation buffers will be established, which provide "setback" distances of mining areas from riparian, wetland and estuarine vegetation, to minimise sediment transport into streams and to protect sensitive vegetation types;
- Storm water and runoff from upstream catchments will be diverted away from active mining and disturbed areas;
- Active mining pits and backfilled pits awaiting rehabilitation will be lower than surrounding landform, which effectively provides internally draining sumps that contain storm water runoff. Contained storm water runoff then infiltrates through the pit floor and walls;
- Areas disturbed by mining activities and infrastructure are to be rehabilitated to a stable landform with a self-sustaining vegetation cover and where possible post mining drainage flows will emulate pre mining flows;
- In the event that active or backfilled pits are not fully internally draining, storm water runoff would be directed via a sediment pond;
- Where mining leaves batters on the edges of the pit, these will be recontoured to a maximum slope of 20% (one in five);
- Mine development work will be completed during the dry season where possible;
- Disturbed areas around construction sites will be rehabilitated promptly, and
- Sediment traps will be included as part of the drainage designs at points where haul roads cross watercourses.

An Erosion and Sediment Control Management Plan will be prepared prior to construction.

Contamination Prevention

A number of Notifiable Activities are proposed to be undertaken within the Project area (see **Table 2-2**). These activities have the potential to cause land contamination through spills, leaks or uncontrolled runoff from contaminated areas.

Potentially contaminated runoff from the heavy equipment workshops and service bays, fixed-plant workshops, and light vehicle and heavy vehicle wash-down areas will be directed to mine industrial area drainage slots (see **Figure 6** and **Figure 7**) from where it will be recycled to the tailings storage facility.

Hydrocarbons will be stored and handled in the heavy equipment workshop and service bays, fixed-plant workshops, and diesel and oil storage areas within the Boyd and Norman Creek infrastructure areas. Fuel storage areas have the potential to cause land contamination through leaks, spills and rupture of tanks. Contamination will be prevented by bunding fuel storage areas. Flammable and combustible liquids, including petroleum products, will be stored and handled in accordance with *AS1940:2004 The Storage and Handling of Flammable and Combustible Liquids*. The potential for contamination of land and waters will be minimised by diverting storm water around contaminated areas and facilities used for the storage of chemicals and flammable or combustible liquids.

There is the potential for land contamination to arise from hydrocarbons spills in workshops and hydrocarbon storage areas during operations. This potential will be minimised through the development and implementation of standard operating procedures for transport, handling and storage of hydrocarbons. Employees will be trained in hydrocarbon handling and emergency spill response.

Mineral Wastes

The subsoil and overburden above the bauxite are benign and there will be no out-of-pit dumps of excavated wastes. Tailings are also benign and will be contained in tailings storage facility structures. There is no risk of soil or water contamination from excavated subsoil and overburden or tailings, therefore no specific management strategies are required.

Final Landform

Areas disturbed by mining activities and infrastructure are to be rehabilitated to a stable landform with a self-sustaining vegetation cover. After overburden and soil are returned to mined-out pits the final rehabilitated landform will be at a lower elevation than the original landform due to the removal of the bauxite, but the overall slope of the landform will be similar. Where mining leaves batters on the edges of the pit, these will be recontoured to a maximum slope of 20% (one in five). The final landform will not have any out-of-pit dumps of excavated wastes or soil.

The tailings storage facility embankments and surface will be revegetated after decommissioning and minor earthworks undertaken to install suitable water management features.

Rehabilitation strategy

The rehabilitation strategy for the Project is consistent with the *Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland – Determination of Post-Mine Land Use* (DME/DEH 1995). The strategy consists of the following integrated measures:

- Implementation of practical landform designs, to prevent erosion and establish final landform stability;
- Revegetation trials, for selection of appropriate revegetation species and methodologies;
- Progressive rehabilitation of disturbed areas as areas become available and in accordance with the Plan of Operations, using rehabilitation procedures appropriate to the type of disturbance;
- Appropriate management of the final bauxite processing waste, including construction of an earth cover; and
- Implementation of erosion-control measures, consistent with the practices described in the *Technical Guidelines for Environmental Management for Exploration and Mining in Queensland – Erosion Control* (DME/DEH 1995).

Topsoil Management

Prior to mining, all topsoil, subsoil and waste bauxite overlying the surface of the bauxite is stripped. Soil moisture levels would be assessed before soil stripping commences to ensure the soil is not so wet that it will lose its structure when handled. Approximately 600mm soil will be stripped and directly placed on mined-out areas in readiness for regeneration, however, if required soil will be stockpiled. If soil is stockpiled, it will be managed as to maintain optimum growth media properties by maximising the stockpile surface area and minimising compaction. Stockpiled soil shall be typically used within one year to maximise the benefits of the natural seed bank and conserve symbiotic micro-organisms. Any soil stockpiled for more than one year will be sown with a native local seed mix to control weeds and erosion. Areas receiving stockpiled material are sown with a special seed mix containing additional species to the standard seed mix, including seed of species that usually "volunteer" from natural seed store in freshly returned topsoil, such as grasses and *Acacia* species. Procedures for topsoil stripping will be developed and included in the site rehabilitation procedure.

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Revegetation

At RTA's current operations north of the Embley River, the following approach is taken to revegetation:

- ripping the mine floor and compacted areas;
- respreading of freshly stripped topsoil or stockpiled topsoil;
- soil surface scarifying along the contour immediately before seeding;
- seeding with a seed mix of locally occurring native species at a density and richness to facilitate a self-sustaining local native ecosystem; and
- application of fertiliser at an appropriate rate, if required.

A similar revegetation methodology shall be adapted and refined for the Project area.

For areas disturbed by mining, the mine floor will be ripped with a bulldozer to a minimum depth of 500mm at 3.4m centres to break up the compacted mine floor and increase water filtration rates. Ripping may occur either through replaced material or directly through the mine floor. Other compacted surfaces to be rehabilitated, such as haul roads, will be repeatedly cross-ripped to ensure water infiltration and root penetration is achieved.

Native species seed mixes would be tailored to the anticipated post-mining conditions of the area to be rehabilitated. The proximity of the post-mined landscape to the wet season water table is the key factor determining which native plant community is the most appropriate for the post-mining landscape. Free draining areas are most suited to "Tall Darwin Stringybark woodland on lateritic red earths" and "Tall Darwin Stringybark woodland on yellow earths". Free draining, post-mining landscapes would be seeded with a range of tree, shrub and groundcover species from these communities. Post-mining landscapes likely to be less free draining and seasonally inundated are most suited to Melaleuca swamp and Melaleuca/Swamp mahogany vegetation communities.

Success Criteria

Preliminary rehabilitation success criteria for the Project area will be developed within three years of commencement of bauxite mining. On-site revegetation trials will be undertaken to test selected species, seeding rates and establishment methodologies. Success criteria will be based on the outcomes of the rehabilitation trials and on-going monitoring. Rehabilitation performance will be measured against the adopted criteria. Different success criteria may be developed for different developmental stages of each relevant vegetation community. The criteria may change over time as more rehabilitation knowledge relevant to the Project area is gained.

Soil indicators such as bulk density, surface cover and soil invertebrates are potentially suitable for the Project area. Appropriate indicators of ecological function may include framework species presence, species richness, structural composition, native species recruitment, presence of weed species, resilience to disturbance and fauna.

Decommissioning

The decommissioning and final rehabilitation of the Project will occur on a staged basis over several years. A Final Rehabilitation Report (FRR), which includes a contaminated site assessment, will be prepared prior to surrender of the mining lease. A contaminated site register will be maintained for the operation. Areas of soil contamination will be investigated prior to rehabilitation. Contaminated sites will be managed using methods developed on a case-by-case basis in accordance with DERM guidelines.

On the completion of mining, buildings, structures and other infrastructure will be treated as follows:

- The barge/ferry terminal, port, water-supply dam and certain roads may have some on-going beneficial use. Subject to agreement with relevant regulators and Traditional Owners, certain of these facilities may be left in place. Otherwise, RTA shall remove these facilities; and
- Buildings, plant, equipment, tanks, conveyors, pipelines and transmission lines shall be removed and the surface rehabilitated. Concrete pads will be broken up, buried, and then the area rehabilitated.

Monitoring

A monitoring program will be developed to regularly assess the success of rehabilitation against preliminary completion criteria.

The monitoring would focus on a range of indicators that reflect vegetation composition and structure and may include species richness and density, structural composition, native species recruitment and presence of weed species. The monitoring methodology is likely to be similar to that currently used for operations north of the Embley River and include:

- monitoring in the first year after establishment at a scale of one 500m^2 transect plot per 10 hectares of rehabilitation, and
- follow-up monitoring four, eight and 12 years after establishment.

Soil indicators such as bulk density, surface cover and soil invertebrates may be useful indicators in some situations and may also be monitored. Fauna indicators such as representative species of soil mites, ants, birds, mammals and reptiles may be useful indicators in some situations and may also be monitored.

The outcomes of the monitoring program will be used to refine rehabilitation success criteria, identify areas that may need remedial measures, plan progressive certification of the acceptability of rehabilitation areas and, in the longer term, relinquishment.

The impacts of both controlled burning and wildfire on rehabilitation areas will be monitored.

An erosion monitoring procedure has been developed and implemented at the existing RTA mining operations north of the Embley River, and a similar procedure will be implemented for the Project. After the end of the wet season each year, mined areas and other potential erosion sites will be visually monitored to identify active erosion rills and gullies. Areas where erosion has remediated previously will also be monitored.

3.7.4 Proposed Environmental Authority Conditions: Schedule G – Land

Note: The draft conditions in this Schedule are subject to change due to the pending approval of the ML7024 Environmental Authority for the existing Weipa mining operations.

Land

G1 All buildings, structures, mining plant and equipment erected and/or used for the mining activities must be removed from the site prior to surrender of this environmental authority except where agreed in writing by the administering authority and the landowner.

Chemicals and flammable or combustible liquids

G2 All explosives, hazardous chemicals, corrosive substances, toxic substances, gases, dangerous goods and flammable and combustible liquids must be stored and handled in accordance with the relevant Australian Standard where such is applicable.

Where no relevant Australian Standard exists, store such materials within an effective on-site containment system.

Advisory note regarding condition G2:	
An effective on-site containment system would be:	
Storage tanks -	bunded so that the capacity and construction of the bund is sufficient to contain at least 110% of a single storage tank or 100% of the largest storage tank plus 10% of the second largest storage tank in multiple storage areas.
Drum storages -	bunded so that the capacity and construction of the bund is sufficient to contain at least 25% of the maximum design storage volume within the bund.

G3 Flammable and combustible liquids, including petroleum products, must be stored and handled in accordance with *AS 1940:2004 The storage and handling of flammable and combustible liquids.*

G4 Minimise the potential for contamination of land and waters by diverting storm water around contaminated areas and facilities used for the storage of explosives, hazardous chemicals, corrosive substances, toxic substances, gases, dangerous goods, and flammable or combustible liquids.

Rehabilitation

G5 Land disturbed by mining activities must be rehabilitated to satisfy the objectives contained in condition G8 or developed in accordance with condition G9.

G6 Rehabilitation must commence progressively as areas become available and in accordance with the Plan of Operations.

G7 Reasonable and practicable measures will be employed to make rehabilitated land safe for humans and wildlife, non-polluting, stable and able to sustain the proposed post-mining land use(s).

G8 Rehabilitation objectives shall comprise appropriate native vegetation ecosystems unless alternative land use systems are agreed in accordance with G9.

G9 Alternative land use systems will be considered on the basis of stakeholder consultation and regulatory approval, and in accordance with G7.

G10 Develop suitable rehabilitation completion criteria for all proposed land uses within three years of commencement of bauxite mining.

G11 A rehabilitation monitoring program must be developed and implemented within three years of commencement of bauxite mining.

G12 Each Plan of Operations will:

(a) identify land to be rehabilitated during the term of the Plan of Operations;

(b) identify rehabilitation objectives for the land to be rehabilitated;

(c) include works and measures to be undertaken so as to meet the rehabilitation objectives for the land to be rehabilitated;

(d) state a rehabilitation monitoring program (providing for at least annual monitoring) for the land to be rehabilitated;

(e) state continuing rehabilitation monitoring requirements for any land previously rehabilitated, and

(f) include a program of actions to identify rehabilitation objectives for lands to be rehabilitated under future Plans of Operations.

END OF CONDITIONS FOR SCHEDULE G

3.8 Nature Conservation

3.8.1 Value/Background

Terrestrial flora, fauna and biodiversity studies have occurred over the Project area. These are described in RTA (2010). The marine and freshwater aquatic ecology of the Project area are also described in RTA (2010).

Marine

Albatross Bay is recognised as containing environmentally important marine habitats (Baker and Sheppard 2006). There are no declared Fish Habitat Areas (FHA) under the *Fisheries Act 1994* (Qld) in the vicinity of the Project. The State Government is proposing to declare Albatross Bay as a FHA and is currently conducting public consultation about the proposal.

While the vast majority of the Gulf of Carpentaria consists of sandy and muddy habitats, some reef habitat occurs. Fringing reef communities have established over the ironstone formations in the vicinity of Pera Head and Boyd Point. The importance of these reef systems in a regional context is considered to be high as they support resources which are of conservation, cultural, commercial and recreational importance. In particular, the nearshore reefs are considered to provide a food resource for a range of turtle species in the area.

Seagrass beds also provide habitat for a number of species of conservation significance. Seagrass beds are typically present in the more sheltered areas of Albatross Bay, including the lower reaches of the Embley and Mission Rivers and Pine River Bay, and are largely restricted to shallow sand and mud banks of less than four metres below mean sea level (MSL) (Roelofs *et al*. 2003).

The Albatross Bay mangrove assemblage is extremely diverse and is the most extensive system of mangroves on the eastern Gulf of Carpentaria. Mangroves are absent from the foreshores at and adjacent to the port site. The foreshore at the location of the Hey River barge/ferry terminal has a thin mangrove fringe (one to two trees wide), established over a mud and gravel shore at the base of a low pisolite plateau.

Ten marine species of conservation significance under the *Nature Conservation Act 1992* (Qld) (NC Act) have been identified as known to occur, likely to occur, or possibly occurring in the vicinity of the Project. Fourteen marine species listed under the *Environment Protection and Biodiversity Conservation Act 1999* (Cwlth) (EPBC Act) have been identified as known to occur, likely to occur, or possibly occurring in the vicinity of the Project area. Of these species, those that are known to occur within the Project area are shown in **Table 3-13**.

Descriptions of these species and their habitats are provided in RTA (2010).

Table 3-13 Marine Species of Conservation Significance - Known to Occur

Species	NC Act Status	EPBC Act Status
Estuarine Crocodile (*Crocodylus porosus*)	Vulnerable	Migratory
Indo-Pacific Humpback Dolphin (*Sousa chinensis*)	Near threatened	Migratory
Australian Snubfin Dolphin (*Orcaella heinsohni*)	Near threatened	Migratory
Dugong (*Dugong dugon*)	Vulnerable	Migratory
Hawksbill Turtle (*Eretmochelys imbricata*)	Vulnerable	Vulnerable, Migratory
Flatback Turtle (*Natator depressus*)	Vulnerable	Vulnerable, Migratory
Olive Ridley Turtle (*Lepidochelys olivacea*) (also known as the Pacific Ridley Turtle under the NC Act)	Endangered	Endangered, Migratory

Freshwater Aquatic Ecology

A number of different aquatic habitats occur in the Project area including:

- Perennial flowing streams;
- Semi-perennial coastal lakes and lagoons;
- Perennial channel hosted pools and lagoons;
- Coastal swale swamps;
- Tree swamps;
- Seasonal stream channels;
- Seasonal coastal lakes;
- Spike rush swamps;
- Drainage depressions and flood runners;
- Groundwater seepage zones and springs; and
- Estuaries.

The Project area sheds runoff from a centrally located topographic high to the west via Ina and Norman Creek (with four major tributaries), to the north via Triluck - Winda Winda Creek (with three major tributaries), Roberts and Leithen Creeks (the latter two primarily estuarine), to the east via unnamed tributary drainages of the Hey River estuary and to the south via the Ward River system (with two named tributaries, Coconut and Tappelbang Creek). A number of smaller, less-defined drainage depressions also flow independently to the Gulf of Carpentaria between these named drainage systems. Coconut and Tappelbang Creeks have their headwaters in the Aurukun Project area to the east of the Project. Within the Project area there are also several swamps that occur in depressions within the bauxite plateau, which are largely isolated from defined drainage networks.

The southern extremity of the Project area overlaps with the Archer Bay Aggregation, which is a nationally significant wetland area listed in the Directory of Important Wetlands (DIWA) (Blackman *et al.* 1999).

A full summary of the Cape York Peninsula Land Use Strategy (CYPLUS) (Abrahams *et al.* 1995) assessment of conservation values is provided in RTA (2010). With respect to aquatic ecosystems, two areas of conservation significance were identified adjacent to the Project area comprising:

- the estuary of the Embley River, which is the only known habitat of River Garfish (*Zenarchopterus buffonis*) on Cape York Peninsula, and
- the Aurukun Wetlands to the immediate south of the Project area, which have natural conservation significance due to a number of wetland and terrestrial biodiversity attributes.

The northernmost portion of the Project area is within the catchment of the Embley River. The southernmost portion of the Project area is within the catchment of the Ward River, which drains to the Aurukun Wetlands.

A total of 45 species of fish were recorded from the study area from combined field sampling conducted during May 2008 and 2009 (RTA 2010).

Four species listed under the EPBC Act have been identified as being likely to occur or possibly occurring in the Project area. However, no threatened aquatic species listed under the NC Act or the EPBC Act were confirmed as present within the Project area.

Several vulnerable or near threatened species, which may be considered semi-aquatic or dependent upon aquatic ecosystems of the Project area, were recorded during field surveys, including the Black-necked Stork (*Ephippiorhynchus asiaticus*) and Radjah Shelduck (*Tadorna radjah*).

Terrestrial Flora

The Weipa area is located within the Cape York Peninsula Bioregion. The Project area and wider Weipa area are located within the Weipa Plateau province (subregion) of the Cape York Peninsula

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Bioregion. This area is relatively homogenous in vegetation and landform, and is characterised by large areas of Darwin Stringybark (*Eucalyptus tetrodonta*) open forests or woodlands, dissected by smaller areas of riparian vegetation, vine thicket patches and paperbark swamps.

Thirty two vegetation (land) units defined by Godwin (1985) and Gunness *et al.* (1987) were mapped in the Project area with three of these being further divided into sub units for a total of 38 vegetation units. Subdivision was required to adequately describe the vegetation variation evident in the Project area that was not present in the Weipa area where the vegetation unit scheme was originally derived. Of these, unit 2b (*Eucalyptus tetrodonta/ Corymbia nesophila* Tall Woodland on lateritic red earths) is the most widespread vegetation type, accounting for approximately 86% of the vegetation within the Project area and occurring almost exclusively upon the bauxite plateau areas where mining occurs. The remaining vegetation units are of much smaller spatial extent within the Project area and associated predominantly with drainage systems and coastal complexes peripheral to the bauxite plateau. Detailed descriptions of the vegetation of the Project area are provided in RTA (2010).

Of the 26 regional ecosystems (REs) occurring in the Project area, three are listed under the *Vegetation Management Act 1999* (Qld) (VMA) as "of concern":

- RE 3.2.3 *Melaleuca dealbata* ± *Acacia crassicarpa* open forest. Occurs in dune swales on the west coast;
- RE 3.2.6a *Casuarina equisetifolia* woodland. Occurs on foredunes; and
- RE 3.2.25 Sparse herbland of mixed herbaceous species on foredunes and beach ridges.

Regional ecosystem 3.5.2 (*Eucalyptus tetrodonta*, *Corymbia nesophila* tall woodland on deeply weathered plateaus and remnants), corresponding with vegetation unit 2b and 2c1, is the most widespread RE within the Project area comprising 87,465 ha or approximately 86% of the Project area. There are no endangered regional ecosystems within the Project area.

The EPBC search did not identify any Endangered Ecological Communities (EEC) as likely to occur within the Project area, and none were identified during the field surveys.

A total of 519 plant taxa have been recorded from all vegetation types within the Project area based on results of preliminary and EIS surveys (RTA 2010).

Six flora species listed under the EPBC Act were identified as potential inhabitants of the Project area and the following two species were confirmed:

- *Dendrobium bigibbum* Cooktown Orchid (vulnerable). Occurs within footprints of Dam C, and in the vicinity of a proposed access road crossing of an upper Norman Creek tributary, and
- *Dendrobium johannis* Chocolate Tea Tree Orchid (vulnerable). Occurs within the infrastructure corridor downstream of Dam C, and in the vicinity of proposed access road crossings of Winda Winda Creek and an upper Norman Creek tributary.

Of the 15 NC Act-listed species identified as known to occur, likely to occur, or possibly occurring in the Project area, only three species were confirmed as present in vegetation surveys. These include:

- *Dendrobium bigibbum* Cooktown Orchid (vulnerable)
- *Dendrobium johannis* Chocolate Tea Tree Orchid (vulnerable).

No weeds or introduced flora species have been confirmed as occurring within the Project area although there was an unverified sighting of the invasive scrambler Rubber Vine (*Cryptostegia grandiflora*) on the lower reaches of Norman Creek.

Terrestrial Fauna

A total of 269 native terrestrial vertebrate fauna species were recorded from all habitat types within the Project area based on the results of EIS surveys and preliminary studies (RTA 2010). About 98 species or approximately 36% of the total compliment of species from the Project area have been identified from Darwin Stringybark open woodland, which is the habitat that occurs almost exclusively on the bauxite plateau. A detailed list of the fauna species recorded from the Project area indicating the relative abundance and habitats for each species and the results for each of the twelve

comprehensive survey sites is provided in RTA (2010). A summary of species numbers is provided in **Table 3-14**.

Table 3 – 14 Native Fauna Diversity Recorded within the Project Area

	Birds	Mammals	Reptiles	Amphibians	Total
Eucalyptus tetrodonta habitat	62	10	23	3	98
All habitat types	184	23	45	17	269

Three species listed under the EPBC Act have been identified as possibly occurring in the Project area, however none were located during surveys. Two of these species are listed as vulnerable with one species (*Dasyurus hallucatus* - Northern Quoll) listed as endangered. No EPBC Act species are known to occur within the Project area.

A large group of bird species recorded in the Weipa region are listed in international agreements and conventions such as the Japan-Australia Migratory Bird Agreement (JAMBA), the China-Australia Migratory Bird Agreement (CAMBA) and the Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention), and are covered by the EPBC Act.

The following 20 species were confirmed as present in the Project area during EIS surveys:

- *Acrocephalus stentoreus* Clamorous Reed-Warbler;
- *Apus pacificus* Fork-tailed Swift;
- *Ardea alba* Great Egret, White Egret;
- *Charadrius mongolus* Lesser Sand Plover;
- *Crocodylus porosus* Estuarine Crocodile, Salt-water Crocodile;
- *Egretta sacra* Eastern Reef Egret;
- *Fregata minor* Great Frigatebird;
- *Fregata ariel* Lesser Frigatebird;
- *Haliaeetus leucogaster* White-bellied Sea-Eagle;
- *Hirundapus caudacutus* White-throated Needletail;
- *Merops ornatus* Rainbow Bee-eater;
- *Myiagra cyanoleuca* Satin Flycatcher;
- *Numenius madagascariensis* Eastern Curlew;
- *Numenius phaeopus* Whimbrel;
- *Pandion haliaetus* Osprey;
- *Plegadis falcinellus* Glossy Ibis;
- *Rhipidura rufifrons* Rufous Fantail;
- *Sterna albifrons* Little Tern;
- *Tringa nebularia* Common Greenshank, and
- *Tringa stagnatilis* Marsh Sandpiper.

Twenty of the 44 species identified as potential inhabitants of the Project area are trans-equatorial migratory waders, which arrive in Australia each spring and disperse throughout the continent to feeding grounds amongst coastal and wetland habitats. The western Cape York coastline is known as a major entry corridor for many individuals of these species travelling to eastern Australia. The Project area, however, is not regarded as providing key feeding grounds for these waders and this is

supported by observations of a relatively low diversity of wader species and low numbers of individuals during field surveys.

The remaining species are known to undertake seasonal migratory movements within mainland Australia or to the mainland from areas to the north including Papua New Guinea and eastern Pacific islands.

Sixteen terrestrial fauna species listed under the NC Act have been identified as known to occur, likely to occur, or possibly occurring in the vicinity of the Project. Three species listed under the EPBC Act (not including marine/migratory species) have been identified as possibly occurring in the vicinity of the Project area. Of these species, those that are known to occur within the Project area are shown in **Table 3-15**. Descriptions of these species and their habitats are provided in RTA (2010).

Table 3–15 Fauna Species of Conservation Significance - Known to Occur

Species	NC Act Status	EPBC Act Status
Crocodylus porosus Estuarine crocodile	Vulnerable	Marine Migratory (see Table 3-13)
Ephippiorhynchus asiaticus Black Necked Stork	Near Threatened	
Esacus magnirostris Beach Stone Curlew	Vulnerable	
Ninox rufa meesi Rufous Owl	Near Threatened	
Numenius madagascariensis Eastern Curlew	Near Threatened	
Probosciger aterrimus macgillivrayi Palm Cockatoo	Near Threatened	
Sterna albifrons Little Tern	Endangered	
Tadornah radjah Radjah Shelduck	Near Threatened	

In summary, the potential impact to habitat is as follows:

- *Crocodylus porosus* Estuarine Crocodile (vulnerable) – The Estuarine Crocodile was recorded in all freshwater and marine habitats in the Project area. Overall, the species is widespread and numerous within the study area. Foraging and nesting habitat for this species occurs with the footprint of Dam C;
- *Ephippiorhynchus asiaticus* Black Necked Stork (near threatened) – Project-related disturbance will not detrimentally affect preferred habitat types;
- *Esacus magnirostris* Beach Stone Curlew (vulnerable) – The area where the Hey River barge/ferry terminal is located supports the species but habitat will not be substantially affected;
- *Ninox rufa meesi* Rufous Owl (near threatened) – The riparian gallery forest area where the species was recorded occurs within the footprint of Dam C. The majority of potential wetland and riparian gallery forest habitat for the species will not be disturbed by mining or infrastructure;
- *Numenius madagascariensis* Eastern Curlew (near threatened) – The preferred intertidal habitat of this species will not be affected by mining or infrastructure development apart from minimal disturbances associated with the port and the Hey Point barge/ferry terminal;
- *Probosciger aterrimus macgillivrayi* Palm Cockatoo (near threatened) – The Project-related disturbance would disturb known nesting sites of the Palm Cockatoo in the Dam C footprint, although the majority of preferred habitat areas will not be disturbed by the Project,
- *Sterna albifrons* Little Tern (endangered) – Several Little Terns were observed with other shorebirds near the mouth of Waterfall Creek. The species is likely to forage in coastal and estuary areas. The only development in coastal and estuarine areas in the port and the barge and ferry terminals, which are outside the preferred breeding environments for the Little Tern, and

- *Tadornah radjah* Radjah Shelduck (near threatened) – The preferred habitat of this species will not be affected by mining or infrastructure development.

Six species of introduced fauna were detected during the survey, including three species listed under the *Land Protection Regulation 2002* (Qld) (class two pest animals):

- feral cat;
- dingo/dingo hybrid;
- feral pig;
- cane toad;
- feral horse; and
- feral cattle.

3.8.2 Objectives

The environmental protection objective is to manage flora and fauna at the mine site and to minimise the risks to flora and fauna outside the immediate mine and industrial areas.

3.8.3 Commitments

Performance Criteria

The performance criteria for nature conservation are:

- Comply with the conditions of the EA; and
- No unauthorised clearing of native vegetation.

Implementation Strategy

The primary mitigation measures for reducing the loss of flora and fauna habitat include:

- Restrict clearing of vegetation for mining and infrastructure to the minimum required for the safe operation of mining equipment and infrastructure;
- No vegetation should be cleared outside of the mine plan/infrastructure footprint for infrastructure or purposes that could be accommodated within areas already disturbed by mining or to be disturbed by mining (e.g. borrow pits, laydown areas, access tracks);
- Wherever possible, linear infrastructure such as roads, tracks, pipelines, power lines should be located in a single consolidated infrastructure corridor rather than several smaller corridors; and
- Plan for clearing of vegetation and stripping of topsoil to occur as soon as practicable before mining to avoid redundant clearing of vegetation due to changes in the mine plan.

A number of sensitive environmental areas for flora have been identified and are described in **Table 3-16**. These comprise areas of particular local, regional or national significance with respect to habitat values, biodiversity, presence of threatened species, conservation status, refugial function, or landscape connectivity function.

The disturbance of sensitive environmental areas by mining will be avoided by the development of an environmental buffer system. The system will comprise a methodology for determining set-back distances from sensitive vegetation types and the preclusion of mining from within the designated buffers.

The sensitive vegetation to be buffered by Darwin Stringybark woodland will comprise the following vegetation types; riparian, wetland, estuarine, vine forest, and coastal vegetation on sand.

Table 3–16 Sensitive Environmental Areas for Flora

Flora Attribute/Area	Description
"Of Concern" Regional Ecosystems.	Of concern REs occupy approximately 411ha (1.3%) of the Project area comprising 3.2.3, 3.2.6a, and 3.2.25. All of these REs are located within Land Zone 2, which comprises coastal sand dunes and swales. Land Zone 2 would not be disturbed for mining.
Riparian gallery forest and adjoining alluvial/collegial flats along groundwater fed sections of freshwater streams. (i.e. veg units 4a1,4a3, 5e, 5j1, 5j2).	This vegetation community is associated with shallow aquifer discharge at the periphery of drainage corridors (base of the bauxite plateau) and directly into streams. The floristic diversity of these areas is very high relative to their spatial extent and dependent on continued groundwater discharge. The vegetation types within these areas are also confirmed and are a potential habitat for a high number of threatened flora species.
Semi-permanent groundwater springs/seepage areas with rainforest/palm closed forest.	These closed forests are of very limited spatial extent but provide refugia for rainforest flora and contain flora species not occurring in other vegetation units. These areas are dependent on groundwater discharge. The vegetation is variable and range from rainforest with vines and palms, to riparian gallery forests, to ferny swamp forest with rainforest species which has affinities for unit 4a2.
Vine Forest on coastal sands and the bauxite plateau.	Vine forest patches provide a refugial function for flora and supports threatened flora. Vine Forest on the bauxite plateau is most likely indicative of an historic vegetation community where closed forest vegetation was more widespread than currently distributed.

The buffer system will exceed the minimum requirements of the Queensland Government's Regional Vegetation Management Codes as they relate to clearing set-back distances from watercourses and wetlands. In Cape York, the recommended minimum buffer distances from watercourses vary depending on stream order and, from wetlands, they depend on the significance of the wetland (DERM 2009b). These buffer distances are:

- A 50m buffer from each high bank of a watercourse with stream order one or two;
- A 100m buffer from each high bank of a watercourse with stream order three or four;
- A 200m buffer from each high bank of a watercourse with stream order five and above;
- A 100m buffer from a natural wetland; and
- A 200m buffer from a natural significant wetland.

A variable environmental buffer system will be implemented that takes into account factors such as sensitive vegetation type, important locations of threatened flora and fauna, stream order and hydrology when determining buffer distances. In all cases the above Code requirements will be met or exceeded.

Surveys will be carried out to define the boundaries of mapped sensitive vegetation types in the field. The field surveys will be carried out prior to clearing for drill lines (which are typically established for detailed orebody definition) and prior to clearing ahead of mining. The surveys will also assess the stream order of any watercourses and the presence or absence of significant ecological features such as springs, aquatic refugia and threatened flora and fauna in and around the sensitive vegetation types.

Buffer distances will then be set based on the findings of the surveys and, where relevant, stream order. Establishment of the buffer distance and authorisation for clearing non-buffered areas would be managed through a ground disturbance approval.

With respect to potential weed impacts, a weed management program comprising monitoring and control components will be important to prevent impacts on undisturbed vegetation. A weed management plan will be developed and implemented prior to commencement of construction. The main focus of the weed management program should be early detection and early control of any weed invasions. The weed management plan will include the following management strategies:

- Prior to the establishment of the mine access road, any vehicles travelling to the Project area would be required to be washed down for weeds;
- Wash-down facilities will be provided at the Humbug barge terminal and all vehicles thoroughly washed before transfer to the Hey River barge/ferry terminal and site access road;

- Wash-down facilities will be constructed, positioned and managed such that wash water and soil is contained and not released to the surrounding ecosystems;
- Training courses will be conducted regularly for all mine personnel highlighting significant weed species and basic identification features for weeds likely to be encountered on the site, and identification charts will be posted in prominent areas around the mine site;
- Protocols will be established for easy reporting of weed occurrence by any personnel working on site and be of a format that encourages reporting;
- Results of the weed survey and any weed reporting will be uploaded to the site geographic information system in a timely manner so that weed mapping is maintained as a live database; and
- Any weed infestation areas will have controlled access until appropriate treatment and suppression is complete and there is no risk of propagules being translocated.

The primary mitigation measure for avoiding long-term impacts on the fauna community is to implement a program of post-mining vegetation/habitat regeneration that seeks to establish similar habitats to the pre-mining landscape and include as far as possible, key flora species from the pre-mining vegetation communities (refer to **Section 3.7.3**). In the event that injured fauna is identified on the site, personnel trained in handling injured fauna will be accessed to manage the injured fauna in an appropriate manner.

A fire management program and feral animal control program will be prepared to mitigate impact to threatened fauna in undisturbed areas by enhancing the current habitat values in these areas. The fire management program will also aim to protect infrastructure and rehabilitated areas from fire damage.

RTA are consulting with Traditional Owners under the auspices of the relevant WCCCC Sub-committee to develop a Community, Heritage and Environment Management Plan (CHEMP) as a long-term management strategy, which will include flora and fauna, weeds, and environmental monitoring.

Fish way structures will be incorporated into each water supply dam spillway to provide aquatic habitat connectivity as part of waterway barrier permits under the *Fisheries Act 1994* (Qld).

Monitoring

A selective vegetation monitoring program will be carried out to identify any effects on vegetation from edge effects and altered hydrological regime (and any other causes) and investigate measures to minimise similar future impacts. The vegetation monitoring program will have the following attributes:

- Monitoring sites would be established in representative areas of sensitive vegetation units occurring adjacent to mining areas and in downstream areas, both in terms of surface and groundwater hydrology. The monitoring sites would include seasonally stratified sampling data prior to mining or development (i.e. one late wet/early dry season and one pre-wet season survey event);
- Specimens will be collected for herbarium identification if the plant cannot be identified;
- Control sites for each vegetation unit should be established within the Project area in areas well away from proposed mining or infrastructure that are unlikely to experience surface or groundwater modification, and
- Monitoring would be undertaken periodically at an interval that would allow effective remediation should significant adverse impacts become evident.

Monitoring of the mangrove ecotonal boundary would also be undertaken using aerial photography.

A weed management program will be developed and implemented prior to commencement of construction, and will include details of a weed monitoring program. The weed monitoring program will include the following:

- Annual weed surveys will be conducted post-wet season targeting:
    - all operational areas (mining and infrastructure) and immediately adjacent ecosystems, and

- site access roads.

- Periodic weed surveys will be conducted at least every three years targeting:
  - habitats where key weed species are most likely to become established, and
  - areas within the mining lease where there is high recreational visitation (especially riparian and wetland areas).

Detailed mapping of the above areas will form the basis of the weed management program and guide annual weed surveys.

Fish species composition will be surveyed above and below Dam C after one year of operation. Periodic (three to five years) monitoring of freshwater aquatic fauna will be undertaken in reaches upstream and downstream of the water supply dam.

3.8.4 Proposed Environmental Authority Conditions: Schedule H – Nature Conservation

Note: The draft conditions in this Schedule are subject to change due to the pending approval of the ML7024 Environmental Authority for the existing Weipa mining operations.

H1 A weed management program must be implemented prior to the commencement of construction activities.

Advisory note regarding condition H1: As per the *Land Protection (Pest and Stock Route Management) Act 2002* (Qld) a person must not introduce or release a declared pest anywhere in the State. For further information go to http://www.deedi.qld.gov.au.

END OF CONDITIONS FOR SCHEDULE H

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3.9 Waste Management

3.9.1 Value/Background

The environmental value to be protected or enhanced is the life, health and well-being of people and the diversity of ecological processes and associated ecosystems surrounding the Project. Inappropriate disposal of waste may lead to contamination of land and water causing adverse effects on ecosystem health.

The major sources of waste with the potential to cause impacts are:

- Green waste/cleared vegetation;
- Tailings;
- Oversize material;
- Excavated waste (including subsoil and overburden, waste rock, dredged material and contaminated soil);
- Regulated waste (e.g. oily rags, oily absorbent matting, oil filters, solvents, lubricants, coolant, paints, resins, light and heavy vehicle tyres, clinical waste);
- General waste (e.g. benign construction waste, plastic and wood products, clean rubber hose, computer and electrical equipment, food scraps, wrapping paper and rags, ship waste);
- Recyclable general waste (e.g. printer toner cartridges, aluminium cans);
- Recyclable scrap metal (e.g. beneficiation screens, conveyor rollers, scrap steel, bulk swarf, clean drums);
- Recyclable regulated waste (e.g. batteries, waste oil)
- Sewage effluent and sewage sludge; and
- Ballast water.

Tailings

Beneficiation produces tailings consisting of water, fine bauxite pisolites, sands and clays. Approximately 0.4Mt of tailings is produced for every 1Mdpt of bauxite. Depending on the source of crude ore, the geotechnical classification of tailings ranges from a sandy silt with clay to a clayey silt. Bauxite tailings are benign, contain no added chemicals and are not classed as hazardous under the DERM criteria for *Determining Dams Containing Hazardous Wastes* (EPA 2003). A geochemical assessment of tailings is described in RTA (2010).

Dredged Material

The potential for the dredge material from the port and barge/ferry terminal areas to be characterised as an acid sulphate soil has been assessed and is described in RTA (2010). For each of the dredge areas, sediments have the ability to generate acidity, however, it was evident this had not yet taken place. All sediments also had sufficient acid-neutralising capacity to neutralise any acid generated.

3.9.2 Objectives

Minimise the impact of waste on the environment by managing the following aspects of the operation effectively:

- excavated wastes;
- tailings;
- ballast water;
- regulated waste;
- sewage treatment plant wastes; and
- general construction and operational wastes.

3.9.3 Commitments

Performance Criteria

The performance criteria for waste management are:

- Volume of general and regulated wastes generated is minimised;
- All regulated waste is tracked and disposed of appropriately, and in accordance with EA criteria; and
- *Escherichia coli* (*E. coli)* levels in treated sewage effluent complies with EA criteria.

Implementation Strategy

The waste management strategy ensures compliance with regulatory requirements as a minimum and incorporates the waste minimisation hierarchy in order of preferred options:

- waste avoidance;
- waste re-use;
- waste recycling;
- energy recovery from waste; and
- waste disposal.

Waste generated on the Project during the construction, operation and decommissioning phases is minimised through:

- waste stream characterisation and separation;
- assessment of waste reduction opportunities for identified waste; and
- management of waste in accordance with the waste minimisation hierarchy.

A waste management program will be developed prior to construction. Waste streams are assessed for potential reuse, and if a feasible reuse option is not available, the waste will be transported to a licensed disposal facility by a licensed waste transporter. Wastes will be stored appropriately to prevent pollution until they are transferred off-site.

Certain types of regulated waste are defined as "trackable waste" in Schedule 1 of the *Environmental Protection (Waste Management) Regulation 2000* (Qld) (e.g. waste oil, clinical waste, sewage sludge, etc). Generators of trackable waste must record prescribed information about the waste and provide it to the transporter. Procedures for identification of regulated wastes and an appropriate waste tracking system for those wastes are maintained as part of the site's Environmental Management System (EMS).

Green Waste

Timber harvesting takes place on current mining areas north of the Embley River. There have been a number of recent studies undertaken to assess the economic sustainability of a timber harvesting operation for the area of the mining lease located south of the Embley River, including "Visions and Realities for a Wik Forestry Industry on Cape York Peninsula, Australia," undertaken by the University of Queensland School of Economics (Venn 2004).

RTA supports the establishment of a Traditional Owner timber harvest operation south of the Embley River that would harvest timber on areas of the mining lease proposed to be mined or cleared for development of Project infrastructure.

Green waste from vegetation cleared prior to mining will be pushed into windrows and burned.

Tailings

The tailings would be pumped in slurry form (30% solids by weight) from a tailings sump at the beneficiation plant to a tailings storage facility. The tailings storage facilities are "turkey's nest" dams where tailings are discharged from the perimeter wall into cells within the dam. The tailings solids will beach, suspended solids will settle out, and water will be decanted and pumped back to the beneficiation plant for reuse in processing. The tailings storage facilities are divided into cells to

facilitate the cycling of tailings perimeter deposition within a cell, and between cells, to enhance formation of a broad tailings beach adjacent to the perimeter walls that dries quickly to a consistent density over its full depth. Tailings storage facility walls will be raised in lifts of approximately three metres using the upstream raising technique.

The tailings storage facilities for the Boyd and Norman Creek beneficiation plants will be located close to the plants (see **Figure 4** and **Figure 5**). Prior construction of each cell, the economic bauxite reserves from within each cell will be mined and fed into the plant if it is operating, or stockpiled for later processing if not. This approach will avoid sterilisation of economic bauxite reserves and reduce the extent of clearing of vegetation. The final Boyd tailings storage facility will have a capacity of approximately 182Mt and cover an area up to 580ha. The final Norman Creek tailings storage facility will have a capacity of approximately 204Mt and cover an area of approximately 580ha.

Excavated Material

Excavated wastes include subsoil and overburden, waste rock, dredged material and contaminated soil. Topsoil is not considered a waste as it is retained for use in rehabilitation.

Overburden will be replaced into mined-out areas, there is no need for permanent waste rock dumps.

Sites that become contaminated will be investigated, managed and remediated in accordance with the requirements of the contaminated land provisions of the EP Act. Hydrocarbon contaminated soil will be excavated and treated on-site using bioremediation techniques in an on-site landfarm. Landfarm areas will be constructed near the sludge-drying ponds at the Boyd and Norman Creek infrastructure areas. The area will be bunded and water runoff collected in the site's water management system. Soil will be remediated to a level that meets the objective for final land use in accordance with the *Draft Guidelines for the Assessment and Management of Contaminated Land in Queensland* (EPA 1998).

General Waste

General wastes are collected and segregated on-site for re-use, recycling or disposal. Waste is transported off-site by a licensed waste contractor.

Regulated Waste

Any hazardous materials used on site will be recorded in a Hazardous Materials Register. This register will include details of storage location; storage requirements; proper usage; handling information; and disposal procedures. This information will be available in material safety data sheets (MSDSs) which will be kept for all materials and chemicals maintained within the Hazardous Materials Register.

In addition:

- *AS 1940:2004The storage and handling of flammable and combustible liquids* will be implemented on site;
- Contractors will provide a list of hazardous chemicals and their associated MSDS prior to bringing chemicals on site;
- No chemical will be allowed on site without an MSDS;
- A chemical register will be established on site;
- Corrosive materials will be stored and handled in accordance with *AS 3780.8 The storage and handling of corrosive substances* (Class 8 substances – corrosives);
- Fuels, oils and chemicals in containers of 200L or more will be stored in a bunded area with capacity of at least 110% of the largest container;
- Fuels, oils and chemicals in containers less than 200L capacity will be stored as above or in a fenced and roofed compound;
- All fuels, oils, and chemicals will be clearly labelled;
- Transfer of bulk fuel and handling of hazardous chemicals will be undertaken only by trained personnel;

- Spill clean-up kits, including absorbent materials, will be kept at each fuel and chemical storage facility;
- An area will be designated for the temporary storage or bioremediation of hydrocarbon contaminated soils; and
- Waste is transported off-site by a licensed waste contractor.

Sewage

During the initial construction phase, prior to the STP being commissioned, sewage will be stored in holding tanks and regularly trucked to Weipa for treatment by a licensed regulated waste transporter. This method would also be utilised if temporary mobile construction camps were used for the Mine Access Road or an accommodation barge used during dredging of the Port.

Once constructed, the construction camp would be serviced by a package STP via a gravity sewerage system. The treated effluent would be recycled for dust suppression, landscape watering or other appropriate uses on-site suitable for the quality of water.

The *Water Quality Guidelines for Recycled Water Schemes* (DNRW 2008) recommend the use of national or industry guidelines for irrigation for uses other than food crops. One of these, the *National Guidelines for Water Recycling: Management Health and Environmental Risks* (National Resource Management Ministerial Council *et al.* 2006), recommend that water used for landscape irrigation, including trees, shrubs and public gardens, should contain *E. coli* levels of less than 100 cfu/100mL.

Water Supply (Safety & Reliability) Act 2008 (Qld) does not apply to water service infrastructure used for mining purposes, however, in absence of defined criteria the water quality criteria for pathogens referred to under this Act (defined in Schedule 3D of the *Public Health Regulation 2005*) is proposed. The *E. coli* criteria for Class A Recycled Water are shown in **Table 3-17**. The regulations specify if a sample exceeds the criteria, then a follow-up sample must be taken, which must meet the "follow-up sample criteria". The annual criterion applies to an annual rolling average.

Table 3–17 Standard for Quality of Class A Recycled Water

Factor	Frequency of Sampling	Criteria	Follow-up Sample Criteria	Annual Value
E. coli	Weekly	100 cfu/100mL	10 cfu/100mL	10 cfu/100mL found in 95% of the samples taken for a 12-month period.

The STP at the construction camp will be designed and operated to treat water to meet the *E. Coli* criteria defined in Schedule 3D of the *Public Health Regulation 2005* (refer **Table 3-16**).

Once operational, sewage generated at the site will be treated using a biological aerobic modular system. The effluent from the secondary process will be treated by an ultra-filtration membrane in order to provide a "Class A" effluent. The effluent will be pumped to the process water pond for re-use in the beneficiation plant.

Each STP will have a sludge-drying bed to dry the small amount of sludge that will be generated. Water will be decanted and pumped back to the process water pond. The sludge-drying beds will be capped and rehabilitated or buried in pit at the end of the project life.

Ballast Water

All vessels owned and contracted by Rio Tinto will manage ballast water through a Ballast Water Management Plan, which will comply with the Australian mandatory requirements and the *International Convention for the Control and Management of Ships' Ballast Water and Sediments* (IMO 2004).

Monitoring

The Project will monitor the volume and type of general and regulated waste generated and undertake audits to:

- ensure correct segregation of different types of waste;
- monitoring for potential environmental impacts; and
- providing baseline data to enable continuous improvement of waste avoidance, reduction and management measures.

See also **Section 3.5.3** for groundwater quality monitoring in the vicinity of tailings storage facilities.

Monitoring of *E. coli* levels will be carried out regularly to verify performance of the STPs.

RTA will undertake regular mussel trap monitoring in the vicinity of the new port at such time that overseas ships are utilised. If an abnormal growth of organisms is detected, an appropriate response will be developed in consultation with relevant regulatory authorities.

3.9.4 Proposed Environmental Authority Conditions: Schedule I – Waste Management

Note: The draft conditions in this Schedule are subject to change due to the pending approval of the ML7024 Environmental Authority for the existing Weipa mining operations.

General and Regulated Waste Disposal

I1 General and regulated waste is authorised to be stored and disposed of at the Evans Landing Landfill located within the Cook Shire Local Authority Reserve identified as the Gonbung Refuse Tip on ML7024, or can be removed to an alternative facility that can lawfully accept these wastes.

I2 Waste that can be disposed of on the mining lease outside of the Evans Landing Landfill includes:

(a) Mine waste including green waste, waste bauxite and tailings; and,

(b) sewage sludge in drying beds located at the Awonga Point STP, the South of Embley construction camp, the Boyd infrastructure area and the Norman Creek infrastructure area.

I3 General and regulated waste generated in the mining activity can be temporarily stored on-site awaiting removal provided it is stored in a place and circumstance in which there is minimal risk of it causing a fire hazard or contamination of land or waters.

I4 A landfarm may be operated to treat hydrocarbon-contaminated soil to a level suitable for use in rehabilitation in a place and circumstance in which there is minimal risk of it causing contamination of land or waters.

I5 Tyres stored awaiting disposal or transport for take-back and recycling or waste-to-energy options should be stockpiled in volumes less than three metres in height, 200m^2 in area and at least 10m from any other tyre storage area.

I6 All combustible materials, including grass and vegetation, must be removed within a 10m radius of any scrap tyre storage area.

Waste Management Program

I7 A waste management program in accordance with Part 5 of the *Environmental Protection (Waste Management) Policy 2000* must be developed, implemented and maintained for all mining activities within the mining lease. The waste management program must include:

(a) a description of the mining activities that may generate waste; and

(b) the types and amounts of wastes generated by the mining activities; and

(c) a program for reusing, recycling or disposing of all wastes; and

(d) how the waste will be dealt with in accordance with the waste management hierarchy, including a description of the types and amounts of waste that will be dealt with under each of the waste management practices in the waste management hierarchy (i.e. avoidance, reuse, recycling, energy recovery, disposal); and

(e) procedures for identifying and implementing opportunities to minimise the amount of waste generated, promote efficiency in the use of resources and improve the waste management practices employed; and

(f) procedures for dealing with accidents, spills, and other incidents that may impact on waste management; and

(g) details of any accredited management system employed, or planned to be employed, to deal with the waste; and

(h) how often the performance of the waste management practices will be assessed; and,

(i) the indicators or other criteria on which the performance of the waste management practices will be assessed; and

(j) staff training and induction to the waste management program.

Acid sulphate soils

I8 Treat and manage acid sulphate soils in accordance with the latest edition of the administering authority's "*Queensland Acid Sulphate Soil Technical Manual*".

END OF CONDITIONS FOR SCHEDULE I

3.10 Community

3.10.1 Value/Background

The Project is located in the Western Cape Region, which includes the Aurukun, Mapoon, Napranum and Weipa communities. At the time of the 2006 Census, the total population of the four communities in the Western Cape region was 5191 people. Weipa accounted for most of the region's population with 3089 people, followed by Aurukun (1039 people), Napranum (829 people) and Mapoon (234 people). Extensive community consultation and social impact assessment was undertaken as part of the EIS and is described in RTA (2010).

The area of land south of the Embley River is primarily the traditional lands of the Wik and Wik Way people. The Wik and Wik Way people, by birth right, are the Traditional Owners of the Wik lands, which occupy a large area along the coastal floodplains lying between Pormpuraaw and Weipa and inland to the middle reaches of rivers such as the Archer, Kendall and Holroyd Rivers (O'Faircheallaigh 1996). There are probably more than 50 clan estates and many language groups. The Wik estate occupies more than 72,000 hectares.

Mining is the principal driver of the Weipa economy and the mining workforce is the principal driver of Weipa's population. Based on 2006 Census data, RTA employees and contractors constituted 43% of the total employed workforce in Weipa and about 27% of the town's population of 3,096.

During the construction phase, the Project's workforce will be accommodated in an on-site camp and negligible effects on the local housing market are expected.

Under the 15Mdptpa production scenario, RTA's overall workforce, including Andoom, would be marginally smaller than in 2007-2008 and Weipa would have a population of about 3800, down from just over 4000 reached in 2007-2008. Under the 30Mdptpa production scenario, the overall workforce would reduce slightly (due to greater productivity in SoE operations compared to Andoom operations) and Weipa's population is projected to be about 3300. Future demands on infrastructure and government services are expected to be no higher than in recent years.

SoE mine production would be capable of increasing above 30Mdptpa when market conditions are suitable. Under the 50Mdptpa production scenario, the population of Weipa is projected to be approximately 1200 above the peak of 2007-2008. Such a population rise would require development of more residential land and housing, and provision of expanded government services.

RTA's existing operations are relatively remote from the traditional country of the Wik and Wik Way people and from Aurukun, the nearest community. The SoE Project will bring development activities much closer to the Traditional Owners and their country.

The economic impacts of the Projects are evaluated in RTA (2010) and summarised below:

Construction Phase (for 15Mdptpa production capacity)

- Direct employment averages more than 300 per annum over three years;
- Indirect employment of approximately 179 in the local area, 395 in the Far North Queensland (FNQ) region, 632 state-wide and 705 nationally;
- Direct financial contribution of $264 million locally, $527.9 million in the FNQ region, $989.9 million in Queensland and $1,319.8 million nationally; and
- Indirect financial contribution of $201.7 million locally, $612.2 million in the FNQ region, $1,829.3 million in Queensland and $2,828.2 million nationally.

Operations Phase – 15Mdpta production scenario

- Direct employment, including contractors, of approximately 500 in local region;
- Indirect employment of approximately 390 locally, 788 in the FNQ region, 1170 state-wide and 1771 nationally;
- Direct annual financial contribution of $575 million across the local, regional, Queensland and national economies, and

- Indirect annual financial contribution of $96 million locally, $182 million in the FNQ region, $257 million in Queensland and $423 million nationally.
-

3.10.2 Objectives

The environmental protection objective is to minimise environmental nuisance to neighbours from mining and associated activities and to respond to concerns expeditiously.

3.10.3 Commitments

Performance Criteria

The performance criterion for community is:

- Number of complaints.

Implementation Strategy

RTA has a complaints procedure that includes:

- Maintenance of a register of complaints held on-site;
- A process for receiving, handling and investigating complaints;
- Providing expeditious investigation and a response as soon as practicable; and
- Giving a non-compliance notification to any party whose actions have caused a complaint as a result of non-compliance with site environmental requirements.

RTA will continue to work with Traditional Owners to facilitate access to country, subject to mine safety requirements. RTA will also continue existing employment, training and business development programs and tailor them to the needs of the Project. The potential social impacts of the Project, both adverse and beneficial, and proposed mitigation measures are discussed in RTA (2010).

Monitoring

Complaints will be recorded in accordance with Condition A15.

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3.11 Cultural Heritage

3.11.1 Value/Background

Both Indigenous and non-Indigenous cultural heritage places and values have been recorded in the Project area (RTA 2010).

Indigenous Heritage

The antiquity of human occupation on Cape York has been established through the excavation of rock shelter deposits near Laura, approximately 500km south of the Project area. Radiocarbon determinations from these deposits indicate Aboriginal people have occupied the Cape York region for over 35,000 years. Radiocarbon determinations from shell mounds and the smaller middens around Albatross Bay at Weipa date back to approximately 2500 years before present. Archaeological evidence for occupation of the Weipa area prior to this may have been destroyed by the formation of the current coast line with stabilisation of sea levels approximately 6000 years ago.

Recent cultural heritage surveys around Weipa have documented a diverse record of late Holocene archaeology consisting of scarred trees, shell middens, earthen mounds and stone artefact scatters. The combined results of the archaeological surveys carried out to date in the Project area (RTA 2010) demonstrate the presence of a range of sites and places of cultural and archaeological value. Clear patterns in site distribution have emerged with the majority of sites situated within several kilometres of the coast.

Scarred Trees

Scarred trees are the dominant site type and are most likely to be found within several hundred metres of waterways or the coastal strip. Many of these will not be impacted by the Project development as they are situated within the riparian vegetation buffer. Others that will be impacted will be mitigated in consultation with Traditional Owners through the WCCCA process.

Shell Middens

Shell middens are also common, but are only found in coastal and tidal areas with major shell midden complexes located on both sides of Norman Creek within the riparian vegetation zone several kilometres upstream of the coast. Several shell mound complexes are also found along the margin of the Hey River, also in the Riparian zone. The barge/ferry terminal south of Hey Point has been positioned so as to avoid one of these large complexes.

The Weipa shell mounds are very important to Traditional Owners and are of national archaeological value established through a number of research projects undertaken since the 1960s. Major concentrations of shell mounds have been recorded along the Pine and Mission Rivers north of Weipa and the Hey and Embley Rivers to the south. The Weipa shell mounds were placed on the Register of the National Estate in 1980 (Place ID 9103). Shell mounds have also been identified in areas outside of the National Estate Boundaries.

Stone Artefacts

Stone artefacts are very rare in the area and can only be located in areas with adequate ground surface visibility. Several stone axes have been identified associated with shell middens, but these are generally uncommon. The Project will only have a minor impact on known stone artefacts, with several of these located within the Norman Creek Dam footprint.

Ethnographic Sites

A number of ethnographic sites have been documented within and adjacent to the Project Area. Several of these are located along the coast between Boyd Bay and the mouth of Norman Creek, but none of these will be adversely affected by the proposed port or Boyd infrastructure area facilities. The management of these is on-going with Traditional Owners and is being discussed as part of broader site Protection Plans under the WCCCA process.

Areas of cultural and recreational importance to Traditional Owners include Hey Point, Boyd Bay, Pera Head, Norman Creek, Amban (False Pera Head) and Waterfall (Ina Creek). Plants, animals and features of the natural environment are often associated with important cultural information connected to places of significance.

Land Use

The Project area is currently used by Traditional Owners for camping, fishing and hunting. Aurukun Shire Council administers a permit system for permission to enter Aurukun Shire boundaries, and interest was expressed during consultation for the Project EIS for a permit system to be implemented for the Project area to assist with protection of areas of cultural importance (RTA 2010).

Traditional Owners maintain fire regimes in the Project area. Fire regime is a critical determinant of vegetation condition and overall vegetation community composition with the intensity, frequency and timing of fire important for both fire-adapted and fire-sensitive vegetation types. The current fire regime within the Project area is one of extensive, high-intensity, late-dry season fires with areas close to access tracks and high recreational visitation areas being intentionally burned on an annual basis.

Indigenous Land Use Agreement

All traditional owner groups, RTA and the State of Queensland are parties to an Indigenous Land Use Agreement (ILUA), which covers ML 7024 and ML6024. This agreement, known at the Western Cape Communities Coexistence Agreement (WCCCA), provides the context for Indigenous cultural heritage management on ML 7024 and ML 6024. The ILUA is registered with the National Native Title Tribunal (QAI2001/002) as an agreement which recognises and incorporates indigenous interests in land with development and business activities. The ILUA is recognition of Native Title, which is negotiated separately to any Native Title claims on the Cape that have been determined, or are in the application process. The benefit of the ILUA is it is flexible, negotiable, and is tailored to address specifically the impacts of bauxite mining on the landscape. All parties are bound to the provisions of the agreement.

All Indigenous cultural heritage in Queensland is protected under the *Aboriginal Cultural Heritage Act 2003* (Qld). To comply with the duty of care provision under section 23 of the Act, proponents are required to have a recognised cultural heritage management plan or other agreement that provides for the management of Aboriginal cultural heritage. The *Aboriginal Cultural Heritage Act 2003* (Qld) recognises Indigenous Land Use Agreements (ILUA) as a mechanism for managing cultural heritage as long as cultural heritage is included in the ILUA (as it is in the WCCCA). The WCCCA provides for a system of cultural heritage management over the area covered by the ILUA. In accordance with section 86 of the Act, this agreed process for identifying, assessing and managing places of cultural heritage significance satisfies the requirements of the Act and meets Queensland legislative requirements for any new permits or approvals required for Project development works. The WCCCA requires RTA and Traditional Owners to establish mutually-agreed plans for each commercial activity that may have an impact upon Indigenous cultural heritage. Under the WCCCA, the definition of a commercial activity includes extractive mining, vegetation clearing, the establishment of drill lines and the establishment of infrastructure and other facilities.

The WCCCA sets out the agreed process for consultation between RTA and Traditional Owners and this enables the Traditional Owners who can speak for country to participate in heritage surveys.

Non-Indigenous Heritage

A total of seven non-Indigenous heritage sites have been identified within the Project area and have been assessed as low local significance, with the exception of the house stumps, which have been assessed as low-moderate local significance. The majority of these sites appear to be associated with early exploration drilling for bauxite, extending back to the 1950s and 1960s.

Airstrip

There is an overgrown airstrip near False Pera head believed to have been constructed in the area in the 1950s or 1960s as part of early mineral exploration in the area. The airstrip was suitable for use by light aircraft. Associated with this airstrip is a concrete slab and pole (possibly for a windsock), as well as a small bottle dump.

Log Crossings

Three log-creek crossings have been identified in the Project area, two of these being situated on Norman Creek and the other on the Ward River. Each of these log crossings consist of a series of sawn logs placed horizontally across the water course. The log crossings are thought to have been constructed during the early mineral exploration phase in the 1950s-1960s.

Drilling Camp

Mr Glenn White, a long term RTA mine planning employee, reported the area around the log crossing on the Ward River was also the location of a residential drilling camp. Efforts to re-locate this camp during archaeological surveys have been unsuccessful. It is possible any remnant features associated with this site has subsequently been destroyed through flooding or fire. The camp is believed to have been established in the 1960s as part of early mineral exploration in the area.

House Stumps

It has been reported that some old house stumps were located in the vicinity of Hey Point in the early 1990s. The may have been part of the remnants of a small satellite mission village established around 1913. The village was thought to have been established in response to a proposal to have some of the land south of the Embley River excised from the Weipa Aboriginal Reserve (RTA 2010).

A targeted heritage inspection to locate the house stumps near Hey Point was completed in 2009 under the direction of Traditional Owners who may have been aware of its location. The survey team was unable to find the house stumps at the supposed location and have subsequently concluded the site no longer remains or that local knowledge of the exact location is insufficient to find the site at this point in time. The wooden house stumps would be vulnerable to burning by the frequent fires in the area and they may have disappeared. The general location is not on ML 70124 or ML 6024 and would not be disturbed by the Project.

Weipa Aboriginal Reserve

The Project area was originally part of the Weipa Aboriginal Reserve. Aboriginal Reserves in Australia are now recognised as historic locations (sites), despite the presence or absence of associated physical structures or remains. This is based on the concept of the historic landscape, and the association of this landscape with important phases in history.

3.11.2 Objectives

The environmental protection objective is to preserve the cultural heritage values (Indigenous and non-Indigenous) of the Project area.

3.11.3 Commitments

Performance Criteria

The performance criteria for cultural heritage are:

- Cultural heritage surveys completed prior to physical works; and
- No unauthorised disturbance to sites of cultural significance.

Implementation Strategy

All formal consultation with Traditional Owners is undertaken in accordance with the process outlined in the WCCCA. RTA are required to provide the relevant WCCCA parties with six months minimum notification prior to undertaking commercial activities that have the potential to damage places of cultural heritage value. This notification is in the form of a written work program outlining the location and size of the project area, the nature of the project and a request for the names of Traditional Owners who should be consulted about cultural heritage matters.

RTA consults directly with the Traditional Owners nominated by the WCCCC to establish the scope of any required cultural heritage assessments. The Traditional Owners nominate the names of people they wish to be involved in the heritage assessment. Up to eight, but normally four, Traditional Owners participate in heritage assessment field surveys. Ethnographic surveys are also undertaken and these often involve Traditional Owners from a wider age group. Specific site visits are also undertaken to discuss management issues.

Following the heritage assessment, RTA meets with the Traditional Owners to discuss the heritage assessment report and recommended management of identified cultural heritage sites. The report also describes the proposed commercial activity. The heritage assessment report is submitted to the

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WCCCC Environment and Heritage Sub-committee. These discussions between RTA, Traditional Owners and WCCCC representatives form the content of Site Protection Plans for specific areas that would be affected by mining and mining-related activity. Once the negotiated Site Protection Plans have been implemented, the RTA manager of the commercial activity would be issued a permit authorising the activities. The dispute resolution process outlined in the WCCCA would apply if RTA, the Traditional Owners and the WCCCC representatives fail to negotiate a Site Protection Plan.

Cultural Heritage Management Planning

Cultural heritage sites management on other areas of the lease, which are currently being mined, or are in preparation for mining, include a range of methods developed in negotiation with the relevant traditional owner group involved under the WCCCA. The majority of management plans regarding scarred trees involve their removal to areas specified by Traditional Owners, which are usually environmental buffers or outstations. Stone artefacts are also relocated to specified areas. Shell scatters and middens are of high archaeological and cultural significance and are usually avoided by mining so as to preserve their context and stratigraphy. In some instances, very significant scarred trees are also preserved from mining by the creation of a mining exclusion zone around the scarred tree.

As part of the mine planning process, RTA consults with Traditional Owners through the WCCCA process regarding the proximity of mining to places of cultural significance. Often these places are located within the riparian vegetation zone that will not be disturbed, but occasionally they require the creation of a new zone to ensure protection. Traditional Owners associated with the south of Embley area do not readily distinguish between cultural and natural heritage when discussing the management of country. Plants, animals and features of the natural environment are often associated with important cultural information connected to places of significance. Through consultation with Traditional Owners, the structure of a CHEMP is being developed as a long-term strategy for the management of land access, fire, flora and fauna, signage, weeds, environmental monitoring and further documentation of places of cultural heritage significance. RTA only seeks to obtain information for management purposes and the CHEMP would include protocols for managing culturally-sensitive information. The CHEMP would include procedures to manage the accidental discovery of cultural heritage materials, including human remains, in the Project area. These procedures will be developed in consultation with the Traditional Owners through the WCCCA and will comply with relevant requirements of the *Aboriginal Cultural Heritage Act 2003*(Qld). The procedure will take into consideration the DNRM (2005) guidelines on *The Discovery, Handling and Management of Human Remains.* RTA has established procedures in use at the current Weipa mining operations that may form the basis for procedures specific to the SoE Project.

The proposed Project will have impacts on known scarred trees and two known stone artefact scatters. Mitigation measures will be developed through consultation with Traditional Owners. The recorded shell middens and ethnographic sites are located outside of the areas for proposed facilities and future mining. The results of archaeological surveys suggest scarred trees are the site type most likely to be impacted by the proposed project. Other site types are typically found in the riparian vegetation zone around water courses, the coastline and significant vegetation, such as thickets of vine forest. The majority of project facilities are situated outside of this riparian vegetation zone. Further management work will be undertaken in accordance with the WCCCA process to fully assess the impact of the proposed project on Aboriginal cultural heritage and develop mitigation strategies where required. This will include detailed surveys of all areas identified for future development.

The majority of known places of cultural heritage are well outside of future mining areas, although access to some of these places may be affected by mine development. RTA will take a proactive approach to the management of places of cultural significance and initiate discussions with WCCCA and the Traditional Owners to establish separate heritage action plans for each location. This will ensure the cultural values of these places are effectively managed over the duration of mining in the area.

RTA has considerable experience working with Traditional Owners to manage cultural heritage at the existing Weipa operations. Management strategies have been developed with Traditional Owners to ensure Aboriginal sites are managed in a culturally-appropriate manner. These include the creation of heritage buffers within mining areas to protect scarred trees and shell middens, the relocation of scarred trees and stone artefacts outside of mining areas and the creation of scarred tree-keeping

places. Significant cultural heritage places are often protected by signage and all employees are required to complete cultural awareness training. Specific project inductions are undertaken with staff to familiarise them with the relevant heritage protection measures. Traditional Owners are also employed as heritage monitors to observe activities identified as having high potential to uncover cultural heritage not visible during the assessment surveys.

As defined under the WCCCA, RTA will continue to engage with Traditional Owners to identify and protect cultural heritage places, while also meeting the provisions of the *Aboriginal Cultural Heritage Act 2003* (Qld).

Monitoring

Cultural heritage assessments are undertaken prior to conducting any commercial activity. The cultural heritage assessment process is described in detail in the Implementation Strategy section above.

The system of cultural heritage management implemented under the registered ILUA shall continue to be implemented. This meets the requirements of the *Aboriginal Cultural Heritage Act 2003* (Qld) and environmental authority conditions under the *Environmental Protection Act 1994* (Qld) are not relevant.

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4 ENVIRONMENTAL MANAGEMENT

4.1 Environmental Management System

Project operations would take place under an EMS consistent with the Australian Standard *Environmental management systems – requirements with guidance for use* (ISO 14001).

The EMS would incorporate a risk management system to identify environmental aspects of activities to be undertaken as part of the Project, carry out an assessment of the risk, and identify appropriate controls. The risk management system will conform to the Australian Standard for *Risk management* (AS/NZS 4360:2004).

Policies and procedures would be prepared for construction, mining and related activities to control significant environmental aspects.

4.2 Monitoring

Environmental monitoring will occur in accordance with the requirements of the environmental authority.

The environmental monitoring for the Project will include dust, surface and groundwater, noise, flora and fauna, and cultural heritage. Commitments and proposed environmental authority conditions have been included in the relevant sections of this EM Plan.

An Environmental Monitoring Manual (EMM) will be developed as part of the EMS. The EMM will outline the environmental monitoring to be undertaken, including monitoring sites, parameters and their frequency of measurement and also make reference to monitoring procedures and records.

All monitoring and research data, collected for the purpose of demonstrating compliance with this environmental authority, must be collated and maintained in a central location, such that the data are accessible on request by the administering authority.

The EMM will be made available to the administering authority on request.

4.3 Reporting

Reporting commitments under the environmental authority and other legislation will be complied and include:

- Prepare Annual Returns as required under the *Environmental Protection Act 1994* (Qld);
- Submit reports for the National Pollutant Inventory (NPI) and the National Greenhouse and Energy Reporting Scheme (NGERS); and
- Notify the administering authority of incidents that may compromise compliance with the conditions of the environmental authority or incidents where serious or material environmental harm is caused, or threatened to be caused, unless that environmental harm is authorised (e.g. by the environmental authority or development approval).

A register of environmental incidents will be maintained and corrective actions assigned where required.

RTA aims to provide timely, relevant and appropriately presented information to government authorities, the local community and the general public on the environmental performance of the Project. An annual Sustainable Development Review is prepared to report publicly on social, environmental and economic performance.

4.4 Studies and Investigations

RTA is committed to the following studies and investigations as a minimum:

- Revegetation – on-site field trials will be conducted with a range of native tree and shrub species and grasses to optimise regeneration on major soil types;

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- Rehabilitation – the criteria for achieving a self-sustaining vegetation community will be developed based on the results of the on-site field trials; and
- Water – Quarterly vertical salinity profiling in Ward River and Norman Creek.

4.5 Staff Training

RTA will ensure employees, contractors and visitors receive appropriate environmental awareness training. This will be achieved through a variety of methods, including induction training, formal presentations, and impromptu meetings.

Specifically, RTA requires employees, contractors and visitors are aware of:

- their roles and responsibilities ,including environmental incident reporting;
- the environmental impacts, potential or actual, of their activities onsite;
- the potential consequences of poor environmental performance; and
- site emergency procedures.

Employees and contractors required to undertake work at the site must undergo an environment, health and safety induction. Environmental awareness training will also be a regular feature of site-wide training. Records of training content and attendance will be maintained.

4.6 Environmental Auditing and Review

RTA will conduct environmental audits to assess compliance with regulatory requirements and the performance of the site EMS. The objectives of the environmental auditing and review programs are to:

- monitor and report on compliance with regulatory requirements, EM Plan commitments, Plan of Operations, environmental policy, company standards, best-practice guidelines and signatory codes;
- monitor the EMS for consistency with the principles of ISO14001; and
- ensure senior management review of performance via consideration of the audit reports.

An environmental auditing program will be implemented at the operation which will include:

- internal environmental audits – annually;
- EMS review – annually;
- Plan of Operations audits – with each Plan of Operations; and
- Administering authority audits – at a frequency determined by the authority.

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5 DEFINITIONS

Words and phrases used throughout this document are defined below except where identified in the *Environmental Protection Act 1994* (Qld) or subordinate legislation. Where a word or term is not defined, the ordinary English meaning applies, and regard should be given to the Macquarie Dictionary.

"µg/L" means micrograms per litre.
"20th percentile flow" means the 20th percentile of all daily flow measurements (or estimations) of daily flow over a 10-year period for a particular site. The 20th percentile calculation should only include days where flow has been measured (or estimated), i.e. not dry weather days.
"50th percentile" means the measured values of the quality characteristic must not be greater than the release limit for any more than three out of six consecutive samples where the time interval between the taking of each consecutive sample is not less than three days.
"80th percentile" means the measured values of the quality characteristic must not be greater than the release limit for any more than one out of five consecutive samples where the time interval between the taking of each consecutive sample is not less than three days.
"acceptance criteria" means the measures by which the actions implemented to rehabilitate the land are deemed to be complete (same as completion criteria).
"administering authority" means the Department of Environment and Resource Management or its successor.
"annual exceedance probability" means the probability that the given event will be exceeded within a one-year period.
"appropriately qualified person" means a person who has professional qualifications, training, skills or experience relevant to the nominated subject matter and can give authoritative assessment, advice and analysis on performance relative to the subject matter using the relevant protocols, standards, methods or literature.
"acid sulphate soils" means sulphidic geological strata most commonly associated with the production of ferrous iron and sulphuric acid, which, when exposed to air and moisture may release a low pH, high heavy-metal discharge.
"authority" means environmental authority under the *Environmental Protection Act 1994* (Qld).
"background noise level" means noise, measured in the absence of the noise under investigation, as either: (a) $L_{A90,T}$ being the A-weighted sound pressure level exceeded for 90 percent of the time period of not less than 15 minutes, using Fast response, or (b) $L_{Abg,T}$ being the arithmetic average of the minimum readings during a representative time period of not less than 15 minutes, using Fast response.
"commercial place" means a place used as an office or for business or commercial purposes, other than a place within the boundaries of the operational land.
"dam" means a land-based structure or a void designed to contain, divert or control flowable substances, and includes any substances that are thereby contained, diverted or controlled by that land-based structure or void and associated works. However; a dam does *not* mean a fabricated or manufactured tank or container designed to a recognised standard, *nor* does a dam mean a land-based structure where that structure is designed to an Australian Standard. In case there is any doubt, a levee (dyke or bund) is a dam, but (for example) a bund designed for spill containment to AS1940 is *not* a dam.
"Decibel (dB)" is the unit of sound measurement.
Decibel (dB) (Linear) is a linear scale of sound measurement that treats all audible frequencies as having equal value. Whereas the "A-weighting filter," which is an approximation of loudness, is used to correct the sound pressure levels to more accurately reflect what the human ear perceives.
"design storage allowance" as defined in the DME/DEH (1995) *Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland.*
"environmental authority" means an environmental authority granted in relation to an environmentally relevant activity under the *Environmental Protection Act 1994* (Qld).
"environmental authority holder" means the holder of this environmental authority.

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"environmental nuisance" is unreasonable interference or likely interference with an environmental value caused by: (a) noise, dust, odour, light; or (b) an unhealthy, offensive or unsightly condition because of contamination; or (c) another way prescribed by regulation.
"flowable substance" means matter or a mixture of materials, which can flow under any conditions potentially affecting that substance. Constituents of a flowable substance can include water, other liquids, fluids or solids, or a mixture that includes water and any other liquids, fluids or solids either in solution or suspension.
"hazard" in relation to a dam as defined, means the potential for environmental harm resulting from the collapse or failure of the dam to perform its primary purpose of containing, diverting or controlling flowable substances.
"hazard category" means a category, either low, significant or high, into which a dam is assessed as a result of the application of tables and other criteria in the *Manual for Assessing Hazard Categories and Hydraulic Performance of Dams* (Version 2.0, 2009) published by the Environmental Protection Agency on its website.
"LAmax adj,T" means the average maximum A-weighted sound-pressure level, adjusted for noise character and measured over a time period of not less than 15 minutes, using Fast response.
"land use" is a term to describe the selected post-mining use of the land, which is planned to occur after the cessation of mining operations.
"land" in the "land schedule" of this document means land excluding waters and the atmosphere.
"leachate" means a liquid that has passed through or emerged from, or is likely to have passed through or emerged from, a material stored, processed or disposed of at the operational land, which contains soluble, suspended or miscible contaminants likely to have been derived from the said material.
"maximum" means the measured value of the quality characteristic or contaminant must not be greater than the release limit stated.
"MaxLpA,T" means the maximum A-weighted sound-pressure level measured over a time period of not less than 15 minutes, using Fast response.
"median" means the middle value, where half the data are smaller, and half the data are larger. If the number of samples is even, the median is the arithmetic average of the two middle values.
"mg/kg" means milligrams per kilogram.
"mg/L" means milligrams per litre.
"minimum" means the measured value of the quality characteristic or contaminant must not be less than the release limit stated.
"natural flow" means the flow of water through waters caused by nature.
"ng/L" means nanograms per litre.
"noise-sensitive place" means: (a) a legal dwelling, caravan park, residential marina or other residential premises; or (b) a motel, hotel or hostel; or (c) a kindergarten, school, university or other educational institution; or (d) a medical centre or hospital; or (e) a protected area; or (f) a public park or gardens. and includes the curtilage of any such place.
"North of Embley area" means that area of ML 7024 that lies north of the Embley River.
"noxious" means harmful or injurious to health or physical well-being.

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"offensive" means causing unreasonable offence or displeasure; is unreasonably disagreeable to the sense; disgusting, nauseous or repulsive.
"percent slope" = $\frac{\text{height difference (metres)}}{\text{horizontal difference (metres)}} \times 100$
"progressive rehabilitation" means rehabilitation (defined below) undertaken progressively OR a staged approach to rehabilitation as mining operations are on-going.
"protected area" means: (a) a protected area under the Nature Conservation Act 1992 (Qld); or (b) a marine park under the Marine Parks Act 1992 (Qld); or (c) a World Heritage Area.
"range" means the measured value of the quality characteristic or contaminant must not be greater than the higher release limit stated nor lower than the lower release limit stated.
"receiving environment" means all groundwater, surface water, land, and sediments that are not disturbed areas authorised by this environmental authority.
"receiving waters" means all groundwater and surface water that are not disturbed areas authorised by this environmental authority.
"rehabilitation" means the process of reshaping and revegetating land to restore it to a stable landform and in accordance with the acceptance criteria set out in this environmental authority and, where relevant, includes remediation of contaminated land.
"representative" means a sample set, which covers the variance in monitoring or other data either due to natural changes or operational phases of the mining activities.
"saline drainage" means the movement of waters, contaminated with salt(s), as a result of the mining activity.
"sediment dam" means a structure for the capture and treatment of storm water runoff contaminated only by sediments from disturbed areas and which discharge off-site once full.
"self-sustaining" means an area of land which has been rehabilitated and has maintained the required acceptance criteria without human intervention for a period nominated by the administering authority.
"sensitive place" [e.g. odour and dust] has the same meaning as and includes a noise-sensitive place and a commercial place.
"South of Embley area" means the area of ML 7024 that lies south of the Embley River.
"stable" means geotechnical stability of the rehabilitated landform where instability related to the bearing capacity, excessive settlement and subsidence caused by consolidation/settlement of the wastes deposited, and sliding/slumping instability has ceased.
"the holder" means the holder of this environmental authority.
"Total Organic Carbon" (TOC) means the sum of all compounds of carbon, which contain at least one carbon to carbon bond plus methane and its derivatives. For the purpose of measurement one gram of TOC is deemed to have the same flame ionisation response as one gram of hexane.
"waters" includes river, stream, lake, lagoon, pond, swamp, wetland, unconfined surface water, unconfined water natural, bed and bank of any waters, dams, non-tidal or tidal waters (including the sea), and any underground water, any part-thereof.

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Environmental Impact Statement

for South of Embley Project

Section 22

EPBC Assessment Report

Environmental Impact Statement for South of Embley Project

EPBC Assessment Report
Referral 2010 / 5642

RTA Weipa Pty Ltd

Rio Tinto Alcan

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1 INTRODUCTION

1.1 Background

RTA Weipa Pty Ltd (RTA) proposes to extend its existing bauxite mining operations north of the Embley River (western Cape York Peninsula) on Mining Lease (ML) 7024, to areas within ML7024 located south of the Embley River. Refer to **Figure 1** for the location of the proposal. The South of the Embley (SoE) Project ('the Project') includes bauxite mining and the construction and operation of two new bauxite processing plants and infrastructure associated with the mining operations, including roads, water supply infrastructure, product stockpiles, barge and ferry facilities, a port and ancillary infrastructure. The Project involves a staged increase in production of up to 50 million dry product tonnes per annum (Mdptpa). The initial installed capacity is subject to ongoing feasibility studies but is likely to be either 15Mdptpa or 22.5Mdptpa. Actual production rates and the timing and size of capacity expansions would depend on market conditions.

The Project is predominately located on the portion of ML7024 that is south of the Embley River and on ML6024. In addition, a ferry terminal would be located at Hornibrook Point and a barge terminal at Humbug Point. Both locations are on Strategic Port Land administered by the North Queensland Bulk Ports Corporation Limited (NQBP) and both are within the Port of Weipa. A third barge/ferry terminal would be located on the Hey River on ML7024. Dredged spoil from the construction of these terminals would be disposed of at the existing Albatross Bay spoil ground in Commonwealth waters.

RTA would also construct and operate new port and ship-loading facilities south of Boyd Point, including a jetty, berths and shiploader. Dredged spoil disposal associated with the construction of the port and ship-loading facilities would be in offshore waters at a proposed new spoil disposal ground located approximately 17km west of the proposed port site in Commonwealth waters.

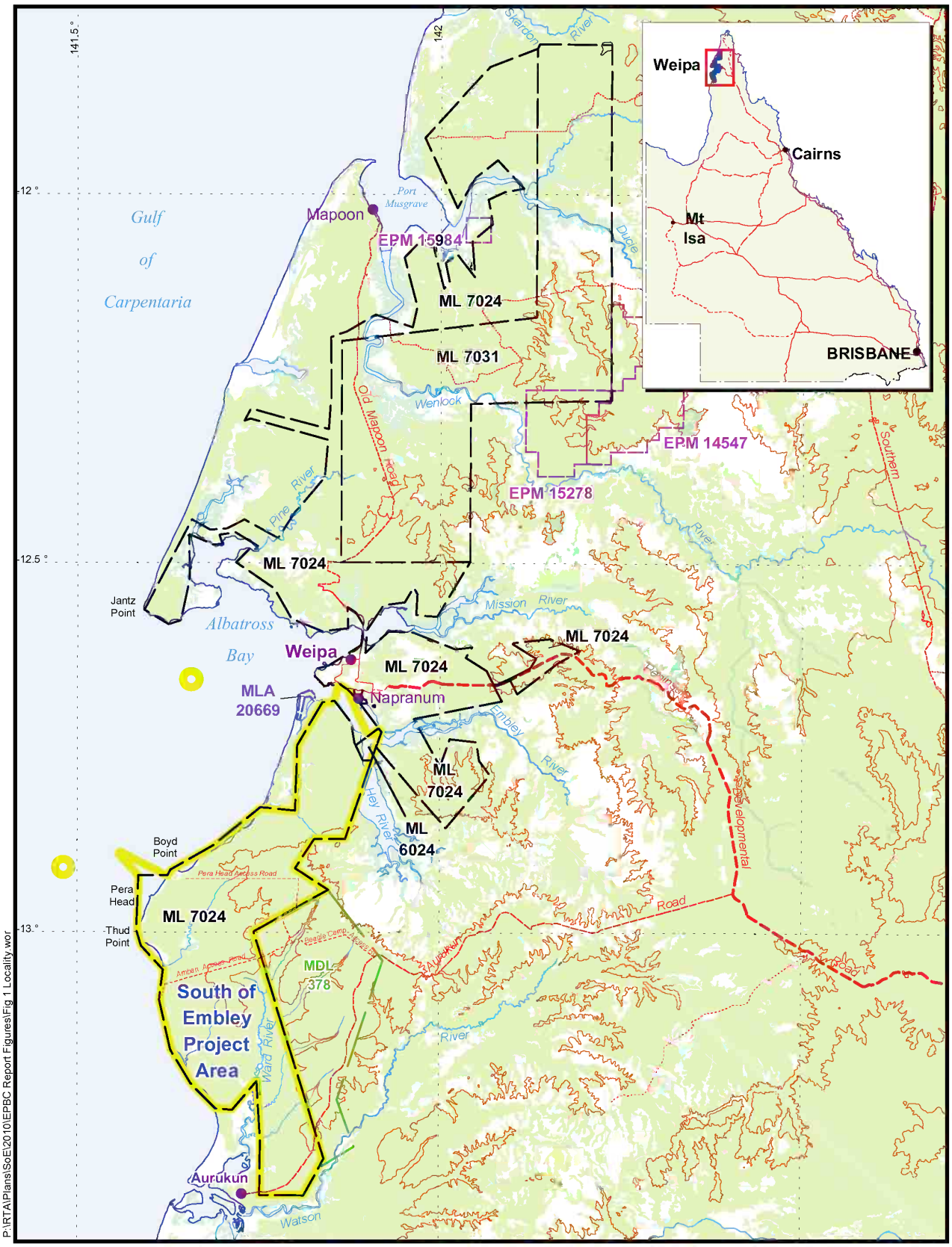
A significant area within the mining lease boundaries would not be disturbed as a result of the Project. Therefore, for the purposes of this assessment, the "site" refers to the infrastructure and mining areas shown on **Figure 3**, including offshore dredging and disposal areas affected by the Project. The "Project area" incorporates the "site" and areas within the mining lease south of the Embley River which would not be disturbed.

Further detailed background information is provided in Section 1 of the South of the Embley Project Environmental Impact Statement ('the EIS').

1.2 Statutory Context

On 13 June 2008, RTA lodged an initial advice statement (IAS) and a request for 'significant project' declaration with the Queensland Coordinator General (CG). The IAS provided an outline of the proposed Project, including the Project rationale and its potential impacts. The IAS was subsequently updated on 3 November 2008.

The SoE Project was declared a '"significant project" for which an Environmental Impact Statement (EIS) is required' pursuant to section 26(1)(a) of the Queensland *State Development and Public Works Organisation Act 1971* (SDPWO Act) on 21 November 2008, by the CG. The first step in the impact assessment process under the SDPWO Act is the development of Terms of Reference (ToR) for the EIS. A draft ToR was advertised for public and advisory agency comment (including the Commonwealth Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) (formerly Department of Environment, Water, Heritage and the Arts (DEWHA)) on 16 January 2009 and finalised in April 2009.



P:\RTA\Plans\SoE\2010\EPBC Report Figures\Fig 1 Locality.wor

RTA Mining Lease boundary
South of Embley Project Area
Oresome Australia Pty Ltd Mineral Sands Project
Chalco Aurukun Bauxite Project
Cape Alumina Pty Ltd's Pisolite Hills Project
Township
Drainage
Road/track
50m Topographic contour

South of Embley Project

Fig. 1: Locality Map

N

10 0 10km

Datum/Projection: GDA94/MGA Zone 54 Date: 09/06/2011

The Project was referred to the Commonwealth Minister for Environment, Water, Heritage, and the Arts in August 2008 (Referral No. 2008/4435). RTA nominated the Project as a "controlled action" under section 75 of the Commonwealth Environmental Protection and Biodiversity Conservation Act 1999 (EPBC Act) on the basis of its potential impact on listed threatened species and communities and migratory species. On 2 October 2008, the Project was declared a "controlled action" and the relevant controlling provisions were:

- listed threatened species and communities (section 18 and 18A of the EPBC Act); and
- listed migratory species (sections 20 and 20A of the EPBC Act).

Following substantial changes to the scope of dredging at the proposed port, the August 2008 referral was withdrawn and a new referral was submitted to the Commonwealth Minister for Sustainability, Environment, Water, Population and Communities on 8 September 2010. The Project was declared a controlled action on 29 October 2010 (Referral 2010/5642) and the controlling provisions were:

- Sections 18 and 18A (listed threatened species and communities);
- Sections 20 and 20A (listed migratory species); and
- Sections 23 and 24 (Commonwealth marine areas).

As a consequence of this decision, the Project requires approval under the EPBC Act. The Commonwealth has also determined an EIS under the EPBC Act is required and released Tailored EIS Guidelines on 21 December 2010 (refer to Appendix 1C of the EIS).

A single EIS will address both Queensland and Commonwealth assessment requirements. The ToR and the Tailored EIS Guidelines specifically require a stand-alone report addressing potential impacts of the Project on matters of national environmental significance (MNES). This report has been prepared to satisfy this requirement.

This report describes the proposed action as it would impact on MNES, the affected environment relevant to the controlling provisions, an assessment of potential impacts on MNES, associated mitigation measures and a summary of conclusions. More detailed information regarding the proposed action is presented in the EIS. Cross referencing to the EIS has been provided in this report where relevant. A cross reference table which links the requirements of Commonwealth Tailored EIS Guidelines with the corresponding section of the EIS where those requirements have been addressed is provided in **Table 38**.

In addition to the approval of the EIS under the SDPWO Act and approval of the "controlled action" under the EPBC Act, the Project will require a number of other approvals, permits and licences for various components of the Project. These are described in Section 1.9 of the EIS.

The DSEWPaC also determined that an application for a permit under the Commonwealth *Environment Protection (Sea Dumping) Act 1981* is required to be assessed under the EPBC Act (refer **Section 1.9.3**). As such, the assessment to support the application for a Sea Dumping Permit for dredging and disposal associated with Stage 1 capital dredging at the port and capital dredging for the barge and ferry terminals is included in the EIS and is summarised in this report.

2 DESCRIPTION OF PROPOSED ACTION

RTA currently undertakes bauxite mining at Weipa in two main areas, East Weipa and Andoom, both of which are north of the Embley River (refer to **Figure 2**). These reserves are gradually depleting and the SoE Project would provide for the long term continuation of mining in the Weipa region and enable continued bauxite supply to Gladstone refineries and third parties.

Based on studies to date, and subject to future modification, the Project consists of the following components.

- Bauxite mining – the Project involves a staged increase in production of up to 50Mdptpa. The initial installed capacity is subject to ongoing feasibility studies, but is likely to be either 15Mdptpa or 22.5Mdptpa. Actual production rates and the timing and size of capacity

expansions would depend on market conditions. The initial phase of mining operations would involve production to replace depleted East Weipa production as well as developing third party markets. Production capacity would expand to replace Andoom production once those reserves are depleted. Production capacity would thereafter be expanded to 50Mdptpa when market conditions are suitable. The mining process would involve clearing vegetation, salvage of topsoil, stripping of overburden, extraction of the bauxite, replacement of topsoil and revegetation. Mined bauxite would be transported to stockpiles near the beneficiation plants using a network of internal haul roads. Mined areas would be progressively rehabilitated.

- Bauxite processing – mined bauxite would be processed in one of two beneficiation plants (Boyd infrastructure area, followed by a second plant at Norman Creek) (refer to **Figure 3**). Beneficiation would involve the separation of the bauxite and waste materials through screening, crushing, grinding, washing and dewatering. Chemicals would not be used in the process, only water. Fine waste materials would be discharged to tailings storage facilities.
- Port and ship-loading facilities – construction and operation of new port, ship-loading and tug mooring facilities between Boyd Point and Pera Head. The port would include an approach jetty and two berths totalling 900m in length and a fair-weather mooring point along the jetty for tugs. A 1.2km conveyor would transport bauxite from the product stockpile to the ship loader. The port would be built with an initial capacity of 30Mdptpa. Prior to production exceeding 30Mdptpa, the wharf would be expanded to accommodate two extra berths at the port to a capacity of at least 50Mdptpa. Initially, approximately 6,500,000m^3 of marine sediments would be dredged to establish the berth pockets and departure areas over a period of about three hundred days. To accommodate the extra berths and departure areas, approximately 2,400,000m^3 of material would be dredged. For the purposes of evaluation studies, it has conservatively been assumed that vessel departures would be unrestricted by tides and hence the depth of dredging required has been matched to this assumption. The dredging would be carried out by a cutter suction dredger (CSD) re-depositing material on the sea bottom. Deposited material would be retrieved by a trailing suction hopper dredge (TSHD). Dredged spoil would then be transported by the TSHD to a new off-shore spoil disposal ground located approximately 17km west of Boyd Point (refer to **Figure 4**). Maintenance dredging of 890,000m^3 every year is expected to be required to maintain under keel clearance for ships. An allowance would be made in the second stage port expansion to accommodate up to 13Mdptpa product from third parties following agreement on suitable commercial terms.
- Product bauxite stockpiles – product stockpiles and a stacker-reclaimer would be established adjacent to the port facilities. The stockpile area would be expanded in stages as production increases. Should ore from neighbouring mines operated by others be shipped through the proposed port, such ore would be conveyed by others across ML7024 to the stockpile area. Allowance has been made in the stockpile layout to enable additional stockpile capacity to be added adjacent to RTA's facilities to accommodate product from third parties following agreement on suitable commercial terms. At a production rate of 15Mdptpa, the stockpile capacity would be 680,000 dry product tonnes (dpt) and it would occupy 16ha of land with the capacity to increase to a maximum of 2.55Mdpt, occupying 59ha of land (assuming 13Mdptpa production from third parties).
- Ancillary infrastructure – including diesel-fuelled power station, workshops, warehouse, administration facilities, vehicle wash-down facilities, tyre bay, package sewage treatment plant, waste storage and diesel storage.
- Water infrastructure – a water supply dam would be constructed on a freshwater tributary of Norman Creek (Dam C). The reasons why a freshwater tributary of Norman Creek was chosen as a dam site to provide water supply for the Project over other alternatives is summarised in Section 5.2.3 of the EIS. Later, a water pumping station on the Ward River would be constructed, plus pipelines and up to 12 artesian bores. Dam C would have a maximum storage capacity of 29GL and may be constructed in either in two stages or a single stage. The dam would be constructed in a single stage should expansion of production above 15Mdptpa be anticipated to occur quickly, or should an initial production rate of 22.5Mdptpa

be adopted. This is the subject of ongoing feasibility studies.

- Temporary onsite camp for the construction phase, of up to 630 beds. During the operations phase, employees would be housed in the existing Weipa community and commute to site on a daily basis via ferry and an all weather sealed 38km Mine Access Road from the Hey River Terminal to the Boyd infrastructure area.
- Barge/ferry facilities – construction and operation of a new ferry terminal at Hornibrook Point, a roll-on roll-off (RORO) barge facility at Humbug Point, and a new barge/ferry terminal on the western bank of the Hey River. These would be used to transport workforce, materials and equipment between Weipa and the SoE Project.
    - Humbug Terminal - approximately 10,700m^3 of material would be dredged and disposed of at the existing Albatross Bay spoil ground.
    - Hornibrook Terminal - approximately 19,000m^3 of material would be dredged and disposed of at the existing Albatross Bay spoil ground.
    - Hey River Terminal - approximately 17,300m^3 of material would be dredged and disposed of at the existing Albatross Bay spoil ground. A thin band of mangroves (approximately 400m^2) would be required to be cleared. The extent of mangrove clearing represents approximately 0.008% of RE 3.1.1a and 0.003% of the mangrove communities within the Project area.

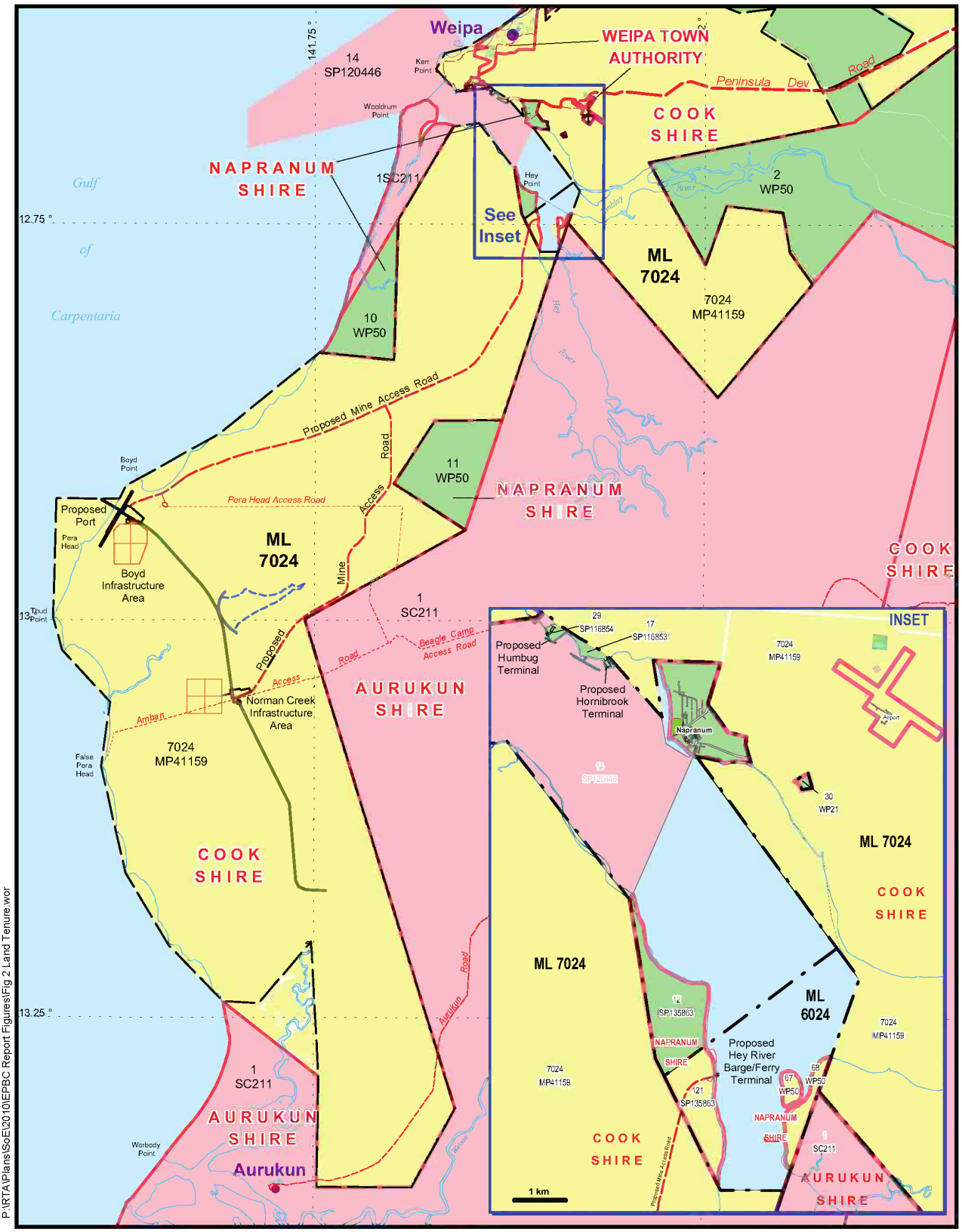
  Pile driving would also be required for the construction of the barge/ferry facilities. Pile driving for these facilities is expected to be of fairly short duration (approximately 15 days). The number of piles that would be required for the barge/ferry facilities would be as follows.
    - Humbug Terminal – 14 by 600mm piles.
    - Hornibrook Terminal – 10 by 600mm piles.
    - Hey River Terminal – 20 by 600mm piles.
    - Navigational Aids and Tug Station – 4 by 1050mm, 12 by 750mm and 12 by 610mm piles.

The main infrastructure elements are illustrated in **Figure 3** and proposed spoil ground locations are shown in **Figure 4**. Further information on the area of physical land disturbance associated with the Project is provided in Table 7.10 of the EIS. The areas that would be dredged for the port and barge/ferry facilities are provided on Figure 2.3, Figure 2.4, Figure 2.5 and Figure 2.6 of the EIS.

A more detailed Project description is provided in Section 2 of the EIS, which includes a description of works to be undertaken, how the works would be undertaken, structures to be built, and design parameters where relevant. Section 1.6 of the EIS describes the feasible alternatives to the proposed action including a comparative description of the impacts of each alternative on the matters protected by the controlling provisions for the proposed action.

An extensive stakeholder consultation program has been undertaken and further consultation will be undertaken throughout the EIS process, and Project construction and operational phases. Details of the consultation undertaken with various stakeholder groups and the key issues raised are provided in Section 15.2 of the EIS. A full discussion on the social and environmental issues raised by stakeholders and RTA's proposed mitigation strategies are set out in the Social Impact Assessment (Section 16 of the EIS). Section 16.3.3 of the EIS describes the proposed ongoing community engagement processes for the Project.

The definition of "affected parties" under Section 500(1) of the EPBC Act encompasses those who have suffered loss or damage as a result of a contravention of the Act or regulations. Therefore, there are no potentially "affected parties" with respect to the Project.



P:\RTA\Plans\SoE\2010\EPBC Report Figures\Fig 2 Land Tenure.wor

RTA Mining Lease boundary

Shire Boundary

Weipa Airport

Road/track

Tenure

Freehold

Lands Lease

State Land

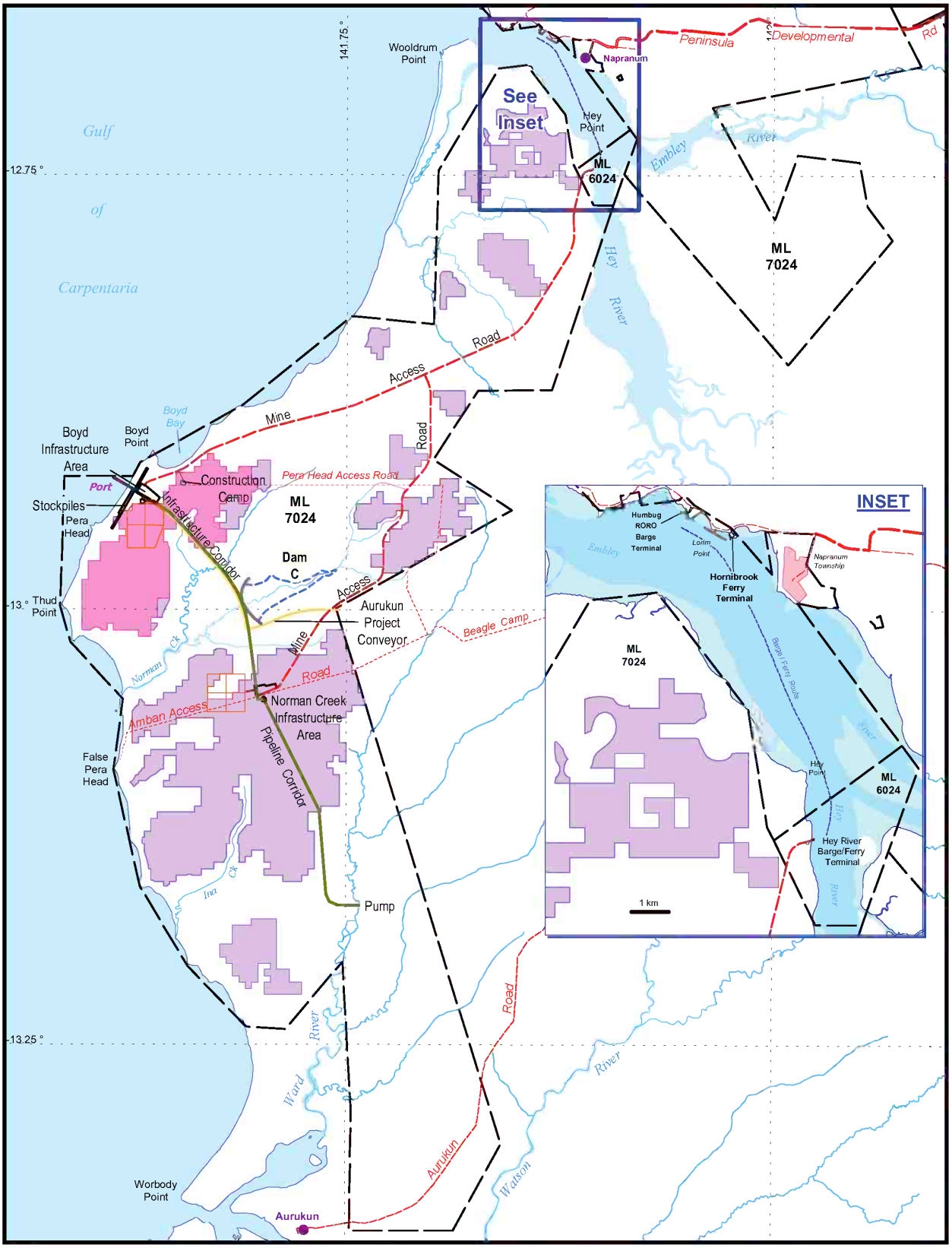
South of Embley Project

Fig. 2: Land Tenure and Local Government Boundaries

N

5 0 5km

Datum/Projection: GDA94/MGA Zone 54 Date: 09/06/2011



P:\RTA\Plans\SoE\2010\EPBC Report Figures\Fig 3 Infrastructure and 40 Year Mine Plan.wor

RTA Mining Lease boundary
Township
Road/track
Freshwater dam
Tailings storage facility
Barge / Ferry route
Mining Years 1 -13
Mining Years 14 - 40

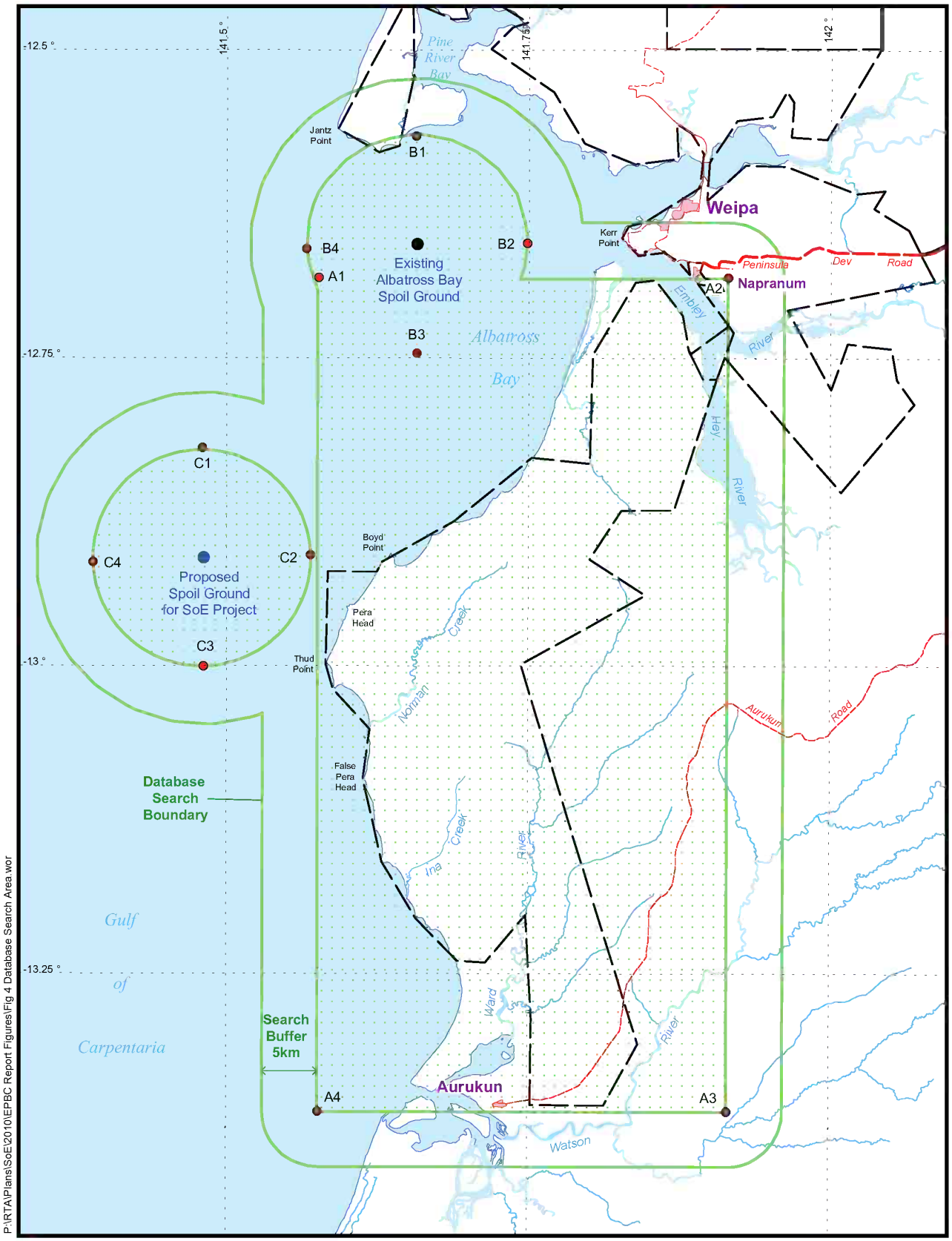
South of Embley Project

Fig. 3: Infrastructure and Conceptual 40 Year Mine Plan

N

5 0 5km

Datum/Projection: GDA94/MGA Zone 54 Date: 29/03/2011



P:\RTA\Plans\SoE\2010\EPBC Report Figures\Fig 4 Database Search Area.wor

RTA Mining Lease boundary
Township
Drainage
Road/track
EPBC Search Coordinates
Project Area
Area of Database Search

South of Embley Project

Fig. 4: Area of Database Search

N

0 5 10 15km

Datum/Projection: GDA94/MGA Zone 54 Date: 29/03/2011

3 PROTECTED MATTERS SEARCH

A search using the DSEWPaC Protected Matters search tool ("EPBC Act database") was conducted over three areas to define the Project area which is bound by the coordinates listed in **Table 1** with a 5km buffer, and shown in **Figure 4**.

Table 1 DSEWPaC Protected Matters Search Coordinates

Location Point	Latitude			Longitude		
	degrees	minutes	seconds	degrees	minutes	seconds
A1	-12	41	4.5	141	34	34
A2	-12	41	4.5	141	54	55
A3	-13	21	43	141	54	55
A4	-13	21	43	141	34	34
B1	-12	34	6.5	141	39	40
B2	-12	39	37.3	141	44	57.7
B3	-12	44	49	141	39	18.7
B4	-12	39	40.3	141	33	58.1
C1	-12	49	21	141	29	8
C2	-12	54	48.9	141	34	23.6
C3	-13	00	13.68	141	28	36.4
C4	-12	54	48.9	141	23	20.9

The Protected Matters search results are summarised in **Table 2**.

Table 2 Matters of National Environmental Significance

Matters of National Environmental Significance	Relevance to the Project
World Heritage Properties	There are no World Heritage Properties within or near the area affected by the proposed development.
National Heritage Places	There are no National Heritage Places within or near the area affected by the proposed development.
Threatened Ecological Communities	No Endangered Ecological Communities (EECs) were returned by the database search or field surveys of the SoE Project area. A review of the regional ecosystem types that were mapped for the Project area indicates that EECs are not likely to occur. This listed groundwater dependant ecological community associated with the Great Artesian Basin does also not occur within the Project area (refer Section 5.3.4 of the EIS).
Threatened Species	4 plants 3 birds 3 terrestrial mammals 2 marine mammals 6 freshwater / marine reptiles 4 fish (freshwater and marine)
Migratory Species	17 birds 7 freshwater /marine reptiles 7 marine mammals 1 fish

Matters of National Environmental Significance	Relevance to the Project
Commonwealth Marine Area	Capital dredging for the proposed Port and disposal of dredged material in a new spoil ground approximately 17km west of Boyd Point. Disposal of material dredged from the barge and ferry terminals at the existing Port of Weipa Spoil Ground in Albatross Bay (this spoil ground lies within the Port of Weipa).

In addition to species identified in the EPBC Act database search, species recorded during field surveys as part of the EIS, and species assessed as potential inhabitants of the area based on available habitats observed during field surveys as part of the environmental impact assessment, have been included in this assessment.

The dredged channel for the proposed port extends from State waters into the Commonwealth marine area. Dredged spoil from the port would be disposed of at a new spoil ground within the Commonwealth marine area, approximately 17km west of Boyd Point (see **Figure 4**). Dredged spoil from the barge and ferry terminals would be disposed of at the existing Port of Weipa Spoil Ground in Albatross Bay (see **Figure 4**). This spoil ground also lies within the Commonwealth marine area.

The relevant MNES within the Project area or potentially affected by the Project are described in this report in terms of: threatened terrestrial flora and fauna, threatened freshwater/marine fauna, migratory species, and Commonwealth marine areas.

It should be noted, that a Protected Matters search of the pre-defined Cape York Natural Resource Management (NRM) region (accessed on the 25/03/2011), identifies the potential occurrence of the threatened ecological community '*The community of native species dependent on natural discharge of groundwater from the Great Artesian Basin'*. Discharge springs, which are defined as spring's supplied by underground water from the GAB, are not found in the Project area or Cape York. It is therefore unlikely that this threatened ecological community would occur in or near the Project area (see **Section 5.3.4**). Detailed baseline surveys of the Project area were carried out and the results are presented in Section 6 (Marine), Section 7 (Terrestrial Flora and Fauna), and Section 8 (Aquatic Ecology) of the EIS. Description of the Environment

The terrestrial part of the Project area (the portion of the mining lease south of the Embley River) is essentially an elevated bauxite plateau that is fringed on much of its coastal margins by low cliffs and lateritic outcrops. The Project area sheds run off from a centrally located topographic high to the east via a series of creeks and tributaries. The main rivers and creeks in the Project area are shown in **Figure 3**. Seasonal variation in the ephemeral reaches of rivers and creeks is pronounced, with wet season discharge typically commencing from mid to late December. The dry season retreat of stream flow over the ephemeral sections can occur from early April. The underlying shallow aquifer is able to sustain baseflows well into the dry season over the lower reaches of the major watercourses. Estuaries are present at the lower reaches of the Ward, Watson and Embley Rivers and of Norman Creek.

The Project area is located within the Western Plains province (subregion) of the Cape York Peninsula Bioregion (Sattler and Williams 1999). This is the most extensive of the six provinces and covers a large area of the central and north-western portions of Cape York Peninsula. This area is relatively homogenous in vegetation and landform, and is characterised by large areas of Darwin Stringybark (*Eucalyptus tetrodonta*) open forests or woodlands, dissected by smaller areas of more mesic riparian vegetation, vine thicket patches and paperbark swamps. More information on protected areas, conservation areas and biodiversity areas within the Cape York Peninsula Bioregion is provided in Section 7.2 of the EIS. Cultural heritage values associated with landscape of the region and the Project area are discussed in Section 11.1.4 of the EIS.

Approximately 99% of the vegetation that would be disturbed as a result of the Project is mapped as Darwin Stringybark (*Eucalyptus tetrodonta*) Open Forest to Woodland on lateritic red earths (Regional Ecosystem (RE) 3.5.2). This RE correlates with the bauxite-bearing Weipa plateau. The 28,970ha of RE3.5.2 proposed to be disturbed over the 40 year mine life of the Project represents 33% of the area of this RE mapped in the Project area and 4.3% of the area of this RE mapped in the Weipa Plateau region. RE 3.5.2 is currently classified as 'Least concern' under the Queensland *Vegetation Management Act 1999* (VMA). Refer to Table 7.10 of the EIS for more information on the types and

areas of vegetation associated with physical land disturbance associated with the Project. Section 7.5.1 of the EIS discusses the vegetation units within the Project area and the associations and interactions with other physical elements such as topography, hydrology and soil.

The EPBC Act search did not identify any Endangered Ecological Communities (EECs) as likely to occur within the Project area, and no EECs were identified during the field surveys. A review of the RE types that are mapped in the Project area indicates that EECs are not likely to occur within the Project area.

Of the 27 REs occurring in the Project area, 24 are listed under the VMA as 'Least concern', and three are listed under the VMA as 'Of concern'. Of these, only one "Of concern" RE (3.2.6a) would be disturbed as a result of the Project. Total disturbance of RE 3.2.6a would be approximately 0.3ha, which is 0.2% of the area of this RE mapped in the Project area and 0.1% of the area mapped in the Weipa Plateau region. No 'Endangered' REs are known to occur within the Project area.

The terrestrial fauna community within the Project area is not regarded as unique or of particular importance, with similar fauna assemblages occurring elsewhere along the west coast of the Cape York Peninsula, particularly within *Eucalyptus tetrodonta* dominated habitats. There is considerable fauna diversity within the Project area reflecting the diversity of habitats present including closed forest, woodland, and a range of stream, wetland and coastal habitats. Fauna diversity is concentrated within the non-Darwin Stringybark open forest habitats which together comprise approximately 1% of the area that would be disturbed by the Project. A description of the main fauna habitats within the Project area is provided in Section 7.14.1 of the EIS. Section 7.14.2 of the EIS discusses the landscape and condition of the main fauna habitats within the Project area.

Aquatic ecosystems within the Project area include swamps, lagoons, freshwater channels, lakes and estuaries (Refer to Section 8.4 if the EIS for further information). The systems are a mix of perennial and seasonal systems, some of which are interconnected with the groundwater system.

The southern extremity of the Project area overlaps with the Archer Bay Aggregation on the lower Ward River (refer Figure 8-1 of the EIS), which is a nationally significant wetland area listed in the Directory of Important Wetlands in Australia (DIWA) (Blackman *et al.* 1999). No mining is proposed within the Archer Bay Aggregation. Archer Bay is fed by the Ward, Watson and Archer Rivers with mining occurring only within the Ward River, which covers only 3.8% of the total contributing catchment of 17,358 km^2 (see Table 5-1 and Figure 5-1 of the EIS). The Project would not affect the Watson or Archer Rivers. An assessment of impacts to the Ward River catchment (see Section 5.2.4 of the EIS) identified that the Project would have only a minor impact to discharge to the Ward River catchment. Therefore the impact to the Archer Bay Aggregation, and any threatened/migratory/marine species which use these systems, would also be very minor, if any.

The Cape York Peninsula Land Use Strategy (CYPLUS) (Abrahams *et al.* 1995) the estuary of the Embley River and the Aurukun Wetlands to the immediate south of the Project area. Further information on conservation areas and sensitive environmental areas associated with aquatic ecosystems in the northern Cape York region is provided in Section 8.2 of the EIS.

There are two other relatively large wetland aggregations partly or wholly contained within the Project area, including the lower Winda Winda–Triluck Creeks and lower Norman Creek. These systems provide wetland habitat, productivity (carbon biomass), fish nursery, fisheries, nesting/feeding areas for migratory birds, aquatic refugia, habitat for threatened species and areas of cultural significance.

A total of 45 species of fish were recorded in the Project area. The number of species recorded indicates that the fish communities within the Project area had less species diversity than adjoining catchments and estuaries in the region. The freshwater fish community comprises species occurring elsewhere in the western Cape York drainage systems. Discussion on aquatic habitat within the Project area is provided in Section 8.4 of the EIS. Section 8.5 of the EIS also provides information on the water quality and hydrology of aquatic habitats within the Project area and Section 8.6 of the EIS discusses the riparian and aquatic flora habitats within the Project area.

Near shore fringing reef communities in the vicinity of the proposed port area occur approximately 2km to the north-east at Boyd Point and approximately 2km to the south-west at Pera Head. These fringing reef communities also occur between Pera Head and Thud Point in State waters. These communities comprise both reefs containing hard corals and low profile reefs containing soft

coral/sponge assemblages. Satellite imagery also indicates there may be numerous small reef outcrops present between Thud Point and Aurukun. Hard corals over the reef areas include species from the following genera: *Porites*, branching *Acropora*, *Turbinaria*, *Monitipora*, *Lobophyllia*, *Platygyra*, *Pavona* and *Favia*. Nine Mile Reef is located approximately 6km south south-west of the proposed new disposal ground in the Commonwealth marine area and has been identified as an important fishing location for local recreational fishermen and commercial line fishing. The importance of these reef systems (Boyd Point to Thud Point and Nine Mile) in a regional context is considered to be high as they support resources which are of conservation, cultural, commercial and recreational importance. In particular, the near shore sponge and soft coral reefs provide a food resource for a range of turtle species in the area. Refer to Section 6.3.2 of the EIS for more information on inshore and offshore reef habitats associated with the Project.

Seagrass beds are typically present in the more sheltered areas of Albatross Bay. Recent surveys for the EIS did not identify seagrass within the proposed dredge footprints of the proposed Hornibrook Terminal and Hey River Terminal, however, it may occur in the wider vicinity as isolated patches. Isolated patches of seagrass have been identified within or immediately adjacent to the proposed dredge footprint at the Humbug barge terminal. Further discussion on seagrass habitat within and surrounding the Project area is provided in Section 6.3.4 of the EIS.

The Project area contains extensive intertidal and sub-tidal soft sediment habitats. The development footprints for all marine infrastructure components of the Project (the proposed port, barge/ferry terminals and new spoil ground) consist primarily of soft sediment habitats. These soft sediments are common throughout the Gulf of Carpentaria and are not considered to be sensitive marine habitats and are therefore not areas of high importance. Section 6.3.5 of the EIS describes these habitats in detail.

The Albatross Bay Spoil Ground currently receives capital and maintenance dredging material from operations within the Port of Weipa. The spoil ground typically receives in excess of 500,000m^3 annually of maintenance spoil dredged from the inner harbour and entrance channel (i.e. South Channel) (GHD 2005). This spoil ground also received over 3,000,000m^3 of capital dredging material from the entrance channel in 2006-2007. Before any material is placed at the Albatross Bay spoil ground, it must be proven to be suitable for placement at sea using the assessment framework described in the National Assessment Guidelines for Dredging (NAGD) (Commonwealth of Australia 2009).

The Project area is not used for agriculture and is relatively undisturbed by development (Refer to Section 3.1.1 of the EIS). Tracks to various parts of the Project area are used by recreational vehicle users, Traditional Owners and for access for exploration. Recreational uses of the area include camping, fishing, pig hunting and recreational quad bike use (refer to Section 16.3.2 of the EIS). The Project area is also used by the Traditional Owners for fishing and hunting. Exploration activities, including drilling and associated road development, have taken place throughout the Project area.

There are no existing surface water dams or weirs in the Project area (Section 5.1.2 of the EIS).

The proposed port site, Hey River Terminal site and Hornibrook Terminal site have no existing infrastructure and no specific existing land use. The Hornibrook Terminal is adjacent to the existing North Queensland Bulk Port's (NQBP) Lorim Point bauxite export wharf. The proposed Humbug Terminal site is adjacent to NQBP's Humbug Wharf which is used by incoming barges carrying general cargo and fuel for Weipa and RTA's existing operations. NQBP undertake regular maintenance dredging in the Embley River for activities within the Port of Weipa. Apart from activities associated with the existing Port of Weipa, the marine ecosystem in the Project area is effectively unmodified. Prawn trawling, commercial fishing and recreational fishing are carried out in surrounding marine areas (refer to Section 6.7 of the EIS).

While overall there has been very little direct disturbance within the Project area and the environment is generally in good condition, some areas have been impacted by camping and rubbish dumping. Some areas have also been significantly affected by frequent fires and damage from feral pigs (refer to Section 7.10.1 of the EIS). The current fire regime on the *Eucalyptus tetrodonta* ecosystem has resulted in the development of a homogeneous vegetation structure that varies little throughout the Project area.

The feral pig is by far the most abundant introduced fauna species within the Project area, occurring within all habitat types. The damage from pigs on the terrestrial environment comprises rooting and wallows predominantly within riparian and wetland areas. Predation by feral pigs is also the primary factor currently impacting sea turtle nesting success at the proposed port site (refer Section 6.6.5 of the EIS). The intensity of nest disturbance by feral pigs is very high, particularly at Boyd Point, immediately to the north of the proposed port area, where there are no cliffs impeding beach access.

3.1 Terrestrial Flora

Surveys were undertaken of vegetation communities and flora within the Project area. The main objectives of the flora survey program were to characterise the flora in the habitats present and provide considerable coverage of threatened species listed under the EPBC Act, as these are the primary matters of national environmental significance relevant for the Project area (i.e. in the absence of threatened communities or populations). The secondary survey methodology of the Queensland Herbarium (Neldner *et al.* 2005) was used to characterise main vegetation types, together with extensive targeted survey traverses in likely habitats for threatened species. Surveys were undertaken in July 2006, May 2007, December 2007, May 2008, December 2008 and May 2009. The spread of survey events provided survey effort over the two key seasons for detecting vegetation and floristic variability within the Project area, namely the dry season and late wet season. The flora surveys focussed on *Eucalyptus tetrodonta* dominated communities on the bauxite plateau which occur within the proposed mining areas and non-*Eucalyptus tetrodonta* communities. The non-*Eucalyptus tetrodonta* communities include riparian forest, vine forest, seasonally inundated areas and beach communities. Further information on the terrestrial flora survey methodology is provided in Section 7.4 and Appendix 7A of the EIS.

A total of 519 plant taxa have been recorded from all vegetation types within the Project area. There is considerable floristic diversity within the Project area, reflecting the diversity of vegetation types and habitats present including closed forest, woodland, and a range of stream and wetland habitats. A total of 184 species, or approximately 36% of the total complement of species from the Project area have been identified within *Eucalyptus tetrodonta* dominated vegetation, which is the vegetation type occurring where mining is proposed. *Eucalyptus tetrodonta* comprises approximately 87% of the Project area and 99% of the area of proposed disturbance.

Based on an assessment of database records, field surveys and the preferred habitat of threatened species, six threatened flora species listed under the EPBC Act were determined to be known to occur or possibly occurring within the Project area. These species are listed in **Table 3** together with an assessment of their likelihood of occurrence within the Project area and proposed areas of disturbance within the Project area.

Of the 6 species identified as potential inhabitants of the Project area, all are listed as "Vulnerable", and:

- 2 species have been confirmed as present in the Project area;
- 1 species is likely to occur in the Project area; and
- 3 species possibly occur in the Project area.

The confirmed locations of threatened flora species are shown on **Figure 5**.

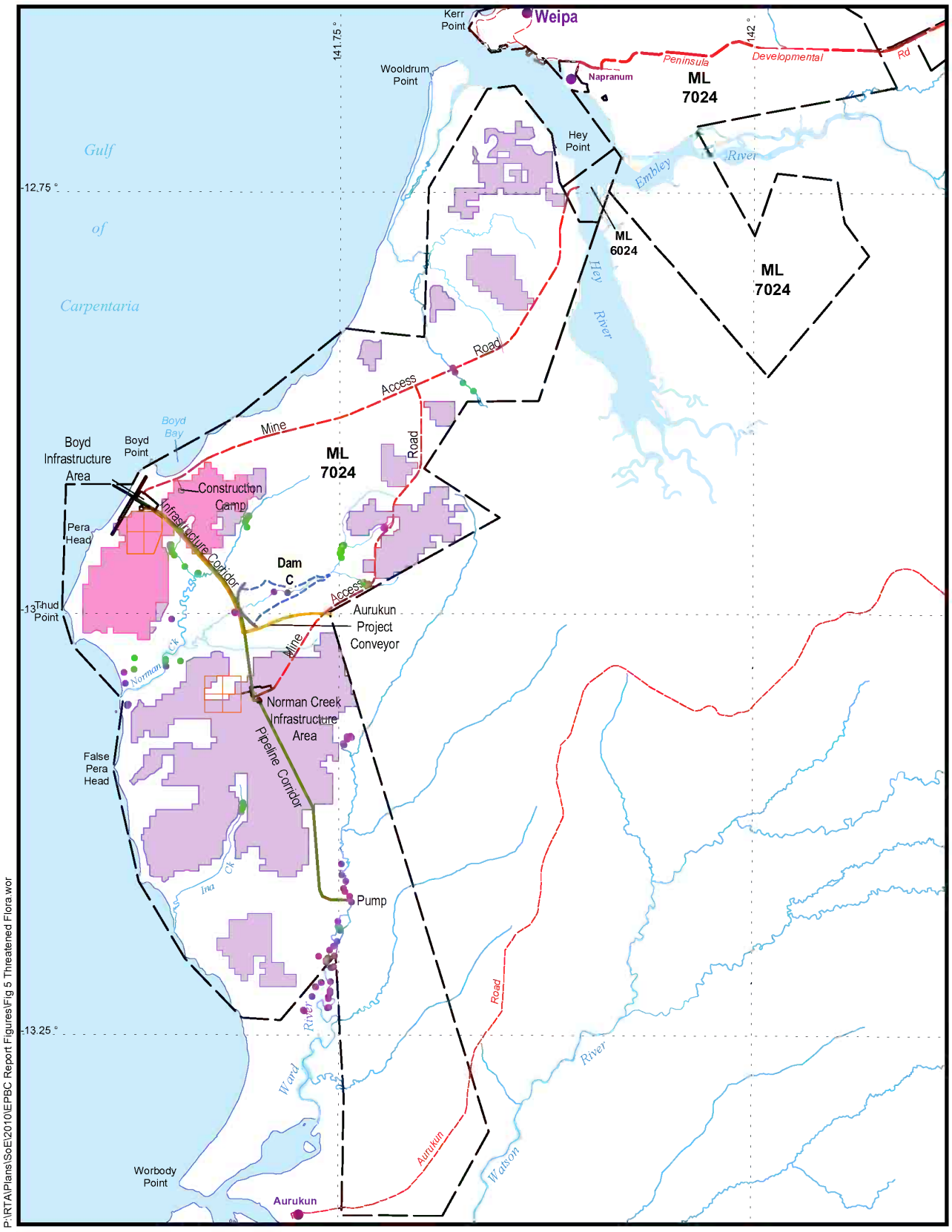
The REs that represent potential habitat for each species are provided in **Table 3**. Refer to **Figure 6**, **Figure 6a**, **Figure 6b**, **Figure 6c** and **Figure 6d** for the location and distribution of these REs within the Project area. Refer to Table 7-10 of the EIS for data on the area of proposed disturbance of REs compared to the total area in the Project area, the Weipa Plateau subregion, and the Cape York Bioregion. The potential impacts and proposed mitigation strategies pertaining to threatened flora are discussed in **Section 5.3**.

Table 3 Threatened Terrestrial Flora Listed under the EPBC Act

Species **Common Name (if exists)** **[Family]**	**EPBC Status**	**Growth Form and Habitat**	**Likelihood of Occurrence within Project Area and Areas of Proposed Disturbance within the Project Area (Site)**
Calophyllum bicolor [Clusiaceae]	V	A small fire sensitive tree known to be associated with permanent groundwater seepage zones, particularly in evergreen vine forest. Potential habitat comprises RE 3.3.5 (refer to Figures 6 to 6d for the locations of REs within the Project area).	**Project area** **Possible**: not detected during field surveys of five semi-permanent groundwater seepage rainforest patches, close to proposed mining areas, that provide suitable habitat for the species, but may occur in the Project area in groundwater-fed riparian gallery forest or seepage zones nearer the coast. Only limited areas of suitable fire retardant habitat occur within the Project area. Six other semi-permanent seepage areas surveyed outside the infrastructure footprint did not have suitable habitat present. **Mining Area** **Unlikely:** No suitable habitat exists in Darwin Stringybark woodland. **Dam C on Norman Creek and infrastructure footprint** **Unlikely:** targeted surveys of the dam area and infrastructure crossings of riparian areas indicated with a high reliability that this species is not present in these locations.
Dendrobium bigibbum (also known as *Vappodes bigibba)* Cooktown Orchid [Orchidaceae]	V	An epiphyte that grows on trees and rocks in situations with moderate light intensity. Occurs in a range of fire sensitive habitats including coastal scrub, streambank vegetation, monsoon thickets, and gullies in open forest and woodland where fire cannot penetrate. In the Weipa area it grows as an epiphyte on trees (rocks absent) and is commonly encountered in coastal vine forest and vine forest on bauxite. Potential habitats comprise vegetation REs 3.1.1a, 3.1.1c, 3.2.2, 3.3.5, 3.5.4 (refer to Figures 6 to 6d for the locations of REs within the Project area).	**Project area** **Confirmed:** located in coastal and non-coastal vine forest, and mangrove edges at several locations within the Project area that would not be affected by mining or infrastructure. **Mining Area** **Unlikely:** no suitable habitat exists in Darwin Stringybark woodland. **Dam C on Norman Creek and infrastructure footprint** **Confirmed**: identified in pockets of riparian rainforest within the footprint of Dam C, in the vicinity of the infrastructure corridor crossings on Norman Creek, and vicinity of road crossings of Norman Creek and Winda Winda Creek.
Dendrobium johannis (also known as *Cepobaculum johannis*) Chocolate Tea Tree Orchid Johann's Orchid [Orchidaceae]	V	An epiphyte that grows in open humid habitats, on slopes in open woodland, close to swamps and in pockets of monsoon forests. It has been recorded growing on Tea-tree in *Melaleuca* woodland and in coastal semi-evergreen vine thicket. In the Weipa area it is commonly encountered growing on *Melaleuca* and *Syzygium suborbiculare* on the margin of Melaleuca swamps and riparian gallery forest. Potential habitats comprise REs 3.2.3, 3.3.5, 3.3.9, 3.3.14a, 3.3.21 (refer to Figures 6 to 6d for the locations of REs within the Project area).	**Project area** **Confirmed:** located in riparian gallery forest and Melaleuca dominated swamps particularly along major drainage lines and associated tributaries throughout the Project area, in areas not to be disturbed. **Mining Area** **Unlikely:** no suitable habitat exists in Darwin Stringybark woodland. **Dam C on Norman Creek and infrastructure footprint** **Confirmed**: occurs within the infrastructure corridor where it crosses Norman Creek.

Species **Common Name (if exists)** **[Family]**	**EPBC Status**	**Growth Form and Habitat**	**Likelihood of Occurrence within Project Area and Areas of Proposed Disturbance within the Project Area (Site)**
Myrmecodia beccarii Ant Plant [Rubiaceae]	V	A tuberous epiphyte known to grow in *Melaleuca* woodland and mangrove areas. Recently recorded from the Weipa area in a small groundwater seepage forest. Potential habitats comprise REs 3.1.1a, 3.1.1c, 3.1.3, 3.3.14a, 3.3.5 (refer to Figures 6 to 6d for the locations of REs within the Project area).	**Project area** **Possible**: this species is of very restricted distribution in the Weipa area. If a permanent groundwater seepage zone was identified within the Project area, this species may occur within this zone. At present only semi-permanent groundwater seepage zones have been identified within the Project area. The species may also occur within or on the landward margin of mangroves within the Project area. **Mining Area** **Unlikely:** no suitable habitat exists in Darwin Stringybark woodland. **Dam C on Norman Creek and infrastructure footprint** **Unlikely:** targeted surveys of the dam area and infrastructure crossings of riparian areas indicated with a high reliability that this species is not present in these locations.
Solanum dunalianum Beach Nightshade [Solanaceae]	V	An herbaceous shrub growing to 2–4m found in or at the edge of semi deciduous vine forest. Potential habitats comprise REs 3.2.2 and margins of 3.5.2 (refer to Figures 6 to 6d for the locations of RE's within the Project area).	**Project area** **Likely**: not detected during field surveys but suitable coastal vine forest and vine forest on bauxite habitat occurs in the Project area in areas not to be disturbed. **Mining Area** **Unlikely:** no suitable habitat exists in Darwin Stringybark woodland. **Dam C on Norman Creek and infrastructure footprint** **Unlikely:** within the Project area the species is expected to be restricted to more mesic habitats, particularly coastal vine forest and vine forest on bauxite,
Spathoglottis plicata [Orchidaceae]	V	A terrestrial orchid with flower stems to 1m that grows in or close to swamps, in seasonally inundated areas and in moist, grassy patches close to streams, in Melaleuca swamp forest and riparian gallery closed forest. Flowers during wet season, difficult to detect when not flowering. Potential habitats comprise REs 3.2.3, 3.3.5, 3.3.9, 3.3.14a, 3.3.21 (refer to Figures 6 to 6d for the locations of REs within the Project area).	**Project area** **Possible**: not detected during field surveys anywhere within the Project area but suitable stream, wetland and seepage habitat occurs extensively in the Project area in areas that would not be directly disturbed by the Project. **Mining Area** **Unlikely:** No suitable habitat exists in Darwin Stringybark woodland. **Dam C on Norman Creek and infrastructure footprint** **Possible:** potential habitat for the species occurs within the proposed footprint of Dam C and the infrastructure corridor crossing of Norman Creek, although targeted surveys did not locate the species within these areas.

Key to Status: V = Vulnerable



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RTA Mining Lease boundary
Township
Road/track
Freshwater dam
Tailings storage facility
Mining Years 1 -13
Mining Years 14 - 40

Threatened Flora

Cooktown Orchid *[Dendrobium bigibbum]* (69 locations)

Chocolate Tea Tree Orchid *[Dendrobium johannis]* (76 locations)

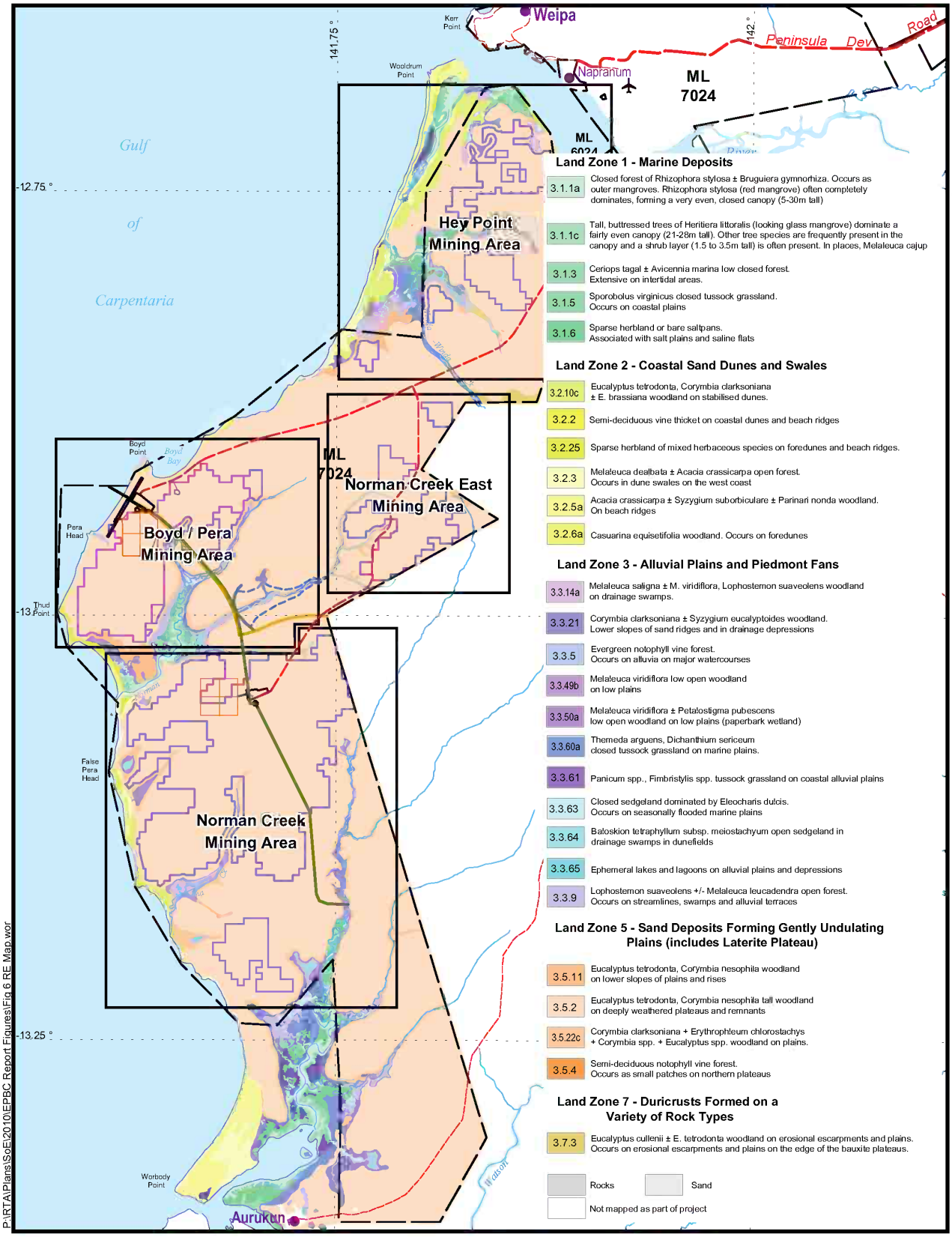
South of Embley Project

Fig. 5: Threatened Flora

N

5 0 5km

Datum/Projection: GDA94/MGA Zone 54 Date: 29/03/2011



RTA Mining Lease boundary
Township
Road/track
Freshwater dam
Tailings storage facility
Mining Years 1- 13
Mining Years 14- 40

Rio Tinto Alcan

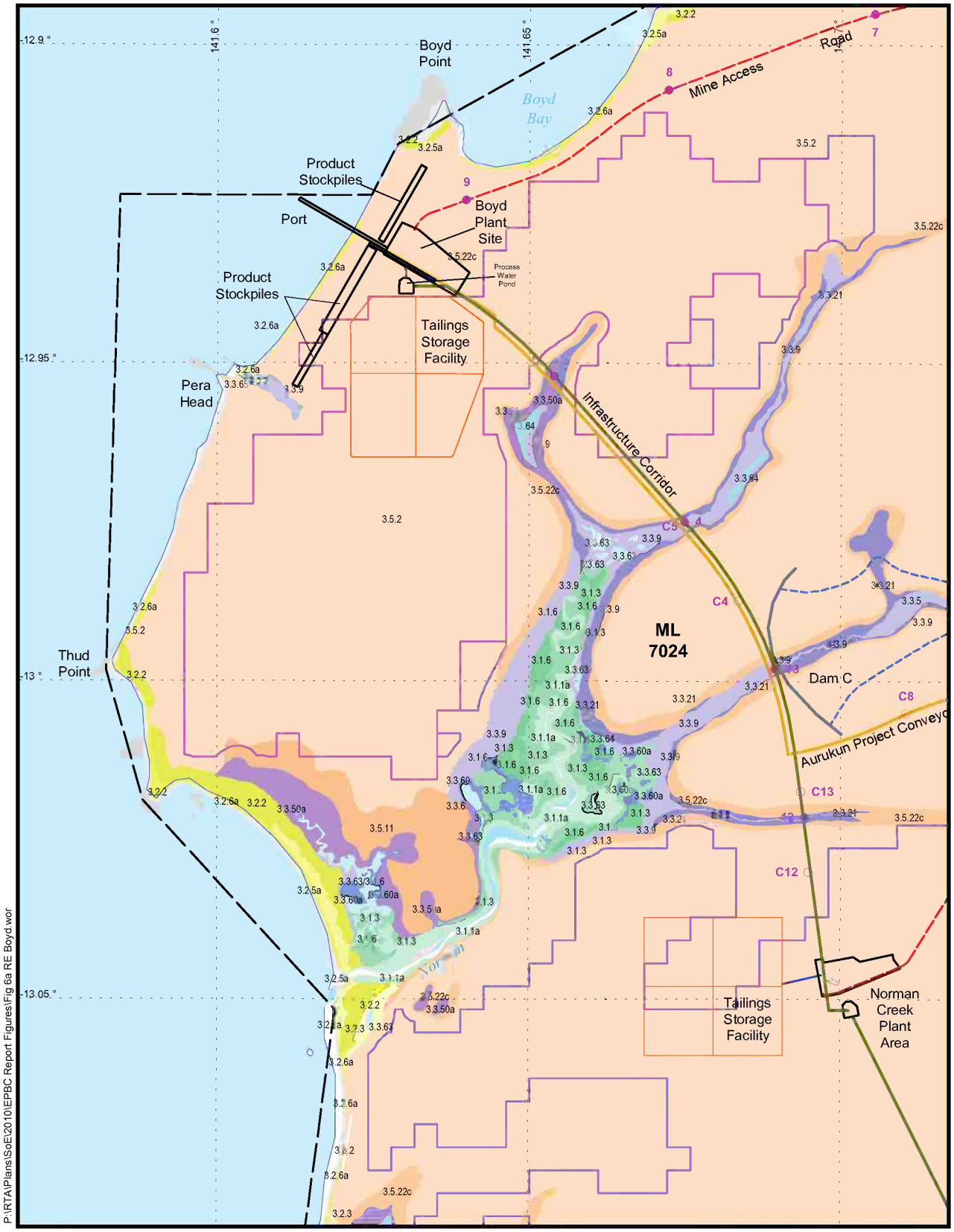
South of Embley Project

Fig. 6: Regional Ecosystems (Ground Surveyed)

N

5 0 5km

Datum/Projection: GDA94/MGA Zone 54 Date: 29/03/2011



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RTA Mining Lease boundary
Freshwater dam
Tailings storage facility
Mining Years 1- 13
Mining Years 14- 40
Culverts

For RE Descriptions See Fig 6

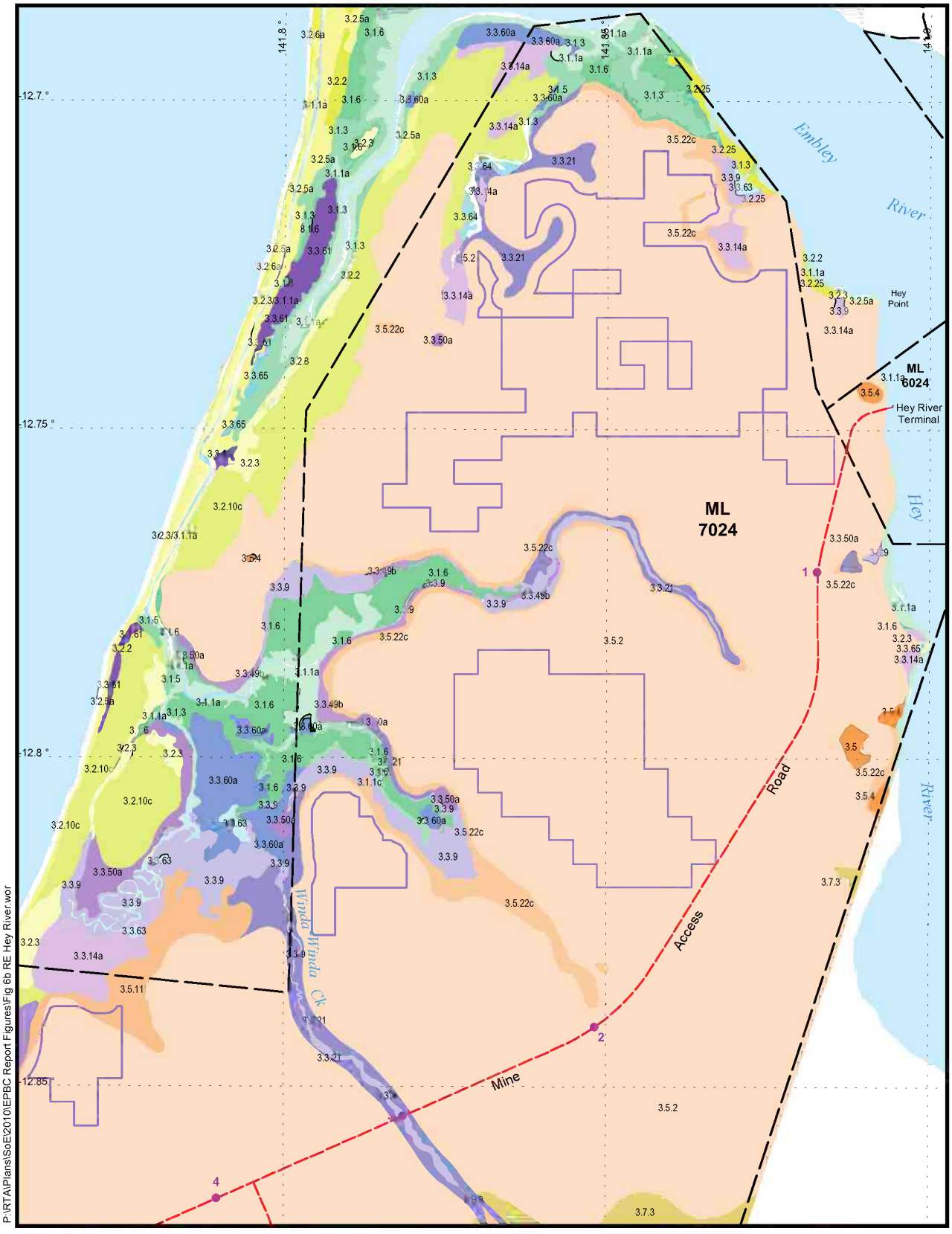
South of Embley Project

Fig. 6a: Regional Ecosystems (Boyd/Pera Mining Area)

N

1 0 1 2km

Datum/Projection: GDA94/MGA Zone 54 Date: 29/03/2011



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RTA Mining Lease boundary

Mining Years 14- 40

Culverts

For RE Descriptions See Fig 6

Rio Tinto Alcan

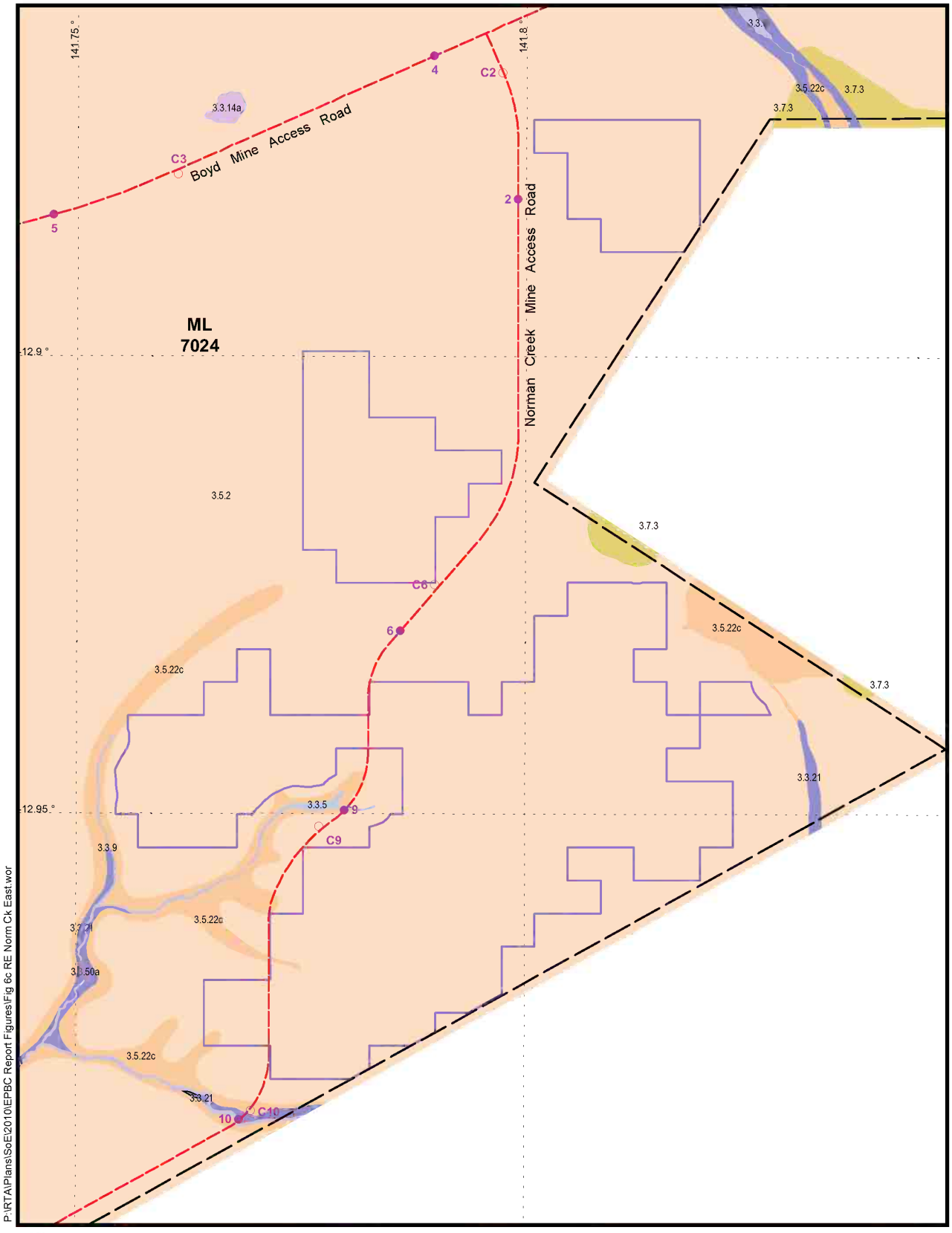
South of Embley Project

Fig. 6b: Regional Ecosystems (Hey Point Mining Area)

N

1 0 1 2km

Datum/Projection: GDA94/MGA Zone 54 Date: 29/03/2011



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RTA Mining Lease boundary

Mining Years 14- 40

Culverts

For RE Descriptions See Fig 6

Rio Tinto Alcan

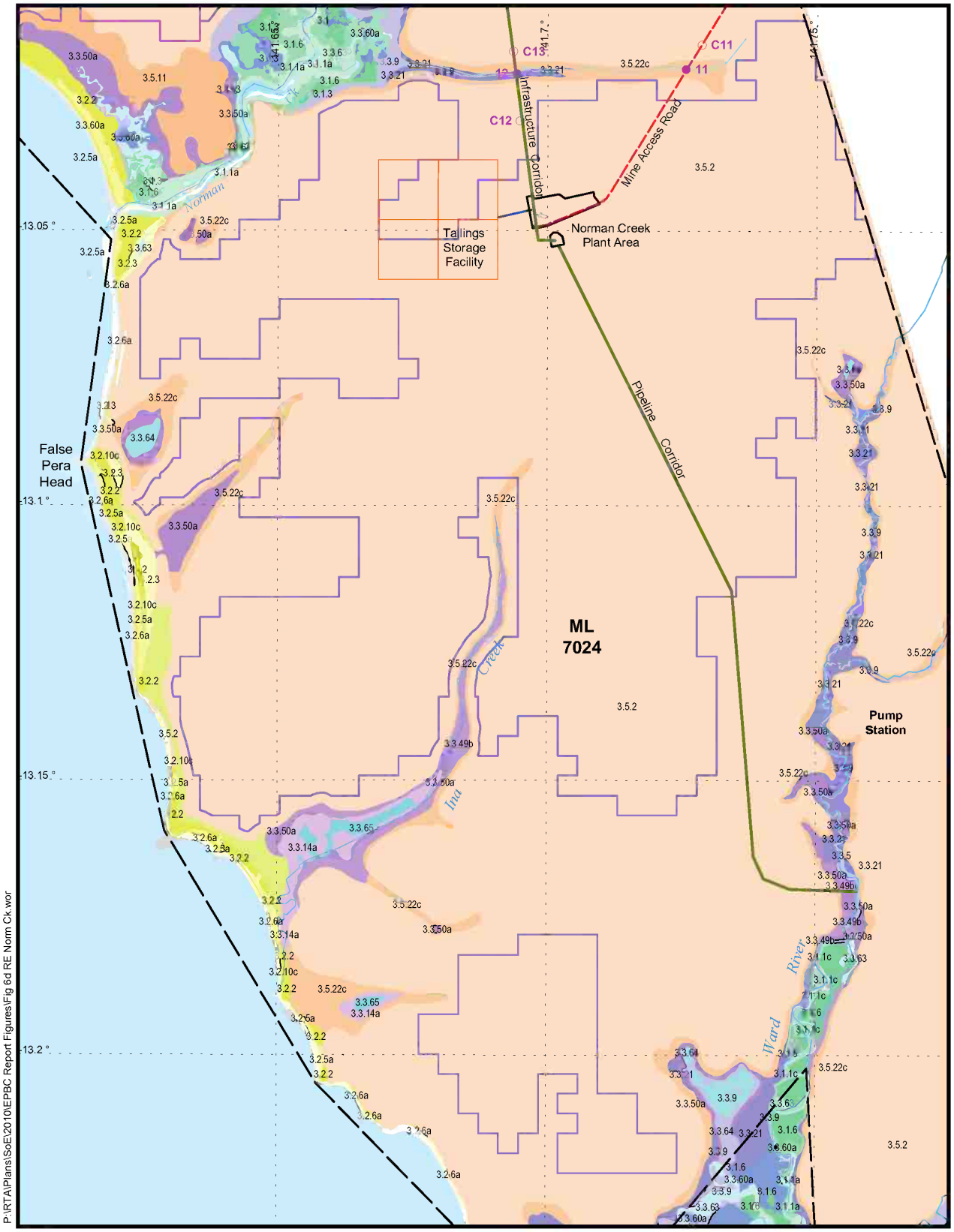
South of Embley Project

Fig. 6c: Regional Ecosystems (Norman Creek East Mining Area)

N

1 0 1km

Datum/Projection: GDA94/MGA Zone 54 Date: 29/03/2011



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RTA Mining Lease boundary
Freshwater dam
Tailings storage facility
Mining Years 14- 40
Culverts

For RE Descriptions See Fig 6

Rio Tinto Alcan

South of Embley Project

Fig. 6d
Regional Ecosystems (Norman Creek Mining Area)

N

1 0 1 2km

Datum/Projection: GDA94/MGA Zone 54 Date: 29/03/2011

Profiles of each of the species from **Table 3** are provided below.

Calophyllum bicolor

Calophyllum bicolor is currently known only from 17 populations on Cape York Peninsula (DERM 2010). It occurs on spring-fed areas that form a distinct habitat with evergreen rainforest and permanently wet substrates. It does not occur on stream banks away from spring-heads. There are four specimen records of the species from the Weipa area, but the species has not been recorded within the Project area. Permanently wet spring heads supporting vine forest have not been identified within the Project area and are therefore considered not as common within the Project area as in the Weipa area. However, five semi-permanent springs/seepage zones with suitable habitat were located and surveyed for the species close to proposed mining areas, but the species was not present. Six other seepage zones lacking suitable habitat were also surveyed and the species was not present. Unsurveyed isolated habitats with these characteristics may occur at the margin of wetlands in the lower freshwater sections of drainages (Norman Creek, Ward River, Winda Winda Creek) and may support the species.

Potential habitats for the species comprise riparian gallery rainforest and swamp forest/woodland, and palm forest vegetation communities. Riparian gallery rainforest occurs within the proposed footprint of Dam C on a freshwater tributary of Norman Creek, however *Calophyllum bicolor* was not located in this area during targeted surveys. The species was not recorded during other surveys of the riparian gallery rainforest and swamp forest/woodland, and palm forest vegetation communities.

If *Calophyllum bicolor* was to occur within the disturbance footprint of the Project area, the location would represent the southern distribution limit for the species and would therefore be regarded as an important population.

There are no threats specifically listed for *Calophyllum bicolor* (DSEWPaC 2010).

Cooktown Orchid *(Dendrobium bigibbum)*

The Cooktown Orchid has been recorded from several locations in the Weipa region, particularly in notophyll vine forest on coastal dunes and on lateritic red earths. The habitat preference of this species in the Weipa region is well known, where the Cooktown Orchid is restricted to closed forest, typically as an epiphyte in rainforest or vine thicket habitats. The species is sensitive to fire and therefore is found only in situations where frequent fires do not occur. Vine forest patches on bauxite provide the required fire protection but with respect to riparian gallery forest the species is more commonly encountered inside broad occurrences of the vegetation, or where lateral seepage zones and mesic ground vegetation suppress fire frequency and scorch height.

The Cooktown Orchid was recorded within the Project area in coastal vine forest and mangroves near the mouth of Norman Creek, in mangroves on the Ward River and in areas of riparian rainforest and riparian gallery forest throughout the Project area. The species was not located in other vine forest areas on bauxite although it may occur in these areas which occur in the Hey Point area. It is likely that the Cooktown Orchid also occurs in other coastal vine forest areas that were not surveyed to the north of Norman Creek and in the Hey Point area.

The Cooktown Orchid occurs within the proposed footprints of Dam C, and in the vicinity of a proposed Mine Access Road crossing of an upper Norman Creek tributary.

The population of Cooktown Orchid recorded within the Project area is not regarded as an important population under the EPBC Act.

Known threats to the Cooktown Orchid include pressure from localised settlement and visitors, altered fire regimes and illegal collection. It has also been suggested that the Cooktown Orchid may also be detrimentally affected by an increase in the incidence of severe cyclones (DEWHA 2008a).

Chocolate Tea Tree Orchid *(Dendrobium johannis)*

The Chocolate Tea Tree Orchid has been recorded from several locations in the Weipa region, including the Andoom, Weipa and Ely mining lease areas. The habitat preferences of this species are well known with the Chocolate Tea Tree Orchid being restricted to mesic habitats, typically as an epiphyte on mature *Syzygium* spp. and *Melaleuca* spp. trees in riparian gallery forest and on the

margins of swamp habitats and their associated ecotones.

In the Project area, the species has been identified within riparian gallery forest and Melaleuca dominated swamps, particularly along major drainage lines and associated tributaries. It is anticipated that the species occurs in these habitats throughout the Project area. The Chocolate Tea Tree Orchid occurs within the infrastructure corridor downstream of Dam C, and in the vicinity of proposed Mine Access Road crossings of Winda Winda Creek and an upper Norman Creek tributary.

As the Chocolate Tea Tree Orchid is widely distributed throughout the region, the population within the Project area is not regarded as an important population.

The key known potential threats to the Chocolate Tea Tree Orchid include over-collection by orchid enthusiasts and habitat degradation from settlement and visitor pressures (DEWHA 2008b).

Ant Plant *(Myrmecodia beccarii)*

The Ant Plant is known from a variety of denser canopy habitats on Cape York including mangroves, *Melaleuca* dominated wetlands, coastal scrubs, and groundwater seepage zones with swamp vine forest. The Ant Plant was recently recorded from the Weipa area in a small groundwater seepage forest but is apparently of very restricted distribution in the Weipa area.

The Ant Plant was not located during extensive targeted surveys in suitable habitat. If permanent groundwater seepage zones were to occur within the Project area, the species may occur within these areas, however only semi-permanent groundwater seepage zones have been identified within the Project area. Potential habitat for the species does not occur within proposed mining areas, and surveys of suitable habitat within the footprint of proposed infrastructure areas did not locate the species. Vine forest would be protected from mining via the proposed vegetation buffer system (refer **Section 5.2**). Mangrove areas that were not inspected during surveys may also support this species. Only a small area of mangroves (400m^2) would be directly impacted at the proposed Hey River ferry terminal. The extent of mangrove clearing represents approximately 0.008% of RE 3.1.1a and 0.003% of the mangrove communities within the Project area.

If a population of *Myrmecodia beccarii* was to occur within the Project area, it would be considered an important population under the intent of the EPBC Act since the species is little known with no specimen records from western Cape York.

Known threats for the Ant Plant include clearing of lowland paperbark woodlands, localised settlement pressures and the removal or destruction of plants by plant and butterfly collectors (DEWHA 2008c).

Beach Nightshade *(Solanum dunalianum)*

Beach Nightshade is known from a few records near Weipa and on the Torres Strait islands, although more recent surveys for known populations in the Weipa area failed to relocate the species despite targeted searching (Landsberg and Clarkson 2004). The species has generally been recorded in semi-deciduous notophyll vine forest, and the edges of this community. In the Weipa area it has been recorded from vine thicket vegetation on coastal dunes between Pennefather and Duyfken areas north of Weipa and vine forest on bauxite on the north shore of the Embley River near Napranum (Jason Searle pers. comm.). The distribution of this species in the region is poorly known with only a few specimens collected, but it appears likely to be more prevalent in closed forest vegetation.

The species was not recorded during surveys for the Project. Within the Project area it is expected to be restricted to more mesic habitats, particularly coastal vine forest and vine forest on bauxite, and consequently it is highly unlikely populations of this plant would occur in areas subject to mining operations or infrastructure development within the Project area.

DEWHA (2008d) identify the key known threats to some populations of Beach Nightshade as localised settlement pressures including land clearing, exotic animals such as feral pigs, weeds and altered fire regimes. DEWHA (2008d) also noted that a potential threat to the Beach Nightshade may be habitat destruction associated with mining activities.

Spathoglottis plicata

Spathoglottis plicata is known from Cape York between Cooktown and the Jardine River and has been recorded in the Weipa region (DEWHA 2008e). The species was not recorded during targeted surveys

in the Project area. *Spathoglottis plicata* typically occurs in or close to swamps, in seasonally inundated areas, in moist, grassy patches close to streams, in Melaleuca swamp forest and riparian gallery rainforest (Jones 1988; Dockrill 1992, Landsberg and Clarkson 2004). The species may be difficult to detect in the field if not flowering and when aerial shoots are absent, therefore the potential presence of this species in suitable habitat within the Project area cannot be discounted.

Potential habitat for the species occurs within the proposed footprint of Dam C and the infrastructure corridor crossing of Norman Creek, although targeted surveys did not locate the species within these areas or elsewhere within the Project area.

As the regional population size of *Spathoglottis plicata* is relatively small, if this species was to occur within the disturbance footprint of the Project area, this would be regarded as an important population.

The key known potential threats to *Spathoglottis plicata* include over-collection and illegal collection by orchid enthusiasts, disturbance and foraging by feral pigs and altered hydrology (DEWHA 2008e).

3.2 Terrestrial Fauna

Surveys were undertaken of the terrestrial fauna and habitats within the Project area. The main objectives of the fauna survey program were to characterise the fauna communities within the terrestrial habitats present and to provide substantial coverage of threatened and migratory species listed under the EPBC Act, as these are the primary matters of national environmental significance relevant for the Project area (i.e. in the absence of threatened communities or populations). Survey techniques were used that were specifically suited to the species and habitats likely to be present as well as providing an optimal balance of intensive site based data and more extensive data on threatened and migratory species.

The fauna survey satisfied the 6 steps of planning and design of surveys as outlined in the EPBC *Survey Guidelines for Australia's Threatened Birds*, *Bats* and *Frogs* (DEWHA 2010a, 2010b, 2010c respectively). For the Red Goshawk and Masked Owl, the survey methodology satisfied the *Survey Guidelines for Australia's Threatened Birds* (DEWHA 2010a).

Surveys were undertaken of the terrestrial fauna and habitats within the Project area in July 2006, May 2007, December 2007, May 2008, December 2008 and May 2009. The spread of survey events provided survey effort over key seasons for detecting fauna variability within the Project area, namely late dry season (December) and late wet season (May). The fauna surveys focussed on *Eucalyptus tetrodonta* dominated communities on the bauxite plateau which occur within the proposed mining areas as well as non-*Eucalyptus tetrodonta* communities. These non-*Eucalyptus tetrodonta* communities include riparian forest, vine forest, seasonally inundated areas and beach communities. A total of 27 days of targeted survey effort were undertaken. More information on the terrestrial fauna survey methodology is provided in Section 7.13 and Appendix 7E of the EIS.

A combination of surveys and literature reviews were completed to develop an understanding of Project area fauna. A total of 269 native terrestrial vertebrate fauna species (including common species) were recorded from all habitat types within the Project area during the field surveys. About 98 species or approximately 36% of the total compliment of species from the Project area have been identified in the Darwin Stringybark (*Eucalyptus tetrodonta*) open woodland which is the habitat that occurs almost exclusively on the bauxite plateau. There is considerable fauna diversity within the Project area reflecting the diversity of habitats present including closed forest, woodland, and a range of stream, wetland and coastal habitats. Fauna diversity is concentrated within the non-Darwin Stringybark (*Eucalyptus tetrodonta*) open forest habitats which together comprise approximately 13% of the total area of the Project area or 1% of the proposed disturbance area.

A total of three terrestrial fauna species listed under the EPBC Act were determined to possibly occur within the Project area. Three additional species were identified by the EPBC Act database search, however they are unlikely to occur within the Project area. None of the species listed in the EPBC Act database and determined to possible occur within the Project area were confirmed to be present within the Project area. Species that possibly occur within the Project area are listed in **Table 4** together with an assessment of their likelihood of occurrence within the Project area and proposed areas of disturbance within the Project area. The locations of confirmed threatened and migratory

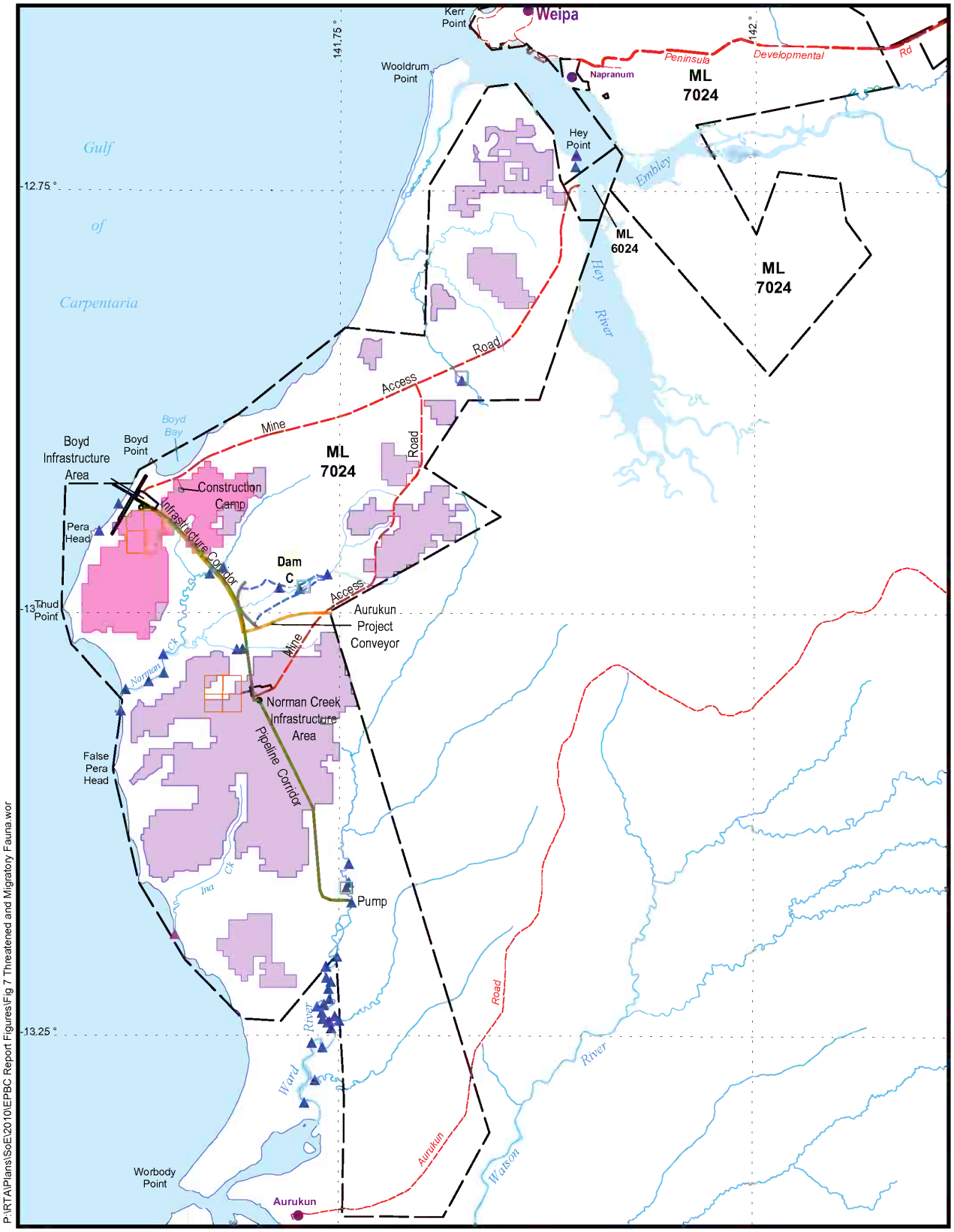
fauna species are shown on **Figure 7**. Profiles of each of the species from **Table 4** are also provided below. Refer to Section 7.15.4 and Table 7-15 of the EIS for further information on the species that are unlikely to occur within the Project area. The REs that represent potential habitat for each threatened species are provided in **Table 4**. Refer to **Figure 6**, **Figure 6a**, **Figure 6b**, **Figure 6c** and **Figure 6d** for the location and distribution of these REs within the Project area. Refer to Table 7-10 of the EIS for data on the area of proposed disturbance of REs compared to the total area within the Project area, the Weipa Plateau subregion, and the Cape York Bioregion. The potential impacts and proposed mitigation strategies pertaining to threatened terrestrial fauna are discussed in **Section 5.4**.

Table 4 Threatened Terrestrial Fauna Listed under the EPBC Act

Species **Common name (if exists)**	**EPBC Act Status**	**Habitat**	**Likelihood of Occurrence within the Project Area and Areas of Proposed Disturbance within the Project Area (Site)**
Birds			
Erythrotriorchis radiatus Red Goshawk	V	Favours Coastal and sub-coastal areas. Prefers a mix of vegetation types including tall open forest, woodland, lightly treed savannah and the edge of rainforest and riparian forests. If present, the species may utilise all REs within the Project area (refer to Figures 6 to 6d for the locations of REs within the Project area).	**Project area** **Possible**: the open forest, woodland, riparian, and wetland habitats that occur throughout the Project area, in areas not to be disturbed by mining, present suitable nesting and feeding opportunities for the species. **Mining Area** **Possible:** the open forests of the mining area and adjacent habitats constitute likely foraging habitat for the Red Goshawk, although no sightings of the Red Goshawk were made during the surveys. Darwin Stringybark woodlands within 1km of permanent water could be used for nesting. It is possible that nests of the species could be within proposed mining areas. **Dam C on Norman Creek and infrastructure footprint** **Possible**: no nests were located within the proposed dam site. However, Dam C contains potential foraging and nesting habitat.
Tyto novaehollandiae kimberli Masked Owl	V	Prefers tall eucalypt forest and woodlands. If present, potential habitat comprises REs 3.2.2, 3.2.3, 3.3.5, 3.3.9, 3.3.14a and 3.5.4 (refer to Figures 6 to 6d for the locations of REs within the Project area).	**Project area** **Possible**: the majority of key habitat resources for the species within the Project area are located in areas not to be disturbed, however, the prevalence of the species may be significantly limited by the apparent paucity of small mammal populations. **Mining Area** **Unlikely:** key potential habitat areas (riparian, wetland and vine forest habitats) and peripheral habitat (Darwin Stringybark open forest habitat adjacent to the key habitat areas), are not located within the proposed mining area. **Dam C on Norman Creek and infrastructure footprint** **Possible**: sections of tall closed forest on major drainages along Norman Creek and the Ward River provide potentially suitable habitat. The Dam C footprint contains some suitable habitat, however, this area is not regarded as especially significant for foraging or breeding. The prevalence of the species may be significantly limited by the apparent paucity of small mammal populations within the Project area.

Mammals			
Dasyurus hallucatus Northern Quoll	E	Rocky escarpments in eucalypt forests and woodlands within coastal regions (Oakwood 2008, Menkhorst and Knight 2004). If present, potential habitat comprises REs 3.2.2, 3.3.9, 3.3.14a, 3.3.21, 3.5.4 and 3.5.22c (refer to Figures 6 to 6d for the locations of REs within the Project area). If present, the species may also utilise RE 3.5.2 to traverse between non-Darwin Stringybark habitats).	**Project area** **Possible**: although the optimal habitat for the species, rocky outcrops and other rocky habitat, is not available within the Project area, the Northern Quoll may occur in vine forest and riparian gallery forest. All vine forest areas, and most riparian habitats within the Project area are located in areas not to be disturbed. **Mining Area** **Unlikely**: this species has declined on Cape York following the spread of Cane Toads to the area. A paucity of favoured rocky habitat and continued exposure to modification and suppression by fire may see limited persistence of the species in suitable habitat within the Project area. Whilst the species may once have utilised Darwin Stringybark woodland it is most likely that patches of vine forest and riparian forest habitat currently provide the most likely habitat for the species within the Project area. Suitable habitat for the species includes the riparian communities of Norman Creek, and the vine forest patches in the Hey Point area, which are not within mining areas. **Dam C on Norman Creek and infrastructure footprint** **Possible**: minor areas of suitable riparian habitats are located within the footprint of the water supply dam, although targeted surveys did not locate the species in these areas. The habitat areas within the proposed dam footprint are not regarded as especially significant for foraging or breeding.
Saccolaimus saccolaimus nudicluniatus Bare-rumped Sheathtail Bat	EC	Known habitats on Cape York include riparian forest and vine forest and adjacent woodland, including Darwin Stringybark dominated habitats. Potential habitat comprises REs, 3.2.10c, 3.3.5, 3.3.9, 3.3.21, 3.3.49b, 3.3.61, 3.5.2, 3.5.4, 3.5.11, 3.5.22c and 3.7.3 (Refer to Figures 7-6 to 7-6d for the locations of RE's within the Project area).	**Project area** **Possible**: This species' habitat is poorly known. The species may favour riparian forest and vine forest and adjacent Darwin Stringybark dominated habitats and was found roosting in Darwin Stringybark at Iron Range. Vine forest areas and most riparian habitats within the Project area are located in areas not to be disturbed. Extensive areas of Darwin Stringybark woodland also occur outside of the disturbance footprint. **Mining area** **Possible**: Darwin Stringybark habitat within proposed mining areas may be suitable for the species, especially in the vicinity of riparian gallery forest and vine forest patches. **Dam C on Norman Creek and infrastructure footprint** **Possible**: Riparian forest within the Dam and infrastructure footprint may present suitable habitat.

Key to Status: E = Endangered V = Vulnerable EC = Critically Endangered



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RTA Mining Lease boundary
Township
Road/track
Freshwater dam
Tailings storage facility
Mining Years 1 -13
Mining Years 14 - 40

Estuarine Crocodile (44 locations)
Estuarine Crocodile Nest
Little Tern (1 location)

Rio Tinto Alcan

South of Embley Project

Fig. 7: Confirmed Threatened and Migratory Fauna

N

5 0 5km

Datum/Projection: GDA94/MGA Zone 54 Date: 29/03/2011

The Red Goshawk, Masked Owl,Northern Quoll and bare-rumped Sheathtail Bat were not confirmed within the Project area, but may possibly occur.

Profiles of each of the species from **Table 4** are provided below. Refer to Section 7.15.4 and Table 7-15 of the EIS for further information on the species that are unlikely to occur within the Project area.

Red Goshawk (*Erythrotriorchis radiatus*)

The Red Goshawk has a wide range from northern WA to northern NSW, although it occurs in low numbers. The species has been recorded in riparian gallery forest associated with the lower Wenlock River to the north of the Project area (Blandford and Associates 1994), and was also recorded in the open woodland of the Merluna Plain to the north-east of the Project area (Winter and Atherton 1985).

The Red Goshawk is known to inhabit large home ranges of between 50 and 220km^2 in Queensland, with foraging regularly taking birds up to 8km from established nesting sites (Marchant and Higgins 1993). Habitat utilised in north Australia is described as tall open forest and woodlands traversed by waterways supporting gallery forest (Garnett and Crowley 2000). The open forests of the Project area and adjacent areas constitute likely habitat for the Red Goshawk, although no sightings of the Red Goshawk were made during the surveys. The species could possibly utilise the Project area at least occasionally as part of its extensive home range.

Nest trees are restricted to trees taller than 20m located within 1km of, and often beside, permanent water (Aumann and Baker-Gabb 1991; DEWHA 2009b; NPWS 2002). On this basis, it is possible that nests of the species could be located within Darwin Stringybark (*Eucalyptus tetrodonta*) open forest adjacent to permanent water or coastal habitats, or adjacent to seasonally inundated wetlands or seasonal watercourses supporting riparian gallery forest.

The species hunts in open forests and gallery forests, taking mostly medium to large birds (Czechura and Hobson 2000). It is most likely that wetlands of the lower Ward River area (located immediately downstream of the Project area) provide the best dry season foraging for the species as they support a greater abundance of these wetland habitats compared to areas contained within the Project area.

Small areas of riparian gallery forest and associated alluvial/colluvial woodland habitat that provide potential habitat for species such as the Red Goshawk (*Erythrotriorchis radiatus*) would be disturbed within the footprint of the water supply dam, however less than 10% of this habitat type within the Project area would be affected.

As the regional population size of this species is relatively small, if the Red Goshawk was to occur within the disturbance footprint of the Project area, it would be regarded as an important population.

Habitat clearing is the major known key threat to the Red Goshawk (EPA 2006). Human disturbance at nest sites are also known to disturb breeding pairs and result in reduced reproductive success, because breeding pairs can use the same nest in successive years (EPA 2006). However, they have been reported to build new nests after nests have failed or been cleared, or to nest in different areas seasonally to be closer to target prey. Debus and Czechura (1988) reported that after clearing of habitat, one pair left their nest site and were presumed to have re-nested 5km away. Aumann and Baker-Gabb (1991) reported that following the failure of a nest the pair concerned constructed a replacement nest. In winter in eastern Australia, the birds appear to move from nest sites in the ranges to coastal plains, where they are associated with permanent wetlands and often feed on waterbirds (Czechura and Hobson 2000). It is likely that Red Goshawks also undertake this habitat shift on northern Cape York as large numbers of waterfowl become concentrated on fewer wetland areas as wet season inundation recedes.

Based on the DSEWPaC (2010) Species Profile and Threats (SPRAT) database, there are a number of other possible threats to the species including the following.

- The theft of eggs for egg collections and the intentional killing of adults.
- The application of persistent pesticides such as DDT may have caused a historic reduction in the population. In 1989, Australia ceased widespread use of organochlorine pesticides and most affected species have now recovered.

- Overgrazing, or other changes in land management which could reduce prey availability, and therefore reduce productivity.
- Altered fire regimes have the potential to impact breeding sites and reduce prey availability, thus reducing productivity.
- The occurrence of a catastrophic event which may exaggerate the impact of existing threats.
- Possible genetic bottlenecks in the population.

Masked Owl (*Tyto novaehollandiae kimberli*)

The northern race of the Masked Owl occurs between Townsville and the Kimberley region with other races extending down the east coast to Tasmania. The Masked Owl has been recorded in the Aurukun area (WildNet Database) although the habitat within which it was recorded is unclear. The species was not recorded during surveys within the Project area. General habitat preference of this species comprises riparian gallery forest, rainforest, mangroves and the periphery of melaleuca swamp forest (Garnett and Crowley 2000). All of these habitat types occur within the Project area, with the sections of riparian forest on major drainages along Norman Creek and the Ward River providing likely habitat. However, the Masked Owl is a specialist predator of small–medium sized ground mammals and the apparent paucity of these mammal populations within the Project area is likely to limit the habitat values of the Project area for the species.

On this basis the Masked Owl is regarded as a possible inhabitant of the Project area but would most likely be restricted to riparian gallery forest above the coastal/brackish wetland zone where reduced seasonal inundation allows persistence of small mammal populations. Potentially suitable habitat occurs along Norman Creek and Coconut Creek/upper Ward River. Construction of the water supply dam would disturb some suitable habitat, although the majority of preferred habitat areas would not be disturbed by the Project.

A population of Masked Owl, if present in the Project area, could be regarded as an important population as the species there are limited recent records on Cape York Peninsula.

There is some evidence to suggest that the main threat to the Masked Owl is the decline in populations of small and medium sized native mammals, which are the Masked Owl's primary food source (Woinarski 2004). The broad scale application of the rodenticide Klerat (now banned) may also have previously lead directly to the mortality of Masked Owls.

Northern Quoll (*Dasyurus hallucatus*)

The Northern Quoll is distributed from south east Queensland across northern Australia to the Pilbara but has declined in many parts of this range. The Northern Quoll historically occurred in Darwin Stringybark (*Eucalyptus tetrodonta*) open forest and associated habitats within the Weipa area prior to the arrival of the Cane Toad in the 1980's. Although numerous records exist for Northern Quoll in the region surrounding Weipa, the majority of these are historical, and no confirmed sightings of the species are available for the area around Weipa after 1990. The decline of Northern Quoll around Kakadu National Park in the Northern Territory as a direct consequence of Cane Toad invasion is now well documented, and has resulted in listing this species as endangered in a national context (EPBC Act 1999).

Consultation with Traditional Owners during a targeted survey for Northern Quoll north of Weipa revealed an anecdotal record from around 2001 in vine forest on bauxite (Possum Scrub); however subsequent consultation with Traditional Owners from the SoE Project area did not indicate any recent sightings of the species. Consequently it is anticipated that the Northern Quoll is now very rare in the Weipa area. With respect to the Project area, whilst the species may once have utilised Darwin Stringybark woodland, patches of vine forest and riparian forest habitat currently provide the most likely habitat for the species. Optimal habitat for the species, rocky outcrops and other rocky habitat, is not available. Nevertheless it is possible that the species could be present in certain locations, most likely the riparian communities and coastal vine forest associated with Norman Creek, and the vine

forest patches in the Hey Point area. If present, the species may traverse between vine forest and riparian forest through Darwin Stringybark (*Eucalyptus tetrodonta*) open forest.

Vine forest areas would not be disturbed by the Project. Minor areas of riparian habitats would be disturbed within the footprints of the water supply dam, although targeted surveys did not locate the species in these areas.

As the regional population size of this species is thought to be relatively small, if the Northern Quoll was to occur within the disturbance footprint of the Project area, it would be regarded as an important population.

A number of factors are considered to be threatening the survival of the Northern Quoll (DSEWPaC 2010). These include:

- inappropriate fire regimes;
- predation following fire; and
- lethal toxic ingestion of Cane Toad toxin.

Bare-rumped Sheathtail Bat (*Saccolaimus saccolaimus nudicluniatus*)

The Bare-rumped Sheathtail Bat has been recorded in the Aurukun area (WildNet Database) although the habitat within which it was recorded is unclear. The species was not recorded during surveys within the Project area.

The Bare-rumped Sheathtail Bat is a poorly known species that is difficult to detect. The species is not readily captured using existing bat trapping techniques, and cannot be reliably identified from Anabat recordings.

Records of the species from Iron Range and Coen indicate that the species may favour riparian forest and vine forest and adjacent woodland including Darwin Stringybark dominated habitats. The species was found roosting in Darwin Stringybark at Iron Range. Based on this information, large areas of the Project area may be suitable for the species, especially in the vicinity of riparian gallery forest and vine forest patches but potentially also deeper into the Darwin Stringybark woodland that occurs across the majority of the Project area.

Known and likely threats are described by Schulz and Thomson (2007). The current known threat to the Bare-rumped Sheathtail Bat is habitat loss due to land clearing. Likely threats include:

- vegetation change due to clearing of understorey vegetation for agriculture and livestock grazing, altered fire regimes, saltwater intrusion and invasion by exotic weed species;
- timber collection and the targeted removal of hollow-bearing and dead trees, resulting in destruction of roosts;
- competition for hollows;
- disease; and
- loss of climatic habitat such as tropical forests caused by anthropogenic emissions of greenhouse gases (identified as a key threatening process under the EPBC Act).

3.3 Threatened Estuarine and Marine Fauna

Benthic (sea floor) habitat surveys of marine and estuarine areas within the Project area were completed during October 2007, June 2008, November 2008 and June 2009 and June 2010. A combination of towed video sled and drop camera video techniques were adopted for this study, allowing the survey of multiple sites in a short period, and providing key information regarding the distribution and structure of benthic habitats. Drop camera video was used over patchy reef habitat, seagrass areas, and the proposed port entrance channel. Towed video sled was used over low profile

soft sediment habitats. Further information on marine habitat, marine fauna, and freshwater aquatic fauna survey methodologies is presented in Section 6.3, Section 6.6 and Section 8.3 of the EIS respectively. In addition, further information on marine water quality and marine sediment characteristics is presented in Section 6.4 and Section 6.5 respectively.

A total of 10 estuarine and marine species listed under the EPBC Act as threatened are known to occur, or are likely to occur, within the Project area. Three additional species were identified by the EPBC Act database search however they are not likely to occur in the Project area. The species that are known to occur or likely to occur are listed in **Table 5** together with an assessment of their likelihood of occurrence within the Project area and proposed areas of disturbance within the Project area. The locations of confirmed threatened and migratory fauna within the Project area are shown on **Figure 7.** Profiles of each of the species from **Table 5** are provided in Sections 4.3.1 and 4.3.2. Refer to Table 6-33 in Section 6 of the EIS for details on the species that are unlikely to occur within the Project area.

3.3.1 Marine Turtles

Field surveys were undertaken to identify marine turtle nests on 27km of beach in the vicinity of the proposed port in 2008. These surveys were undertaken over a 3 day period. Bell (2004) and GHD (2007) have also surveyed 38km and 10km of beach in the same area. The Bell (2004) occurred over a 4 day period in 2003. The GHD (2007) survey occurred over three separate daily survey events between May and July 2007. Further details of the marine turtle nest survey methodology are presented in Section 6.6.5 of the EIS. **Figure 8** identifies the marine turtle nesting locations recorded in the 2007 and 2008 surveys. Table 6.36 of the EIS describes the turtle nesting activities for the 2007 and 2008 surveys. The proposed location of the port is not considered a high density turtle nesting beach (refer Section 6.6.5 of the EIS).

Potential marine turtle foraging habitat (including reef assemblages and seagrass) were identified and mapped based on the results of the benthic habitat surveys. EIS figures 6-18, 6-19 and 6-20 show reef habitat, hard and soft coral habitat, and seagrass habitats respectively, in the local region and **Figure 10** shows reef habitats in the wider local region.

The Flatback Turtle (*Natator depressus*), Olive Ridley Turtle (*Lepidochelys olivacea*) and Hawksbill Turtle (*Eretmochelys imbricata*) are listed as known to nest on the beaches in low to medium densities (refer EIS Section 6.6.5) in the vicinity of the Project area and feed in the surrounding waters. The beaches of western Cape York represent an area of medium density nesting activity for the Flatback Turtle. Nesting of the Olive Ridley and Hawksbill Turtles in the Project area, and throughout western Cape York, is of low density. There are uncertainties regarding whether nesting of Olive Ridley Turtles is still occurring in the western Cape York region. The Loggerhead Turtle (*Caretta caretta*) and the Green Turtle (*Chelonia mydas*) also feed in the waters surrounding the proposed port development but do not nest on the beaches. The Leatherback Turtle (*Dermochelys coriacea*) has not been recorded nesting in eastern Australia since 1996 and the species is rarely found in Queensland. The Leatherback Turtle is generally recognised as principally utilising offshore pelagic areas for foraging, therefore coastal waters like the proposed port are not considered key habitat.

Foraging areas for the six listed turtle species can include coral reef habitats, rocky reef habitats, soft corals, seagrass meadows, and unvegetated sand or mud areas. Preferred food items can include seagrass, seaweed, soft bodied animals (such as soft corals, sea cucumbers and jellyfish), bivalve and gastropod molluscs, and crabs.

Marine turtles are long-lived and late maturing with maturity reached at between 30 and 50 years of age (Miller 1996). Female marine turtles emerge from the water, generally at night, and move up the shoreline to select a nesting location. Most females do not nest in consecutive years (Miller 1996). However, a female marine turtle may lay several clutches of eggs per year (Limpus *et al.* 1984).

Table 5 Likelihood of Occurrence of Threatened Estuarine and Marine Species

Species **Common Name**	**EPBC Act Status**	**Habitat**	**Likelihood of Occurrence within the Project Area and Areas of Proposed Disturbance within the Project Area (Site)**
Eretmochelys imbricata Hawksbill Turtle	V, M	Hawksbill turtle nesting sites occur on islands adjacent to Arnhem Land and north-eastern Cape York. The main feeding habitat for the species tends to be tidal and sub-tidal reefs.	**Project Area** **Known to Occur.** Although difficulties in identifying nest activity of this species exist, low density nesting has been recorded from a number of locations from False Pera Head to Boyd Bay. Reef habitat in the area is also likely to provide significant foraging habitat for the species. **Proposed Port Site** **Likely** Near shore fringing reef communities occur within the vicinity of the proposed port area occur at Boyd Point, Pera Head and between Pera Head and Thud Point. This species may therefore traverse across the proposed port site to access preferred feeding habitat. This species is also known to nest on the beaches in the vicinity of the Project area. Therefore it may be assumed that the footprint of the proposed port site may also contain suitable nesting habitat for this species. **Proposed Spoil Ground** **Possible** As Nine Mile Reef which includes suitable foraging habitat for this species is located approximately 6km south-south-west of the proposed spoil ground, this species may traverse the proposed spoil ground to access Nine Mine Reef for foraging. **Albatross Bay Spoil Ground** **Possible** The Albatross Bay Spoil ground does not contain or is not close to any reef communities. It is therefore unlikely this species would frequently occur in this area; however they may transit the site. **Ferry/Barge Terminals – Hey and Embley Rivers** **Unlikely** The ferry barge terminals would be located within an estuarine environment, which is not a preferred habitat of this species.
Natator depressus Flatback Turtle	V, M	Coastal waters including but not limited to shallow water habitats. Nesting is confined to Australia. The species forages in shallow inshore areas.	**Project Area** **Known to Occur** The Flatback Turtle is likely to forage in the Project area and nesting has been regularly recorded which is best described as medium density nesting. The area is not a major location for breeding aggregations of the species. **Proposed Port Site** **Known to Occur** Nesting has been regularly recorded within and surrounding the proposed port site footprint and is best described as medium density nesting. The area is not a major location for breeding aggregations of the species. This species forages in shallow coastal habitats. The proposed footprint of the port would therefore be considered foraging habitat for this species. **Proposed Spoil Ground** **Possible** As Nine Mile Reef which includes suitable foraging habitat for this species is located approximately 6km south-south-west of the proposed spoil ground, this species may traverse the proposed spoil ground to access Nine Mine Reef for foraging. **Albatross Bay Spoil Ground** **Possible** The Albatross Bay Spoil ground does not contain or is not close to any reef communities and is not shallow in nature. It is therefore unlikely this species would occur in this area beyond transiting the site. **Ferry/Barge Terminals – Hey and Embley Rivers** **Likely** This species forages in shallow coastal habitats. The proposed footprints of the ferry/barge terminals are within an estuarine environment which may be considered foraging habitat for this species.
Lepidochelys olivacea	E, M	Coastal waters including but	**Project Area**

Species **Common Name**	**EPBC Act Status**	**Habitat**	**Likelihood of Occurrence within the Project Area and Areas of Proposed Disturbance within the Project Area (Site)**
Olive Ridley Turtle		not limited to reefs. The species forages in benthic habitats over a range of depths from a few metres to hundreds of metres. Low density nesting has been historically recorded from a number of locations including the eastern Gulf of Carpentaria.	**Known to Occur** Although there are uncertainties regarding whether nesting of Olive Ridley Turtles is still occurring in the western Cape York region,, low density nesting has previously been recorded from a number of locations from False Pera Head to Boyd Bay. **Proposed Port Site** **Known to Occur** Sporadic nesting has been recorded surrounding the proposed port site footprint. This species forages in shallow unvegetated coastal habitats. The proposed footprint of the port would therefore be considered foraging habitat for this species. **Proposed Spoil Ground** **Possible** The proposed spoil ground is too deep to provide foraging habitat for this species; however it is possible that it sporadically transits this area. **Albatross Bay Spoil Ground** **Possible** For the same reasons as the proposed spoil ground, this species is unlikely to frequently occur within the Albatross Bay spoil ground due to lack of preferred habitat; however it may transit the site. **Ferry/Barge Terminals – Hey and Embley Rivers** **Likely** This species forages in shallow unvegetated coastal habitats. The parts of the proposed footprints of the ferry/barge terminals that are not vegetated may therefore provide foraging habitat for this species.
Dermochelys coriacea Leatherback Turtle	E, M	Pelagic environment. The Albatross Bay area is identified as a potential foraging area for the species.	**Project Area** **Likely** The species is likely to occur in the Project Area, using it for foraging. However, Leatherback turtles are rarely found in Queensland so any presence would be sporadic. No leatherback turtle nesting has been recorded in eastern Australia since 1996. **Proposed Port Site** **Likely** The species is likely to occur sporadically in the vicinity of the proposed port site, using it for foraging. **Proposed Spoil Ground** **Likely** The species is likely to occur sporadically in the vicinity of the proposed spoil ground, using it for foraging. **Albatross Bay Spoil Ground** **Likely** The species is likely to occur sporadically in the vicinity of the Albatross Bay spoil ground, using it for foraging. **Ferry/Barge Terminals – Hey and Embley Rivers** **Unlikely** This species prefers oceanic environments to estuarine environments, so it is unlikely to utilise the estuaries that contain the proposed footprints of the ferry/barge terminals as habitat.

Species **Common Name**	**EPBC Act Status**	**Habitat**	**Likelihood of Occurrence within the Project Area and Areas of Proposed Disturbance within the Project Area (Site)**
Caretta caretta Loggerhead Turtle	E, M	Coastal waters including subtidal and intertidal coral and rocky reefs and seagrass meadows as well as soft-bottomed habitats.	**Project Area** **Likely** The species is likely to be transient in the Project area and use it for foraging or resting. No rookeries are present in the Project area. **Proposed Port Site** **Likely** The species is likely to be transient in the vicinity of the proposed port and use it for foraging or resting. **Proposed Spoil Ground** **Likely** This species is likely to occur within the proposed spoil ground for the same reasons that it is likely to occur in the vicinity of the proposed port. **Albatross Bay Spoil Ground** **Likely** This species is likely to occur within the Albatross Bay spoil ground for the same reasons that it is likely to occur in the vicinity of the proposed port. **Ferry/Barge Terminals – Hey and Embley Rivers** **Likely** This species is likely to occur in the vicinity of the ferry/barge terminals for the same reasons that it is likely to occur within the proposed port footprint.
Chelonia mydas Green Turtle	V, M	Coastal waters in particular seagrass beds. The Wellesley Island area in the south western corner of the Gulf of Carpentaria is a significant nesting site.	**Project Area** **Likely** The species is likely to forage in the Project area. Surveys have found no nests in the Project area. No large rookeries are present in the region. **Proposed Port Site** **Likely** This species is known to forage in shallow coastal areas, which would include the proposed port site footprint. Surveys have found no nests within the footprint of the proposed port site. **Proposed Spoil Ground** **Possible** This species prefers to forage in shallow coastal areas or within seagrass beds. The proposed spoil ground would be too deep to provide preferred foraging habitat for this species and it contains no seagrass beds. While the proposed proposes spoil ground does not represent preferred habitat, it is possible they are transient in the area. **Albatross Bay Spoil Ground** **Possible** For the same reasons as the proposed spoil ground, it is unlikely that this species would frequently occur at the Albatross Bay spoil ground; however, it is possible that they transit the area. **Ferry/Barge Terminals – Hey and Embley Rivers** **Likely** As this species is known to forage within shallow coastal areas and seagrass beds. Foraging habitat for this species is present in the estuaries.

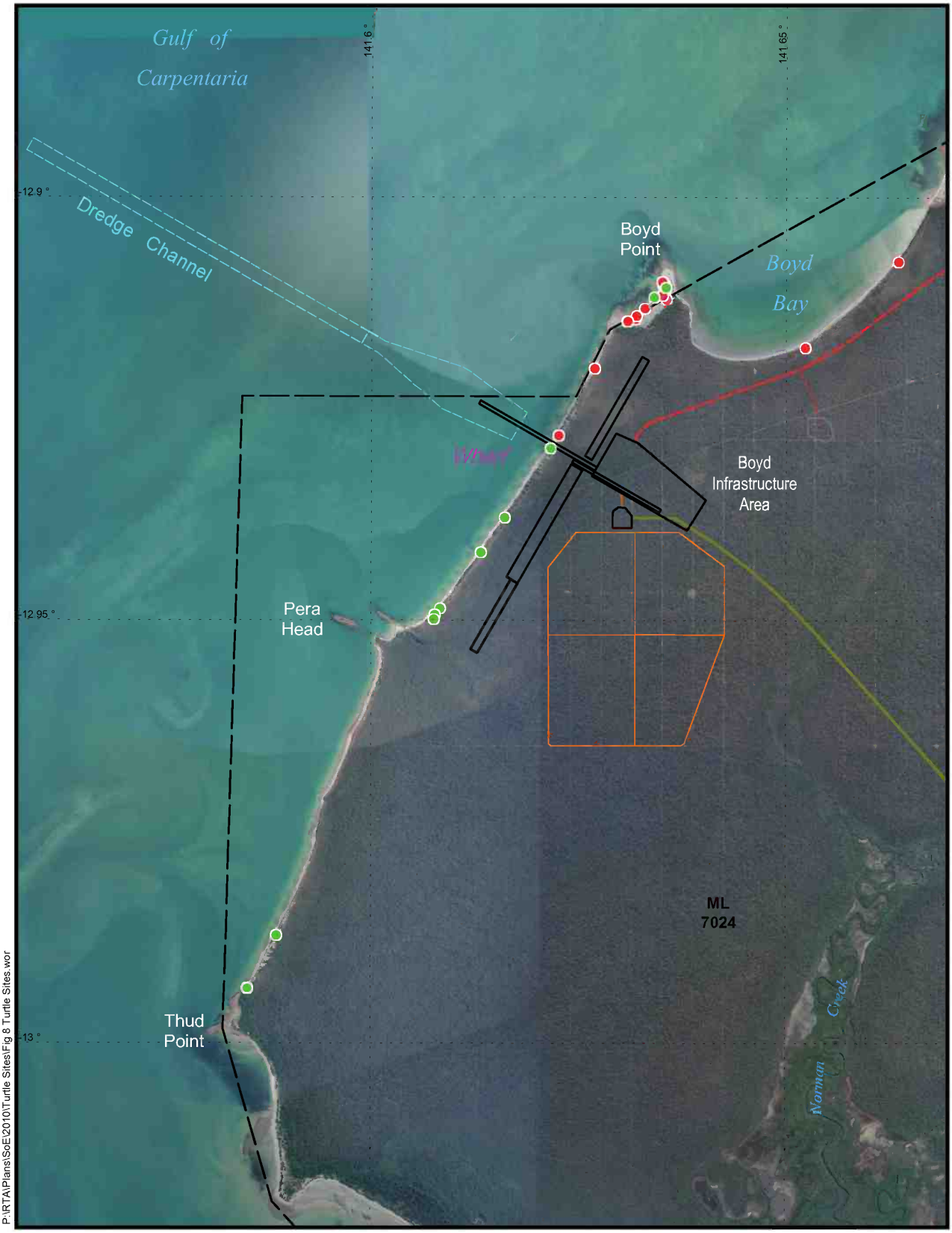
Species **Common Name**	**EPBC Act Status**	**Habitat**	**Likelihood of Occurrence within the Project Area and Areas of Proposed Disturbance within the Project Area (Site)**
Pristis clavata Dwarf or Queensland Sawfish	V	Very few numbers have been recorded in the southern Gulf of Carpentaria. Juveniles more commonly encountered in coastal foreshores and embayments; adults in marine waters (DEEDI 2009).	**Project Area** **Likely** This species may occur in estuarine reaches within the Project area. Suitable habitat is present in near coastal areas and estuaries of Norman Creek, Ward River and Embley River, though generally low abundance of all elasmobranchs species were observed at Norman Creek and Ward River sites. Records for this species exist for an estuarine system (Pine River) 20km to the north, although this system is at least anecdotally thought to have higher turbidity levels. Anecdotal records of sawfish within lower Ward River and Norman Creek estuaries reported by Traditional Owners may include this species. **Proposed Port Site** **Likely** The species has been recorded from Albatross Bay and the proposed port footprint contains suitable habitat for the species. **Proposed Spoil Ground** **Unlikely** This species prefers shallower waters. The proposed spoil ground is in waters that are deeper than what this species would usually prefer. **Albatross Bay Spoil Ground** **Unlikely** For the same reasons as the proposed spoil ground, it is unlikely that this species would occur at the Albatross Bay spoil ground. **Dam C on Norman Creek and Upstream of Dam C** **Unlikely** This species is not found and does not breed within freshwater environments. Dam C would be located in a freshwater reach of Norman Creek. Therefore this species is unlikely to occur within the proposed footprint of Dam C or upstream of the dam. **Ferry/Barge Terminals – Hey and Embley Rivers** **Likely** Suitable habitat for this species is present in near coastal areas and the estuary of the Embley River. Disturbance in the Embley River associated with the Project would be limited to a small amount of dredging activities related to the construction and maintenance of the Hornibrook Ferry Terminal. This species may also utilise as a resting place either side of high tide, the 400m^2 of mangrove forest that would be cleared for the construction of the Hey River ferry/barge terminal. The area of mangroves that would be cleared only represents 0.008% of this mangrove community within the Project area. Therefore there would be sufficient remaining mangrove habitat in the surrounding area which the species would be able to utilise for resting.

Species **Common Name**	**EPBC Act Status**	**Habitat**	**Likelihood of Occurrence within the Project Area and Areas of Proposed Disturbance within the Project Area (Site)**
Pristis zijsron Green Sawfish	V	Occurs in estuaries, river mouths, embayments and along sandy and muddy beaches.	**Project Area** **Likely** The species has been recorded from Albatross Bay and the Project area contains suitable habitat for the species. **Proposed Port Site** **Likely** The species has been recorded from Albatross Bay and the proposed port footprint contains suitable habitat for the species. **Proposed Spoil Ground** **Unlikely** This species prefers shallower waters. The proposed spoil ground is in waters that are deeper than what this species would usually prefer. **Albatross Bay Spoil Ground** **Unlikely** For the same reasons as the proposed spoil ground, it is unlikely that this species would occur at the Albatross Bay spoil ground. **Dam C on Norman Creek and Upstream of Dam C** **Unlikely** This species is not found within freshwater environments. Dam C would be located on a freshwater reach of Norman Creek. Therefore this species is unlikely to occur within the footprint of the proposed Dam C or upstream of this dam. **Ferry/Barge Terminals – Hey and Embley Rivers** **Likely** Records from Albatross Bay adjoining the mouth of the Embley River make occurrence of this species within the estuarine sections of the Hey and Embley Rivers likely. The extent of Project related disturbance of these areas would be minimal in relation to the total estuarine environment available within these rivers. Disturbance would consist of the clearance of 400m^2 of mangroves (0.008% of the associated vegetation community within the Project area) and 2.1ha of riverbed. The dredging in these areas would only be to a depth of -2m LAT.

Species **Common Name**	**EPBC Act Status**	**Habitat**	**Likelihood of Occurrence within the Project Area and Areas of Proposed Disturbance within the Project Area (Site)**
Pristis microdon Freshwater Sawfish	V	Preferred habitat is mud bottoms of river embayments and estuaries, but the species has also been found well upstream (Allen 1997). Are usually found in turbid channels of large rivers over soft mud bottoms (Allen 1991) more than 1m deep, but move into shallow waters when travelling upstream or while hunting prey (Wilson 1999).	**Project Area** **Likely** This species may occur in estuarine and the lowermost freshwater reaches within the Project area. Suitable habitat is present in the brackish reaches of Norman Creek and the Ward River, though generally low abundance of all elasmobranchs species have been observed at these sites (Peverell, McPherson, Garrett and Gribble 2006). Anecdotal records of sawfish within lower Ward River and Norman Creek estuaries reported by Traditional Owners may include this species. **Dam C on Norman Creek and Upstream of Dam C** **Unlikely** Anecdotal records of sawfish species have only been recorded in the lower reaches of Norman Creek, which is downstream of the proposed Dam C footprint. The freshwater tributaries of streams like Norman Creek have extremely low conductivity due to their catchments being highly weathered bauxite landscapes, which do not contribute salts. Recorded conductivity values approach those of distilled water. It is hypothesised that these extremely low conductivity values present an osmoregulation constraint on the freshwater fish community that occur in these systems. This is evidenced by the complete absence of records in the freshwater tributaries of Norman Creek for otherwise ubiquitous families, genera and species of freshwater fishes found throughout tropical Australia, including in adjoining river systems to the Project area. It is suggested that the extremely low conductivities of Norman Creek's freshwater tributaries would present an osmoregulation constraint on the Freshwater Sawfish as it possesses a more primitive osmoregulation capacity than modern ray finned fishes. While the estuarine and possibly lower tidally influenced freshwater reaches of the Norman Creek system do provide potentially suitable habitat for this species, the seasonal freshwater tributaries of Norman Creek, upstream of the proposed Dam C do not. Combined with the abovementioned water quality constraints, the small size and seasonality of Norman Creek would also be a constraint, as the Freshwater Sawfish generally inhabits larger perennial river systems as opposed to small seasonal creeks like Norman Creek. **Ferry/Barge Terminals – Hey and Embley Rivers** **Possible** Although this species has not been recorded in either of these rivers, the footprints of the ferry/barge terminals would be within the estuarine reaches of these rivers that this species may traverse. The extent of disturbance within these areas would be minimal in relation to the total estuarine environment available within these rivers. Disturbance would consist of the clearance of 400m^2 of mangroves (0.008% of the associated vegetation community within the Project area) and 2.1ha of riverbed. The dredging in these areas would only be to a depth of -2m LAT.

Species **Common Name**	**EPBC Act Status**	**Habitat**	**Likelihood of Occurrence within the Project Area and Areas of Proposed Disturbance within the Project Area (Site)**
Glyphis sp. A Speartooth Shark	EC	Relatively shallow, upper freshwater, and possibly brackish, reaches of rivers and associated floodplains of northern Australia.	**Project Area** **Likely** This species may occur in estuarine and the lowermost freshwater reaches within the Project area below the perennial extent of the creeks and rivers. Records exist for the Wenlock River and similar habitat present on the Project site, though generally low abundances of all elasmobranchs species have been observed at these sites (Peverell, McPherson, Garrett and Gribble 2006). **Dam C on Norman Creek and Upstream of Dam C** **Unlikely** The potential area of occupancy of the Speartooth Shark in creek and river systems is restricted from the mouth of a river to the point where the river ceases to be perennial (Stevens *et al.* 2005). The species is not known to utilise small seasonal creek reaches. The proposed Dam C would be on a highly seasonal freshwater tributary of Norman Creek, which although perennial dries to small, shallow pools which are isolated except for connecting trickling flows in the dry season. Therefore, it is unlikely that the Speartooth Shark, if present in Norman Creek would require passage past the proposed site of Dam C. The freshwater tributaries of streams like Norman Creek have extremely low conductivity due to their catchments being highly weathered bauxite landscapes, which do not contribute salts. Recorded conductivity values approach those of distilled water. It is hypothesised that these extremely low conductivity values present an osmoregulation constraint on the freshwater fish community that occur in these systems. This is evidenced by the complete absence of records in the freshwater tributaries of Norman Creek for otherwise ubiquitous families, genera and species of freshwater fishes found throughout tropical Australia, including in adjoining river systems to the Project area. It is suggested that the extremely low conductivities of Norman Creek's freshwater tributaries would present an osmoregulation constraint on the Speartooth Shark as it possesses a more primitive osmoregulation capacity than modern ray finned fishes. While the estuarine and possibly lower tidally influenced freshwater reaches of the Norman Creek system do provide potentially suitable habitat for this species, the seasonal freshwater tributaries of Norman Creek, upstream of the proposed Dam C do not.. **Ferry/Barge Terminals – Hey and Embley Rivers** **Unlikely** Although there has been an unverified report of the presence of the Speartooth Shark in the Embley River in 1985, Stevens *et al.* (2005) notes that ongoing fish surveys over 20 years in the Embley River have not recorded this species. Stevens *et al.* (2005) therefore suggests that this species is restricted the Wenlock and Ducie Rivers in this region, which are large tropical river systems. From this evidence, it is unlikely that this species would occur in either the Embley or Hey Rivers. However if this species was to occur within these rivers, the extent of disturbance associated with the ferry/barge terminals would be minimal in relation to the total environment available within these rivers.

Key to Status: E = Endangered, EC = Critically Endangered, V = Vulnerable, M=Migratory



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RTA Mining Lease boundary

Turtle nest (2008 survey)

Turtle nest (2007 survey)

Rio Tinto Alcan

South of Embley Project

Fig. 8: Marine Turtle Nest Locations

N

1 0 1km

Datum/Projection: GDA94/MGA Zone 54 Date: 29/03/2011

Nesting marine turtles generally demonstrate fidelity to a nesting beach and return to nest on their natal beach with a high degree of precision (Limpus *et al.* 1984). The process by which turtles select nesting sites along a beach has not been clarified (Miller 1996), however the light regime is considered to have a significant impact on the emergence of female marine turtles from the ocean.

Once hatched, lighting cues are identified as critical for hatchlings to move from the beach to the ocean – a behaviour known as 'sea-finding'. Where there are no anthropogenic light sources, hatchlings move away from the dark silhouetted shoreline towards the brighter ocean horizon. Changes to the lighting regime can affect a hatchling's attempts to find water. Lights at a nesting beach can result in turtle hatchlings heading inland rather than into the ocean, with subsequent mortality.

Currently, there are two major threats to nesting marine turtles along the beaches of western Cape York – predation of nests by feral pigs and entanglement in discarded fishing nets (ghost nets). Feral pig predation is currently considered the most significant threat. Feral pigs are identified as a key threatening process under the EPBC Act and a Threat Abatement Plan (TAP) is currently in place to protect marine turtles in Australia. The marine turtle field surveys identified significant destruction of turtle nests by feral pigs in the vicinity of the proposed port. Feral pig activity within the field survey area was particularly prevalent in areas with direct access to the beach from adjacent bushland. During the survey approximately 50 to 60 nests appeared to be disturbed on approximately 500m of beach north of Boyd Point.

The potential impacts of the proposed action and proposed mitigation strategies pertaining to marine turtles are discussed in **Section 5.5**.

Profiles of each of the turtle species known or likely to occur in the Project area are provided below.

Hawksbill Turtle (*Eretmochelys imbricate)*

Hawksbill Turtles are found in tropical, subtropical and temperate waters in all the oceans of the world. Nesting is mainly confined to tropical beaches. There are no concise estimates of global Hawksbill Turtle population numbers; however, Australia holds the largest breeding populations of Hawksbill Turtles in the world. There are two genetically separate subpopulations: one in the northern Great Barrier Reef, Torres Strait and Arnhem Land (north-eastern subpopulation); and the other on the North West Shelf of Western Australia (north-western subpopulation). The SPRAT database identifies that 'several thousand' females nest in Queensland each year.

For the north-eastern subpopulation, the northern Great Barrier Reef, and particularly Milman Island and the inner Great Barrier Reef Cays north from Cape Grenville, are considered to be important foraging grounds and juvenile habitat. The preferred foraging habitat of the Hawksbill Turtle is rocky and coral reefs where preferred food items include algae, seagrass and sponges.

Low density nesting has been recorded from a number of locations from False Pera Head to Boyd Bay in the vicinity of the port development area. Reef habitat in the area is also likely to provide significant local foraging habitat.

Hawksbill Turtles occurring in the vicinity of the Project area are not considered to constitute an important population, geographically distinct regional population, or local population that occurs within a particular bioregion.

Flatback Turtle (*Natator depressus*)

The Flatback Turtle does not have a global distribution. It is found only in the tropical waters of northern Australia, Papua New Guinea and Irian Jaya. The population size of the Flatback Turtle is currently estimated to be approximately 20,285 nesting females (Sea Turtle Conservancy 2010a).

It is considered that nesting is confined to Australia. Nesting locations occur from the Bundaberg region, north to west of the Northern Territory – Western Australian border. Within Australia, the most significant breeding site is Crab Island in the western Torres Strait. The beaches of western Cape York represent medium density nesting habitat. Flatback Turtle nesting occurs in the vicinity of the proposed port area with nesting occurring all year round, but peaking in May through to September.

Foraging habitats for the species are shallow coastal environments including rocky reef and sedimentary habitats where they feed principally on soft bodied animals including sea cucumbers, sea pens and soft corals.

Flatback Turtles occurring in the vicinity of the Project area are not considered to constitute an important population, geographically distinct regional population or local population that occurs within a particular bioregion.

Olive Ridley Turtle (*Lepidochelys olivacea)*

The Olive Ridley Turtle nests throughout tropical waters and migrates through tropical and sub-tropical areas of the world. They generally inhabit shallow unvegetated coastal waters where they feed on gastropod molluscs and crabs

The Olive Ridley Turtle is the most numerous of all marine turtles in the world largely due to the major global nesting areas that occur in Pacific Costa Rica and Pacific Mexico. The DSEWPaC (2010) SPRAT database identifies studies that estimate global annual nesting populations to be 852,000 and 2,000,000. Detailed information on the size of nesting and foraging populations in Australia is unknown, although the Australian nesting population is expected to be in only a few thousand. Low density nesting in Australia has been historically recorded from a number of locations including the eastern Gulf of Carpentaria; however, there is some uncertainty whether nesting still occurs on Western Cape York.

Olive Ridley Turtles occurring in the vicinity of the Project area are not considered to constitute an important population, geographically distinct regional population or local population that occurs within a particular bioregion.

Leatherback Turtle (*Dermochelys coriacea*)

The Leatherback Turtle is a pelagic feeder, found in tropical, subtropical and temperate waters throughout the world. In the vicinity of the Project area, Albatross Bay is identified as a potential foraging area for the species. They principally feed upon soft bodied invertebrates such as colonial ascidians and jellyfish. Leatherback Turtles are considered likely to occur in the Project area, potentially using it for foraging. They are rarely found in Queensland and have not been recorded nesting in eastern Australia since 1996.

The best available data for population size at a global level are the numbers of adult females that breed in particular years. According to the DSEWPaC (2010) SPRAT database, the most recent estimate, in 2004, was that 35,800 females bred that year. There is insufficient data to determine whether the Australian population is distinct, geographically separate or whether it moves in/out of Australia's jurisdiction. The Leatherback Turtle is the most pelagic of all marine turtles, spending most of the time in the open ocean, with individuals traversing thousands of kilometres, it is therefore likely that the population is continuous within Australia.

Given the rarity of this species in Queensland waters and the large home ranges the species may have, the Project area is not considered to be of particular importance to this species. The Project area is not considered to contain an important population, geographically distinct regional population or local population that occurs within a particular bioregion.

Loggerhead Turtle (*Caretta caretta)*

The Loggerhead Turtle has a global distribution throughout tropical, sub-tropical and temperate waters with nesting mainly concentrated on sub-tropical beaches. In Queensland, nesting is concentrated in the south-east, particularly along the Bundaberg coast. The species prefers a range of habitats including subtidal and intertidal reefs, seagrass meadows and soft-bottomed habitats. It has a diverse diet but typical food items include crabs and bivalve and gastropod molluscs.

Surveys have found no nests in the Project area. It is considered likely that this species would be transient in the Project area, using it for foraging or resting, but highly unlikely for nesting.

There are no concise estimates of global population or annual nesting female numbers for the Loggerhead Turtle. The Loggerhead Turtle is considered to comprise of two distinct genetic stocks in Australia—the eastern Australian genetic stock and the western Australian genetic stock. The DSEWPaC (2010) SPRAT database identifies that in 2000 it was estimated that there were 500 nesting females per year in the eastern Australian stock. Adult females comprise approximately 20% of the population.

Loggerhead Turtles occurring in the vicinity of the Project area are not considered to constitute an

important population, geographically distinct regional population or local population that occurs within a particular bioregion.

Green Turtle *(Chelonia mydas)*

Green Turtles are found in tropical and subtropical waters throughout the world. It is estimated that globally there are approximately 88,520 nesting female turtles (Sea Turtle Conservancy 2010b). Green Turtles nest, forage and migrate across tropical northern Australia. Green Turtles forage in shallow coastal areas, in particular seagrass beds. The nearest important foraging ground to the Project area is Wellesley Islands in the south-western corner of the Gulf or Carpentaria. Numerous nesting areas have been identified for Australian waters including western Cape York. The DSEWPaC SPRAT database estimates that the total Australian population of Green Turtles is more than 70,000 individuals, distributed across seven genetically distinct regional populations.

Green Turtles are likely to forage in the Project area, including the Embley and Hey Rivers where seagrass beds occur, but are not known to nest in the Project area. They feed principally on seagrass and seaweeds although juveniles are also carnivorous. It is uncertain which sub-population Green Turtles in the Project area would belong to, as their reported geographic distributions do not include the Project area. They may belong to the Northern Great Barrier Reef population (containing around 41,000 individuals), or the Southern Gulf of Carpentaria population (containing around 5,000 individuals), or both. At the Project scale, Green Turtles occurring in the vicinity of the Project area do not constitute a geographically distinct regional population or local population that occurs within a particular bioregion.

3.3.2 Sharks and Sawfish

Three species of the threatened fishes that were identified in the EPBC Act database search as potentially present within the lower freshwater and/or estuarine habitats were determined to be likely occur within the Project area, namely:

- Dwarf Sawfish (*Pristris clavata*);
- Green Sawfish (*Pristis zijsron*); and
- Freshwater Sawfish (*Pristis microdon).*

The populations of sawfishes in the Gulf of Carpentaria are of global significance. The major threat to sawfish populations is incidental capture in fishing nets.

The preferred habitat of sawfishes is shallow inshore sedimentary habitats (less than 10m), although they have been recorded in the Gulf of Carpentaria from waters deeper than 20m. Sawfishes in the Gulf of Carpentaria breed through the wet season until the beginning of the dry period in May (Peverell 2005).

An additional threatened species, the Speartooth Shark *(Glyphis* sp A.), has been included in the assessment as a potential inhabitant of the Project area. There is limited knowledge regarding the habitat and requirements of these species, however what is available is summarised in **Table 5**.

All of the abovementioned species are considered likely to occur in the estuarine and/or lower brackish reaches of the Project area's main drainage systems due to the suitability of the habitats present and the similarity of these habitats to where these species have been recorded elsewhere on Cape York (including the Pine and Wenlock-Ducie River systems). There are also anecdotal reports from Traditional Owners of generic Sawfish observations in the lower Norman Creek and Ward River systems (H. Marmoss - Kalinda pers. comm.).

Although these species are likely to occur within the Project area, the extent of habitats associated with these species within the Project area that would be disturbed is limited. These species are unlikely to be affected by Project related activities if they are outside the areas of proposed Project related disturbance. Proposed Project related disturbance of aquatic ecosystems would be limited to the following.

- The construction and operation of Dam C in a freshwater tributary of Norman Creek.
- Activities (including dredging and the clearing of 400m^2 of mangrove habitat) associated with the construction and maintenance of the ferry/barge terminals in the estuarine reaches of the Hey and Embley Rivers.

Refer to **Table 5** for the likelihood of each of these species occurring within the areas that would be disturbed as a result of the Project.

Estuarine fish sampling conducted in May 2008 and 2009 recorded no elasmobranchs (sharks and rays) of any species from estuarine sites in the Project area.

Profiles of the Dwarf Sawfish, Green Sawfish, Freshwater Sawfish and Speartooth Shark are provided below. The potential impacts of the proposed action and proposed mitigation strategies pertaining to sawfish are discussed in **Section 5.5**.

Dwarf Sawfish (*Pristis clavata*)

There are no confirmed records of the Dwarf Sawfish outside of Australian waters. The extent of distribution is considered to be from Cairns around Cape York Peninsula, across northern Australian waters to the Pilbara coast in Western Australia; however there have been no records of the species from the eastern coast of Cape York Peninsula. The DSEWPaC (2010) SPRAT database identifies that there is insufficient data available to estimate the total numbers of mature individuals of Dwarf Sawfish in Australian waters.

Dwarf Sawfish inhabit shallow (2–3m) coastal waters and estuarine habitat, moving into marine waters after the wet season. The species prefers highly turbid environments (DSEWPaC, 2010) and are only usually found in silt sections of an estuary which are completely devoid of instream structure (Thorburn *et al.* 2003). However DSEWPaC (2010) does note that this species may rest either side of high tide in inundated mangrove forests. During the wet season the species enters estuarine or brackish waters to breed. Juveniles are more commonly encountered in coastal foreshores and embayments; adults in marine waters (DEEDI, 2009). Estuarine habitats are used as nursery areas by Dwarf Sawfish, with immature juveniles remaining in these areas up until three years of age (Thorburn *et al.* 2007a). Adults are known to seasonally migrate back into inshore waters (Peverell 2007).The Dwarf Sawfish feeds principally on schooling fish, particularly mullet. Individuals appear to move only small distances and occupy only a relatively restricted area.

This species has not been recorded in surveys of the Project area but are considered likely to occur in the estuarine and lower brackish reaches of the Project area's main drainage systems. Any population within the Project area is likely to be locally important on the basis that individuals occupy restricted areas and travel only short distances.

Green Sawfish (*Pristis zijsron)*

No quantitative data is available on the global population size of the Green Sawfish. Green Sawfishes were once widely distributed in the northern Indian Ocean, westwards to South Africa, around South and Southeast Asia and around northern Australia. However, this species may now be virtually extinct in Southeast Asia. Northern Australia may be the last region where significant populations of green sawfish exist. There is no quantitative data regarding the Australian Green Sawfish population, but it is evident that there has been a significant decline in population numbers around the 1960s and 1970s, corresponding to an increase in commercial fishing.

Green Sawfish inhabit estuaries, river mouths, embayments and muddy and sandy beaches. This species may move into marine waters after the wet, and during the wet season enter estuarine or less saline environments (though not freshwater) to breed (Peverell 2005 and DSEWPaC, 2010). They feed primarily on shoaling fish, baitfish, prawns, molluscs and small crustaceans.

This species has not been recorded in surveys of the Project area but it has been recorded from Albatross Bay. The Project area, including the port development area and barge/ferry terminals in the Embley and Hey Rivers, contain suitable habitat for the species.

The Australian population of the Green Sawfish is considered to be unfragmented and occurring throughout northern Australia. It is presumed that since it is a large species, and presumably is capable of long distance movements along the coast, the species should form a continuous population (Stevens *et al.* 2005). On that basis, the occurrence of Green Sawfish within the Project area would not be considered to represent an important population.

Freshwater Sawfish *(Pristis microdon)*

The DSEWPaC (2010) SPRAT database indicates that the Freshwater Sawfish may potentially occur in all large rivers of northern Australia from the Fitzroy River, Western Australia, to the western side of

Cape York Peninsula. The distribution of the Freshwater Sawfish outside of Australia is uncertain, but it is known to occur in several major river basins of Indonesia and Papua New Guinea.

The species is mainly confined to the main channels of large rivers over soft mud bottoms (Allen 1991) more than 1m deep. However they will move into shallow waters when travelling upstream or while hunting prey (Wilson 1999). Anecdotal evidence also suggests that the Freshwater Sawfish may inhabit closed systems (Thorburn *et al.* 2003). Small specimens of this species have also been caught in remote ponds that have been isolated for a number of years (DSEWPaC 2010) Pupping occurs during the wet season, which is also when this species moves into freshwater reaches (DEWHA 2005).

The Freshwater Sawfish is highly vulnerable to gillnet fishing. Other known threats have been identified as Indigenous harvest, habitat modification and recreational 'trophy' fishing.

This species may occur in estuarine and the lowermost freshwater reaches of the Project area. Suitable habitat is present in the brackish reaches of Norman Creek and the Ward River, though generally low abundance of all elasmobranchs species have been observed at these sites. Anecdotal records of sawfish within lower Ward River and Norman Creek estuaries (downstream of the proposed Dam C footprint) reported by Traditional Owners may include this species. As the total population of the Freshwater Sawfish is unknown, if it was to occur within the Project area, it would be regarded as an important population.

Speartooth Shark (*Glyphis* sp. A)

The DSEWPaC (2010) SPRAT database indicates that the Speartooth Shark has been recorded in tidal rivers and estuaries within the Northern Territory and Queensland. Within the Northern Territory the Speartooth Shark has been recorded in the Adelaide River, South, East and West Alligator Rivers, Murganella Creek and Marrakai Creek (DSEWPaC 2010). In Queensland the Speartooth Shark has been found in the Wenlock and Ducie Rivers, Port Musgrave (the mouth of these two rivers) and the Bizant River. The Speartooth Shark has also been recorded close to Port Romilly and the Fly River in New Guinea.

The Speartooth Shark inhabits relatively shallow, turbid, upper freshwater, and possibly brackish, reaches of rivers and associated floodplains. The species seems to be particularly adapted to low oxygen environments. The potential area of occupancy of this species in creek and river systems is restricted from the mouth of a river to the point where the river ceases to be perennial (Stevens *et al.* 2005). Glyphis species do not utilise ephemeral reaches.

The population size of the Speartooth Shark remains unknown, but is thought to be small based on current knowledge and the apparent rarity of the species. There is insufficient data regarding the Speartooth Shark to suggest a decline in population size.

The main threats to the Speartooth Shark have been identified by DSEWPaC (2010) as being recreational line fishing, gillnetting, and habitat degradation or modification.

This species may occur in estuarine and the lowermost freshwater reaches within the Project area below the perennial extent of the creeks and rivers. Records exist for the Wenlock River and similar habitat is present within the Project area, though generally low abundances of all elasmobranchs species have been observed (Peverell, McPherson, Garrett and Gribble 2006). However, Stevens *et al.* (2005) suggests that this species is restricted the Wenlock and Ducie Rivers in this region, so although it may occur within the Project area the probability of its occurrence is small. Information in the DSEWPaC (2010) SPRAT database indicates that the species may be naturally rare. Therefore if the Speartooth Shark were to occur within the Project area, it would be regarded as an important population.

3.4 Migratory Species (Avian)

The EPBC Act listed migratory (avian) species that were confirmed within the Project area or were determined to possibly or likely to occur within the Project area are summarised in **Table 6**. The species listed in **Table 6** comprise:

- species identified in the EPBC Act database search for the Project area that were confirmed or determined to possible or likely occur within the Project area;
- additional species recorded during field surveys as part of the environmental impact assessment; and

- additional species assessed as potential inhabitants of the area based on the array of available habitats observed during field surveys as part of the environmental impact assessment.

Refer to Table 7-16 in Section 7 of the EIS for details on the migratory (avian) species that are unlikely to occur within the Project area.

Table 6 Migratory (Avian) Species Listed under the EPBC Act

Species	**Likelihood of Occurrence within Project Area.**	**Habitats**						
		Darwin Stringybark Open Forest (RE 3.2.10c, 3.5.2, 3.5.11, 3.5.22c)	Riparian Gallery Forest/Alluvial Woodland (RE 3.3.5, RE 3.3.9 (excluding variant dominated by *Melaleuca leucadendra*), RE 3.3.21, 3.3.49b, 3.3.61)	Vine Forest on bauxite (RE3.5.4)	Paperbark Woodland and Wetland Swamps (RE 3.3.9 variant dominated by *Melaleuca leucadendra*, , 3.3.14a, 3.3.50a, 3.3.63, 3.3.64, 3.3.65, 3.7.3)	Foreshores, Tidal Flats, Beach (RE 3.2.3, 3.2.5a, 3.2.6a, 3.2.25)	Coastal Vine Forest (RE 3.2.2)	Mangrove and Estuary (RE 3.1.1a, 3.1.1c, 3.1.3, 3.1.5, 3.1.6, 3.3.60a)
Acrocephalus stentoreus Clamorous Reed-Warbler	Confirmed during EIS surveys	-	-	-	✓	-	-	-
Actitis hypoleucos Common Sandpiper	Possible	-	-	-	-	✓	-	-
Apus pacificus Fork-tailed Swift	Confirmed during EIS surveys	✓	✓	✓	✓	✓	✓	✓
Ardea alba Great Egret, White Egret	Confirmed during EIS surveys	-	-	-	✓	-	-	✓
Calidris acuminata Sharp-tailed Sandpiper	Possible	-	-	-	-	✓	-	✓
Calidris canutus Red Knot	Possible	-	-	-	-	✓	-	✓
Calidris ferruginea Curlew Sandpiper	Possible	-	-	-	-	✓	-	✓
Calidris ruficollis Red-necked Stint	Possible	-	-	-	-	✓	-	✓
Calidris tenuirostris Great Knot	Possible	-	-	-	-	✓	-	✓
Charadrius leschenaultii Greater Sand Plover	Possible	-	-	-	-	✓	-	✓
Charadrius mongolus Lesser Sand Plover	Confirmed during EIS surveys	-	-	-	-	✓	-	✓
Charadrius veredus Oriental Plover	Possible	-	-	-	-	✓	-	✓
Coracina tenuirostris melvillensis Melville Cicadabird	Unlikely; out of range	-	-	-	-	-	-	-
Cuculus saturatus Oriental Cuckoo	Likely	✓	✓	✓	✓	-	✓	✓
Egretta sacra Eastern Reef Egret	Confirmed during EIS surveys	-	-	-	-	✓	-	-
Fregata minor Great Frigatebird	Confirmed during EIS surveys	-	-	-	-	✓	-	✓
Fregata ariel Lesser Frigatebird	Confirmed during EIS	-	-	-	-	✓	-	✓

Species	Likelihood of Occurrence within Project Area.	Habitats						
		Darwin Stringybark Open Forest (RE 3.2.10c, 3.5.2, 3.5.11, 3.5.22c)	Riparian Gallery Forest/Alluvial Woodland (RE 3.3.5, RE 3.3.9 (excluding variant dominated by *Melaleuca leucadendra*), RE 3.3.21, 3.3.49b, 3.3.61)	Vine Forest on bauxite (RE3.5.4)	Paperbark Woodland and Wetland Swamps (RE 3.3.9 variant dominated by *Melaleuca leucadendra*, , 3.3.14a, 3.3.50a, 3.3.63, 3.3.64, 3.3.65, 3.7.3)	Foreshores, Tidal Flats, Beach (RE 3.2.3, 3.2.5a, 3.2.6a, 3.2.25)	Coastal Vine Forest (RE 3.2.2)	Mangrove and Estuary (RE 3.1.1a, 3.1.1c, 3.1.3, 3.1.5, 3.1.6, 3.3.60a)
	surveys							
Gallinago hardwickii Latham's Snipe, Japanese Snipe	Likely	-	-	-	✓	✓	-	-
Glareola maldivarum Oriental Pratincole	Unlikely, out of range	-	-	-	-	-	-	-
Grus antigon Sarus Crane	Likely	-	-	-	✓	-	-	-
Haliaeetus leucogaster White-bellied Sea-Eagle	Confirmed during EIS surveys	-	✓	-	✓	✓	-	✓
Heteroscelus brevipes Grey-tailed Tattler	Possible	-	-	-	-	✓	-	✓
Hirundapus caudacutus White-throated Needletail	Confirmed during EIS surveys	✓	✓	✓	✓	✓	✓	✓
Hirundo rustica Barn Swallow	Possible	✓	✓	-	✓	✓	-	✓
Limnodromus semipalmatus Asian Dowitcher	Possible	-	-	-	-	-	-	✓
Limosa lapponica Bar-tailed Godwit	Possible	-	-	-	-	-	-	✓
Limosa limosa Black-tailed Godwit	Possible	-	-	-	-	-	-	✓
Merops ornatus Rainbow Bee-eater	Confirmed during EIS surveys	✓	✓	✓	✓	✓	✓	✓
Myiagra cyanoleuca Satin Flycatcher	Confirmed during EIS surveys	-	✓	-	✓	-	-	✓
Numenius madagascariensis Eastern Curlew	Confirmed during EIS surveys	-	-	-	-	✓	-	✓
Numenius minutus Little Curlew, Little Whimbrel	Possible	-	-	-	-	✓	-	✓
Numenius phaeopus Whimbrel	Confirmed during EIS surveys	-	-	-	-	✓	-	✓
Pandion haliaetus Osprey	Confirmed during EIS surveys	✓	✓	-	✓	✓	✓	✓
Plegadis falcinellus Glossy Ibis	Confirmed during EIS surveys	-	-	-	✓	-	-	-
Pluvialis fulva Pacific Golden Plover	Possible	-	-	-	-	✓	-	✓
Pluvialis squatarola Grey Plover	Possible	-	-	-	-	✓	-	✓

Species	Likelihood of Occurrence within Project Area.	Habitats						
		Darwin Stringybark Open Forest (RE 3.2.10c, 3.5.2, 3.5.11, 3.5.22c)	Riparian Gallery Forest/Alluvial Woodland (RE 3.3.5, RE 3.3.9 (excluding variant dominated by *Melaleuca leucadendra*), RE 3.3.21, 3.3.49b, 3.3.61)	Vine Forest on bauxite (RE3.5.4)	Paperbark Woodland and Wetland Swamps (RE 3.3.9 variant dominated by *Melaleuca leucadendra*, , 3.3.14a, 3.3.50a, 3.3.63, 3.3.64, 3.3.65, 3.7.3)	Foreshores, Tidal Flats, Beach (RE 3.2.3, 3.2.5a, 3.2.6a, 3.2.25)	Coastal Vine Forest (RE 3.2.2)	Mangrove and Estuary (RE 3.1.1a, 3.1.1c, 3.1.3, 3.1.5, 3.1.6, 3.3.60a)
Rhipidura rufifrons Rufous Fantail	Confirmed during EIS surveys	-	✓	✓	✓	-	✓	✓
Sterna albifrons Little Tern	Confirmed during EIS surveys	-	-	-	-	✓	-	✓
Tringa nebularia Common Greenshank	Confirmed during EIS surveys	-	-	-	✓	-	-	✓
Tringa stagnatilis Marsh Sandpiper	Confirmed during EIS surveys	-	-	-	-	✓	-	✓
Xenus cinereus Terek Sandpiper	Possible	-	-	-	-	✓	-	✓

Of the 44 migratory avian species identified as potential inhabitants of the Project area:

- 19 species have been confirmed as present in the Project area;
- 3 species are likely to occur in the Project area;
- 17 species possibly occur in the Project area; and
- 5 species are unlikely to occur in the Project area.

Twenty of these migratory species are trans-equatorial migratory waders, which arrive in Australia each spring and disperse throughout the continent to feeding grounds amongst coastal and wetland habitats. The western Cape York coastline is known as a major entry corridor for many individuals of these species travelling to eastern Australia.

Given the location of the Project area within the East Asian-Australasian Flyway, these waders were identified in preliminary reviews as a key fauna group for field surveys. A detailed description of the survey methodology used for migratory shorebird species is provided in Appendix 7E of the EIS. Initial observations of likely shorebird habitats including the Gulf shoreline, the lower and upper estuary of Norman Creek, Hey Point estuary, and coastal wetlands associated with Norman Creek and the Ward River revealed a notable paucity of migratory shorebirds both in terms of species diversity and density of individuals. It was also noted that despite the large rise and fall of tides that can occur in the Gulf, the Project area did not support any extensive inter-tidal flats. The shoreline of the Gulf coast in particular was predominantly sandy and of sufficient gradient to expose only minimal tidal flats at the mouth of Norman Creek. Furthermore, seasonal coastal wetlands formed by freshwater inundation of marine plains during the wet season were invariably dry during December survey events and frequently heavily impacted by feral pig activity.

During the field surveys only 5 species of migratory shorebird were recorded within the Project area. The largest group of migratory shorebirds observed at any one time was six Whimbrels (*Numenius phaeopus*) flying up the Norman creek estuary. No high tide roosts of any migratory shorebird were observed during surveys nor any foraging aggregations during lower tides. Isolated roosting shorebirds were occasionally observed in larger roosts of terns.

The paucity of migratory shorebirds within the Project area is attributed to the lack of inter-tidal flat habitat, the dry nature of coastal wetlands during the late dry season until wet season rains occur, and a possible low productivity of inter-tidal benthic habitats potentially related to the very low

sediment loads emanating from contributing spring fed drainages and the extraordinarily low mineral status of these waters. The survey results establish clearly that there are no internationally or nationally important sites or locations for migratory shorebirds located within or immediately adjacent to the Project area, and furthermore the Project area does not support an ecologically significant proportion of any migratory shorebird population.

The remaining species are known to undertake seasonal migratory movements within mainland Australia or to the mainland from areas to the north including Papua New Guinea and eastern Pacific islands.

A number of migratory wetland species occur within the Project area and predominantly utilise the more extensive wetland areas associated with the estuarine reaches of the main drainage systems, with the largest aggregations of species observed on the lower Ward system, downstream of the Project area. No large-scale roosts of these species were observed within the Project area; however, it is possible that roosts and/or breeding of some of the species may occur within these habitats within the Project area. However, these wetland habitats would not be directly affected for mining or infrastructure associated with the Project. The REs associated with potential habitat for each migratory bird species are also provided in **Table 6**. Refer to **Figure 6**, **Figure 6a**, **Figure 6b**, **Figure 6c** and **Figure 6d** for the location and distribution of these REs within the Project area. Refer to Table 7-10 of the EIS for data on the area of proposed disturbance of REs compared to the total area within the Project area, the Weipa Plateau subregion, and the Cape York Bioregion. The potential impacts of the proposed action and proposed mitigation strategies pertaining to migratory birds are discussed in **Section 5.6**.

The only known mainland roosts of the Great Frigatebird (*Fregata minor*) are near Weipa, on the northern side of the Embley River. Targeted surveys undertaken for the EIS found that the Great Frigatebird (*Fregata minor*) and Lesser Frigatebird (*Fregata ariel*) were common along the western coastline of the Project area during the December 2007, May 2008 and December 2008 survey events but were notably not observed during the May 2009 survey. Survey effort for the Great Frigatebird and Lesser Frigatebird included extensive foot traverses and coastal survey tasks undertaken during targeted surveys for threatened species, as well as the comprehensive fauna survey undertaken over 48 nights which involved traversing hundreds of kilometres of the Project area. Fauna survey methods are further detailed in Section 7.13 and Appendix 7E of the EIS. No roosts for the Frigatebirds were observed within the Project area. The individuals observed within the Project area are anticipated to come from the roosts north of the Embley River. The coastal and beach habitats utilised by these species would not be directly affected by the Project other than construction of the proposed port. However, observations of these species in Weipa, and the location of the two roost sites in close proximity to the Weipa Port (north of Humbug Wharf), Weipa Airport, and active mining areas, indicates that they are unlikely to be affected by operations.

The Project area is situated within the East Asian-Australasian Flyway for trans-equatorial migratory waders. The Gulf of Carpentaria is regarded as one of the main access pathways for these species into Australia. The East Asian-Australasian Flyway is a general migratory route used by waders entering Australia from the northern hemisphere. Within the Gulf of Carpentaria, the south-east Gulf is recognised as a key site for waders with extensive wet season wetland habitats and tidal flats providing productive feeding grounds (Driscoll 2001). Tidal and wetland habitats within the Project area and along the Gulf coastline adjacent to the Project area do not provide extensive or productive feeding grounds for the species and although waders are present in these habitats they occur at relatively low densities.

It is anticipated that the majority of waders that utilise the south east Gulf areas access these areas directly, rather than work their way down the west coast of Cape York Peninsula (including the area covered by the Project). Consequently the Project area is not regarded as a significant component of the migratory pathway for migratory waders entering the Gulf of Carpentaria even though the Gulf waters in general form part of the East Asian-Australasian Flyway. A conceptual representation of the migratory pathway for waders is provided in Figure 7-12 of the EIS.

According to DEWHA (2009c), the known threats to migratory shorebird species include the following.

- Clearing, inundation, infilling or draining of habitat.
- Changes in hydrology, water quality or structural changes near roosting sites causing an

indirect loss or degradation of habitat.

- Habitat degradation due to loss of marine or estuarine vegetation, weed invasion of intertidal mudflats, water pollution and changes to the water regime, changes to hydrological regimes leading to the exposure of acid sulphate soils.
- Disturbance of migratory birds during foraging as a result of residential and recreational activities.
- Direct mortality as a result of interferences in the flyways or degradation of important sites across flyways. These may include but are not limited to the development of wind farms in migration pathways, bird strike by aeroplanes and oil and chemical spills.

The above threats are occurring mainly as a result of population growth and economic development, especially in east and south-east Asia.

3.5 Non-avian Migratory species

The non-avian migratory species consist of marine and estuarine species. Benthic habitat surveys of marine and estuarine areas within the Project area were completed during October 2007, June 2008, November 2008 and June 2009 and June 2010 and provided information regarding the distribution and structure of benthic habitats.

The Estuarine Crocodile was included in the targeted surveys for threatened fauna conducted in May 2007, November 2007, May 2008, December 2008 and May 2009. A total of 27 days of targeted fauna survey effort were undertaken. Targeted survey activities for the Estuarine Crocodile focused on establishing the extent of reproductive activity within the Project area.

The EPBC Act database search indicated eight non-avian migratory species (excluding six species that are also threatened species shown in **Table 5**) as potentially occurring within the Project area. Of the eight species that potentially occur, it was determined that five of these species were known to occur or would possibly occur within the Project area. These species are listed in **Table 7**. Refer to Table 6-33 in Section 6 of the EIS for details on the migratory (non-avian) species that are unlikely to occur within the Project area.

Table 7 Non-avian migratory species listed under the EPBC Act

Species **Common Name**	**EPBC Act Status**	**Habitat**	**Likelihood of Occurrence within the Project Area and Areas of Proposed Disturbance within the Project Area (Site)**
Crocodylus porosus Estuarine Crocodile	M	Estuarine and inshore waters.	**Project Area** **Known to Occur** Tracks of this species were recorded during field work within the study area and verified by traditional owners. Nesting was observed near Norman Creek. **Proposed Port Site** **Known to Occur** This species has been recorded in marine environments within the Project area. **Proposed Spoil Ground** **Possible** This species has been recorded within marine environments within the Project area, although not as far out to sea as the proposed spoil ground. However this species is known to occasionally traverse some distance into the marine environment, so it is possible that this species may occur in this area on occasion. **Albatross Bay Spoil Ground** **Possible** This species has been recorded within marine environments within the Project area, although not as far out to sea as the Albatross Bay spoil ground. However this species is known to occasionally traverse some distance into the marine environment, so it is possible that this species may occur in this area on occasion. **Ferry/Barge Terminals – Hey and Embley Rivers** **Known to Occur** This species has been recorded in estuarine environments within the Project area. The ferry/barge terminal sites are within estuarine and sometimes mangrove environments. Estuarine and mangrove habitats of which the ferry/ barge terminal areas are the main habitat for this species. The species is likely to use the habitat within the ferry/barge terminal areas for foraging and shelter. **Dam C on Norman Creek and Upstream of Dam C** **Known to Occur** This species has been recorded in freshwater environments within the Project area. Foraging and nesting habitats for this species have been recorded within the footprint of Dam C.

Species **Common Name**	**EPBC Act Status**	**Habitat**	**Likelihood of Occurrence within the Project Area and Areas of Proposed Disturbance within the Project Area (Site)**
Dugong dugon Dugong	M	The species prefers shallow seagrass beds dominated by pioneering species of species such as *Halophila spp.*	**Project Area** **Known to Occur** The Dugong is known to occur in the area associated with seagrass beds. Traditional owners report that the species migrates through Boyd Bay. The species is highly migratory and would traverse coastal waters between seagrass beds. **Proposed Port Site** **Known to Occur** Traditional Owners report that the species migrates through Boyd Bay which also indicates migration past the proposed port site. **Proposed Spoil Ground** **Possible** This species may migrate through this area between feeding grounds, however it is more likely that the species would migrate through shallower waters than where the footprint of the proposed spoil ground occurs. **Albatross Bay Spoil Ground** **Possible** This species may possibly occur within the Albatross Bay spoil ground footprint for the same reasons that it possibly occurs in the vicinity of the proposed spoil ground footprint. **Ferry/Barge Terminals – Hey and Embley Rivers** **Known to Occur** The Dugong is known to occur in the area associated with seagrass beds. The seagrass beds in the Embley and Hey Rivers potentially constitute feeding habitat for Dugong; however, no Dugong were incidentally observed associating with these seagrass beds during marine field surveys for this Project.
Sousa chinensis Indo-Pacific Humpback Dolphin	M	Inshore coastal waters to a depth of approximately 20 metres.	**Project Area** **Known to Occur** Incidental sightings of this species were recorded during field studies. **Proposed Port Site** **Known to Occur** Incidental sightings of this species were recorded within the proposed port footprint during field studies. **Proposed Spoil Ground** **Possible** This species usually inhabits shallow coastal waters less than 20m deep and are often associated with tidal riverine and estuarine systems, enclosed bays and coastal lagoons (Corkeron *et al.* 1997; Hale *et al.* 1998; Jefferson 2000; Parra 2006). While the proposed spoil ground does not represent preferred habitat, it is possible they are transient in the area. **Albatross Bay Spoil Ground** **Possible** For the same reasons as the proposed spoil ground, while preferred habitat isn't present, it is possible they are transient in the area. **Ferry/Barge Terminals – Hey and Embley Rivers** **Likely** As this species is often associated with tidal riverine and estuarine systems, it is likely that this species may occur in the vicinity of the ferry/barge terminals.

Species **Common Name**	**EPBC Act Status**	**Habitat**	**Likelihood of Occurrence within the Project Area and Areas of Proposed Disturbance within the Project Area (Site)**
Orcaella heinsohni Australian Snubfin Dolphin*	M	Inshore coastal waters to a depth of approximately 20 metres.	**Project Area** **Known to Occur** Incidental sightings of this species were recorded during field studies. **Proposed Port Site** **Known to Occur** Incidental sightings of this species were recorded in the vicinity of the proposed port footprint during field studies. **Proposed Spoil Ground** **Possible** This species usually inhabits shallow coastal waters less than 20m deep and are often associated with tidal riverine and estuarine systems, enclosed bays and coastal lagoons (Corkeron *et al.* 1997; Hale *et al.* 1998; Jefferson 2000; Parra 2006). The proposed spoil ground is in deeper water than this and therefore it is unlikely to represent preferred habitat for this species. However, it is possible they may be transient in the area. **Albatross Bay Spoil Ground** **Possible** For the same reasons as the proposed spoil ground while preferred habitat isn't present, it is possible they are transient in the area. **Ferry/Barge Terminals – Hey and Embley Rivers** **Likely** As this species is often associated with tidal riverine and estuarine systems, it is likely that this species may occur in the vicinity of the ferry/barge terminals.
Balaenoptera edeni Bryde's Whale	M	Pelagic environment including principally continental shelf waters but also extending into coastal and inshore waters.	**Project Area** **Possible** While the Project area does not contain preferred habitat, the recording of the species from tropical inshore waters suggests that is possible that the species may occur sporadically in the Project area. **Proposed Port Site** **Possible** While the proposed port site does not contain preferred habitat, the recording of the species from tropical inshore waters suggests it is possible the species may occur sporadically in the vicinity of the proposed port footprint. **Proposed Spoil Ground** **Possible** This species may possibly occur within the proposed spoil ground footprint for the same reasons that it possibly occurs in the vicinity of the proposed port site. **Albatross Bay Spoil Ground** **Possible** This species may occur within the Albatross Bay spoil ground footprint for the same reasons that it possibly occurs in the vicinity of the proposed port site. **Ferry/Barge Terminals – Hey and Embley Rivers** **Unlikely** Although this species occurs in shallow water, it generally is found in coastal areas rather than estuaries. It is therefore unlikely to occur within the Embley and Hey River estuaries, including in the vicinity of the barge/ferry terminal footprints.

* Previously the Australian Snubfin Dolphin was identified as the widely distributed Irrawaddy Dolphin (*Orcaella brevirostris*) (Beasley *et al.* 2005).

Key to Status: M=Migratory

Profiles of each of the species from **Table 7** are provided below. A description of potential impacts of the proposed action and proposed mitigation measures pertaining to non-avian migratory species are provided in **Section 5.7**.

3.5.1 Estuarine Crocodile

The Estuarine Crocodile occurs in coastal and sub coastal areas in northern Australia between Maryborough in Queensland and Broome in Western Australia. The Estuarine Crocodile is commonly encountered in the Weipa area including the freshwater swamps and creek systems within the Weipa mining leases (Winter and Atherton 1985; Herbert 1995; Dames and Moore 1996). The tributaries that collectively form the Port Musgrave (Wenlock River/Tent Pole Creek) system and the Albatross Bay system surrounding Weipa (including the Embley/Hey estuary adjacent to the Project area) have been identified as the two most significant Estuarine Crocodile habitats in Queensland (Taplin *et al.* 1988).

The Estuarine Crocodile was recorded in all freshwater and marine habitats in the Project area, including freshwater swamps and streams well inland. Overall, the species is widespread and numerous within the Project area. Habitat utilisation appears to change seasonally with more use made of inland freshwater habitats during the wet season including the middle and upper reaches of groundwater-fed tributaries of Norman Creek and Coconut Creek. Several nests and hatchling aggregations were located within the Project area on the middle reaches of Norman Creek and the lower reaches of the Ward River. Field surveys located one nest within the footprint of the proposed water supply dam (Dam C). Areas suitable for Estuarine Crocodile habitat in and around the Project area are shown in Figure 7-13 of the EIS.

The REs associated with the habitats that the Estuarine Crocodile occurs within the Project area are REs 3.1.1a, 3.1.1c, 3.1.3, 3.1.5, 3.1.6, 3.3.9, 3.3.14a, 3.3.50a, 3.3.60a, 3.3.63, 3.3.64, 3.3.65, 3.5.22c. Refer to **Figure 6**, **Figure 6a**, **Figure 6b**, **Figure 6c** and **Figure 6d** for the location and distribution of these REs within the Project area. Refer to Table 7-10 of the EIS for data on the area of proposed disturbance of REs compared to the total area within the Project area, the Weipa Plateau subregion, and the Cape York Bioregion.

Known threats to the Estuarine Crocodile (DSEWPaC 2010) include incidental mortality from fishing nets and habitat destruction. The incidence of feral animals within the Estuarine Crocodile's habitat may also lead to increasing drainage and destroying vegetation within the habitat.

Adult individuals of the Estuarine Crocodile are capable of extensive movements throughout the landscape and are known to move over several hundred kilometres in some cases, although it does not appear that large scale migratory movements are a regular occurrence. Localised migration associated with dispersal of individuals from breeding areas and accessing nesting and feeding habitats however is common (EPA 2007). Within the Project area, seasonal movements of individuals into freshwater habitats created by wet season rains and movement between proximal drainage systems have been observed and are likely to represent the predominant movements undertaken by the species in the area.

In contrast to the Wenlock Basin, the area between Weipa and Aurukun within which the Project area occurs is not regarded as key breeding habitat for the species (Magnusson *et al.* 1980), although observations of nests and juvenile individuals confirm that the species does breed within the Project area at least at low densities. Some of the smaller seasonal stream systems within the Project area appear unlikely to support successful nesting and hatching of young, but support adult individuals, implying that seasonal movement of individuals between stream systems occurs within the Project area. Figure 7-13 of the EIS illustrates the likely movement pattern of individuals of the Estuarine Crocodile between stream systems within the Project area.

In addition to movement between drainage systems, regular wet season movement of sub-adult and adult individuals from estuary to freshwater stream reaches and wetlands occurs. Numerous observations have been made of individuals and slides (tracks made by crocodiles on the edges of waterways) well upstream on seasonal systems including Ward River/Coconut Creek, Norman Creek, and Triluck/Winda Winda Creek. These movements seem to be undertaken to take advantage of the nesting and feeding habitats that become available within these freshwater habitats during the wet season. The estuarine reaches of streams within the Project area are not well suited to nesting due to the occurrence of dense fringing mangroves or the flooding of Melaleuca swamps, whereas the grassy woodland habitat along the banks of the incised freshwater stream reaches provides flood-free

nesting locations and access to deep water habitat for mothers. Seasonally available feeding resources that are exploited by Estuarine Crocodiles in wet season freshwater habitats are underpinned by seasonal fish breeding activity in seasonal wetlands and most likely the availability of feral pigs and macropods adjacent to freshwater streams. Figure 7-13 of the EIS illustrates notional wet season movement paths within the Project area.

3.5.2 Dugong

Dugongs are abundant at many locations in the Gulf of Carpentaria and are usually associated with seagrass beds. Of the estimated 27,602 (± 3,110) Dugongs in the Gulf of Carpentaria, only 15% occur in Queensland waters, reflecting the much greater area of seagrass present along the Northern Territory coast (Saalfield and Marsh 2004).

In a 1997 survey (Saalfeld and Marsh, 2004), the following number of dugongs were sighted within the vicinity of the Project area.

- two dugongs within Albatross Bay;
- three dugongs at sea adjacent to Albatross Bay;
- one dugong near Aurukun; and
- one dugong to the north of Jantz Point.

This represents a total of seven dugongs sighted within the vicinity of the Project area, which represents approximately 0.2% of the Queensland Gulf of Carpentaria Coast population, between 0.023% and 0.035% of the Gulf of Carpentaria population and 0.009% of the Australian population.

Dugongs almost solely consume seagrass and their distribution is associated with seagrass beds in the Weipa region. However, the region is not identified as supporting large populations of Dugong. Dugongs prefer to feed on seagrasses that are early or 'pioneer' species, particularly species of the genera *Halophila* and *Halodule* (DEWHA 2010d). The long, strap-like seagrass *Enhalus acoroides*, which dominates the seagrass beds of the Embley and Hey Rivers, is not a preferred species in Dugong's diet. Dugongs were not observed at the proposed port location nor in the seagrass beds in the Embley and Hey Rivers during field studies. However, it is likely that Dugong traverse through the proposed port area as they travel between seagrass resources.

Dugong mortality in the Gulf of Carpentaria may currently be caused by traditional hunting, incidental capture in commercial mesh nets, targeted capture by illegal foreign fishing vessels in Australian waters, and boat strikes from fast moving vessels. Populations would be vulnerable to a reduction in the area and quality of seagrass beds.

3.5.3 Whales and Dolphins (Cetaceans)

There are no specific studies of the distribution and abundance of cetaceans in the Project area. Incidental observations while undertaking the habitat mapping at the proposed port confirmed the presence of the Indo-Pacific Humpback Dolphin, at least one species of the Bottlenose Dolphin (most probably the inshore form) and the Australian Snubfin Dolphin.

The Indo-Pacific Humpback Dolphin and Australian Snubfin Dolphin usually inhabit shallow coastal waters less than 20m deep and are often associated with tidal riverine and estuarine systems, enclosed bays and coastal lagoons (Corkeron *et al*. 1997; Hale *et al*. 1998; Jefferson 2000; Parra 2006). On the east coast of Australia, the inshore Bottlenose Dolphin inhabits estuaries and shallow offshore waters (<30m) (Hale *et al*. 1998, 2000). Bottlenose dolphins are listed cetacean species under the EPBC Act but are not threatened or migratory species[1].

Elsewhere in Australia, the dolphin species co-exist with coastal development including extensive port facilities such as the Port of Brisbane and Cleveland Bay (Townsville) (Hale *et al*. 1998; Parra 2006).

There are two forms of Bryde's Whales: coastal and offshore. The coastal form of Bryde's Whale appears to be limited to the 200m depth contour, moving along the coast in response to availability of

[1] It is noted that the Arafura/Timor Sea sub-population of *Tursiops aduncus* is migratory, but their distribution does not include the Project area or Gulf of Carpentaria.

suitable prey (Best *et al.* 1984). The SPRAT database states that it is likely that Australian inshore stocks of Bryde's Whales will be small, possibly of similar size to those off South Africa (estimated at 582 ±184 animals: Best *et al.* 1984), and therefore it is unlikely that significant numbers would occur in the vicinity of the Project area. There is no evidence of large-scale migrations of the inshore form of Bryde's Whales. The offshore form is found in deeper water (500m to 1000m). Bryde's Whale is considered to be a fairly opportunistic feeder, readily consuming whatever shoaling prey is available (Kato 2002; Martin 1990). Bryde's Whale (*Balaenoptera edeni*) inhabits inshore tropical waters, so it may occur sporadically in the vicinity of the port area, but not in the shallower estuarine areas of the Embley and Hey Rivers.

3.6 Commonwealth Marine Areas

Areas within Commonwealth marine areas that would be impacted by the Project include part of the dredged channel for the proposed port, the proposed new spoil ground 17km west of Boyd Point and the existing Albatross Bay spoil ground. The existing environmental values of these areas are described in **Section 3.1**.

4 ASSESSMENT OF POTENTIAL IMPACTS AND MITIGATION MEASURES

This section provides an assessment of potential impacts and mitigation measures on EPBC Act listed threatened flora, threatened terrestrial fauna, threatened marine and estuarine fauna, avian and non-avian migratory species, and the Commonwealth marine area.

4.1 Potential Impacts on Threatened Flora

Darwin Stringybark (*Eucalyptus tetrodonta*) Open Forest to Woodland on lateritic red earths (Regional Ecosystem (RE) 3.5.2) comprises 87% of the Project area and 99% of the proposed disturbance area for the Project. This RE is correlated with the bauxite-bearing Weipa plateau. The threatened flora species that are likely to be encountered within the Project area occur in non-*Eucalyptus tetrodonta* vegetation communities, especially riparian gallery forest, and coastal and non-coastal vine thicket communities. Consequently, none of the threatened flora species are likely to occur in areas to be directly affected by bauxite mining operations as all mining activities are proposed to occur solely within the Darwin Stringybark (*Eucalyptus tetrodonta*) forest. However, some threatened flora species may occur in riparian gallery forest along creeks in areas that would be disturbed for associated Project infrastructure (e.g. water supply dam, water pipelines, conveyor, roads etc).

The EPBC Act listed species listed in **Table 3** have been assessed against the DEWHA (2009a) significant impact guidelines. Individual significant impact assessments are presented in **Table 8** to **Table 13**. A summary of potential RE habitats for each threatened flora species and estimated disturbance to each RE from Project activities is presented in **Table 14**.

Impacts and proposed mitigation strategies for EPBC Act listed threatened flora are described in the following sections.

4.1.1 *Calophyllum bicolor*

Calophyllum bicolor was not recorded within the Project area. As the regional population size of this species is relatively small, if *Calophyllum bicolor* was to occur within the disturbance footprint of the Project area, the population would be regarded as an important population. If a population was present within the Project area it would be unlikely to be impacted because its' habitat would not be directly affected by mining, and hydrological impacts on the groundwater dependent habitats it occupies would be minimised through implementation of the proposed environmental buffer system and post mining rehabilitation measures.

Table 8 Significant Impact Assessment – *Calophyllum bicolor*

Will the proposed works...	***Calophyllum bicolor*** : Vulnerable
....lead to a long-term	*Calophyllum bicolor* is currently known only from 17 populations on Cape York Peninsula

Will the proposed works...	***Calophyllum bicolor*** : Vulnerable
decrease in the size of an important population of a species?	(DERM 2010). It occurs on spring-fed areas that form a distinct habitat with evergreen rainforest and permanently wet substrates, but does not occur on stream banks away from the spring-heads. There are four specimen records of the species from the Weipa area, but the species has not been recorded in the SoE Project area. *Calophyllum bicolor* was not recorded within the Project area despite the location and survey of five semi-permanent groundwater seepage zones that provided suitable habitat for the species. The species was absent from six other seepage zones surveyed where the habitat was unsuitable. These sites were located in close proximity to proposed mining areas and no other potential habitat areas appear to occur close to mining or infrastructure areas. However, unsurveyed isolated patches of suitable habitat may occur at the margin of wetlands in the lower freshwater sections of the main drainages (Norman Creek, Ward River, Winda Winda Creek) and may support the species. Any population of *Calophyllum bicolor* that may be present within the Project area would be regarded as an important population as the location would represent the southern distribution limit for the species. The semi permanent groundwater seepage habitats on the lower sections of the main drainages where the species may occur are well removed from the proposed mining area and infrastructure and would not be directly disturbed. These habitats would be susceptible to impacts from altered groundwater hydrology; however, their habitat location is well away from mining areas and the implementation of the proposed environmental buffer system and post mining rehabilitation measures, which would aim to protect hydrological regimes are anticipated to minimise effects on semi permanent groundwater seepage areas. As such it is unlikely that the species, if present, would be adversely affected. It is not anticipated that the Project would lead to a long-term decrease in any population of *Calophyllum bicolor* that may be present.
....reduce the area of occupancy of an important population?	If *Calophyllum bicolor* is present within the Project area, its habitat would not be directly affected by mining and it is not anticipated there would be sufficient hydrological impacts on the groundwater dependent habitats it occupies to lead to a reduction of the area of occupancy of an important population.
....fragment an existing important population into two or more populations?	*Calophyllum bicolor* has a naturally patchy and restricted distribution associated with the isolated occurrence of permanent groundwater seepage zones. Populations of *Calophyllum bicolor* on Cape York are therefore naturally fragmented and not sensitive to disturbance of sub optimal habitat between patches of preferred habitat. The Project would not lead to fragmentation of any potentially occurring *Calophyllum bicolor* populations.
....adversely affect habitat critical to the survival of a species?	The Project area does not include any critical habitat areas for *Calophyllum bicolor* that are listed under the EPBC Act or identified in Recovery Plans.
....disrupt the breeding cycle of an important population?	If *Calophyllum bicolor* is present within the Project area, it is not anticipated that its preferred habitat would be adversely affected by the Project and consequently the breeding cycle of the species would not be disrupted.
....modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?	If *Calophyllum bicolor* is present within the Project area its habitat would not be directly affected by mining and it is not anticipated that there would be sufficient hydrological impacts on the groundwater dependent habitats it occupies to lead to a decline in the species.
....result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?	The Project area is currently predominantly free of serious weeds and invasive species; however a number of significant environmental weeds occur in the surrounding region. The preferred habitat of *Calophyllum bicolor* is often favoured by invasive species due to the moist nature of the habitat. Should *Calophyllum bicolor* be present, the potential introduction of Rubber Vine (*Cryptostegia grandiflora*) would be of particular concern. Proposed mitigation measures for invasive species include a rigorous weed management program which would include preventative measures and control measures for weeds within the Project area. Riparian areas including groundwater discharge areas would be one of the habitats targeted by the program. These mitigation measures would be effective in managing the impacts of weeds on *Calophyllum bicolor*. The Project is not anticipated to lead to the introduction or spread of invasive weeds within any potential habitat of *Calophyllum bicolor*.
.....introduce disease that may cause the species to decline?	Disease is not known as a threat to this species. It is not anticipated that the Project would represent a threat with respect to the introduction of disease.
....interfere substantially with the recovery of the species?	It is not anticipated that the Project would adversely affect *Calophyllum bicolor* (if present). The Project would not interfere with the recovery of *Calophyllum bicolor*.

4.1.2 Cooktown Orchid (*Dendrobium bigibbum)*

The Cooktown Orchid was recorded within the proposed disturbance area and therefore the action is likely to impact individuals within the disturbance areas. The relevant impact on this species includes a minor reduction of the extent of riparian habitat supporting the species, due to the inundation of riparian habitat by the water supply dam and construction of linear infrastructure. However, the population within the Project area is not considered an important population and the Project is not expected to interfere with the recovery of the species because the species occurs at a number of locations in the surrounding areas and throughout the Project area, in areas that would not be disturbed.

Table 9 Significant Impact Assessment – Cooktown Orchid

Will the proposed works...	**Cooktown Orchid *(Dendrobium bigibbum)***: Vulnerable
...lead to a long-term decrease in the size of an important population of a species?	The Cooktown Orchid occurs on Cape York Peninsula north from Princess Charlotte Bay and Kowanyama to the tip and into southern Asia, and has been recorded from several locations in the Weipa region, particularly in notophyll vine forest on coastal dunes and on lateritic red earths. The Cooktown Orchid was recorded from a number of locations throughout the Project area in coastal and Weipa plateau vine forest, mangrove communities and in areas of riparian rainforest and riparian gallery forest and is expected to be widespread within the entire Project area and adjoining areas in suitable habitat. The Cooktown Orchid was confirmed in two pockets of riparian rainforest within the proposed footprint of Dam C. The population of Cooktown Orchid within the Project area is not considered an important population under the EPBC Act.
...reduce the area of occupancy of an important population?	In line with the discussion above, the population within the Project area is not regarded as an important population.
...fragment an existing important population into two or more populations?	In line with the discussion above, the population within the Project area is not regarded as an important population.
...adversely affect habitat critical to the survival of a species?	The Project area does not include any critical habitat areas for the Cooktown Orchid that are listed under the EPBC Act or identified in Recovery Plans. The species is widespread through Central and northern Cape York.
...disrupt the breeding cycle of an important population?	In line with the discussion above, the population within the Project area is not regarded as an important population.
...modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?	Two pockets of rainforest with Cooktown Orchids within the proposed footprint of Dam C, would be inundated. The orchid was also found in the vicinity of the proposed infrastructure corridor crossings on Norman Creek and vicinity of road crossings at Norman Creek and Winda Winda Creek. None of the vine forest or mangrove habitat types supporting Cooktown Orchid within the Project area would be directly affected by clearing for mining. No significant modifications of these habitats due to changes in hydrology are anticipated. Overall, the reduction of habitats supporting the species would be very minor. The proposed fire management program would favour the species by reducing the impacts of the current fire regime on fire sensitive habitats such as vine forest.
...result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?	The Project area is currently predominantly free of serious weeds and invasive species; however a number of significant environmental weeds occur in the surrounding region. The vine forest habitat of Cooktown Orchid is not considered at risk of weed invasion as most of the significant weeds in the region do not colonise closed forest. The mangrove habitat of the species is threatened by the introduction of Rubber Vine (*Cryptostegia grandiflora*). Proposed mitigation measures include a rigorous weed management program which would include preventative measures and control measures for weeds within the Project area. Riparian areas including mangroves would be one of the habitats targeted by the program. These mitigation measures would be effective in managing the impact of weeds on the Cooktown Orchid. The Project is not anticipated to lead to the establishment of invasive weeds within the habitat of the Cooktown Orchid.
....introduce disease that may cause the species to decline?	Disease is not known as a threat to this species. It is not anticipated that the Project would represent a threat with respect to the introduction of disease.
...interfere substantially	The Project would lead to a minor reduction in the extent of habitats supporting the species

Will the proposed works...	**Cooktown Orchid *(Dendrobium bigibbum)***: Vulnerable
with the recovery of the species?	due to the inundation of riparian habitat by the proposed water supply dam and linear infrastructure. However, given the extensive occurrence of the species elsewhere within the Project area and surrounding areas it is not anticipated that the Project would interfere substantially with the recovery of the species.

4.1.3 Chocolate Tea Tree Orchid (*Dendrobium johannis)*

The Chocolate Tea Tree Orchid was recorded within the proposed disturbance area and therefore the action is likely to impact individuals within the disturbance areas. The relevant impact on this species within the Project area would result in a minor reduction of the extent of habitats supporting the species due to the infrastructure corridor crossing of Norman Creek and also possibly the water supply dam. However, the population is not considered an important population and the Project is not expected to interfere with the recovery of the species because the species occurs in a number of locations in surrounding areas and throughout the Project area, in areas that would not be disturbed.

Table 10 Significant Impact Assessment – Chocolate Tea Tree Orchid

Will the proposed works...	**Chocolate Tea Tree Orchid (*Dendrobium johannis)*** *:* Vulnerable
....lead to a long-term decrease in the size of an important population of a species?	The Chocolate Tea Tree Orchid occurs from the Coen area north to the tip of Cape York and in Torres Strait and New Guinea, and has been recorded at several locations in the Weipa region, including the Andoom, Weipa and Ely mining lease areas. The habitat preferences of this species are well known: the Chocolate Tea Tree Orchid is restricted to mesic habitats, typically as an epiphyte on mature *Syzygium* spp. and *Melaleuca* spp. trees in riparian gallery forest and on the margins of swamp habitats and their associated ecotones. The Chocolate Tea Tree Orchid was recorded in a number of locations throughout the Project area in riparian gallery forest and *Melaleuca* dominated wetlands and is expected to be widespread within the entire Project area and adjoining areas in these habitats. The population of the Chocolate Tea Tree Orchid within the Project area is not considered an important population under the intent of the EPBC Act. The Chocolate Tea Tree Orchid occurs within riparian and wetland habitats throughout the Project area. The population within the Project area is not a discrete population, as the species occurs throughout the Weipa Plateau subregion and within the wider Cape York Bioregion.
....reduce the area of occupancy of an important population?	In line with the discussion above, the population within the Project area is not regarded as an important population.
....fragment an existing important population into two or more populations?	In line with the discussion above, the population within the Project area is not regarded as an important population.
....adversely affect habitat critical to the survival of a species?	The Project area does not include any critical habitat areas for the Chocolate Tea Tree Orchid that are listed under the EPBC Act or identified in Recovery Plans. The species is widespread through central and northern Cape York.
....disrupt the breeding cycle of an important population?	The population within the Project area is not regarded as an important population.
....modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?	Areas of riparian gallery forest and fringing *Melaleuca* wetland supporting the Chocolate Tea Tree Orchid would be disturbed by the infrastructure corridor crossing of Norman Creek. While the species was not found within the footprint of the water supply dam, there is suitable habitat present in this location. Elsewhere the habitats of the species would be avoided by the mine plan and buffered by the proposed environmental buffer system. Significant modification of these habitats due to changes to hydrology is not anticipated. Overall there would be a minor reduction of the extent of habitats supporting the species but given the extensive occurrence of the species outside of these impact areas, it is not anticipated that the species would be caused to decline. The proposed fire management program would favour the species by effectively reducing the impacts of the current fire regime on fire sensitive habitats such as riparian gallery forest and melaleuca wetlands.

Will the proposed works...	**Chocolate Tea Tree Orchid (*Dendrobium johannis)* :** Vulnerable
....result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?	The Project area is currently predominantly free of serious weeds and invasive species; however a number of significant environmental weeds occur in the surrounding region. The habitats of the Chocolate Tea Tree Orchid are often favoured by weed invasion, as the moist nature of the habitats supports weed establishment. Of particular threat is the introduction of Rubber Vine (*Cryptostegia grandiflora*) which can thrive and displace native vegetation in riparian and wetland situations. Proposed mitigation measures include a weed management program which would involve preventative measures and control measures for weeds within the Project area. Riparian areas would be one of the habitats targeted by the program. These mitigation measures would be effective in managing the impacts of weeds on the Chocolate Tea Tree Orchid. The Project is not anticipated to lead to the establishment of invasive weeds within the habitat of the Chocolate Tea Tree Orchid.
.....introduce disease that may cause the species to decline?	Disease is not known as a threat to this species. It is not anticipated that the Project would represent a threat with respect to the introduction of disease.
....interfere substantially with the recovery of the species?	The Project would lead to a minor reduction of the extent of habitats supporting the species due to the proposed infrastructure corridor crossing of Norman Creek. However, given the extensive occurrence of the species elsewhere within the Project area and surrounding areas it is not anticipated that the Project would interfere substantially with the recovery of the species.

4.1.4 Ant Plant *Myrmecodia beccarii*

Myrmecodia beccarii was not recorded within the Project area. If a population of *Myrmecodia beccarii* within the Project area was found, it would be considered an important population since there is little known of the species, with no specimen records from western Cape York. Any population of *Myrmecodia beccarii* that may be present within the Project area would not be adversely affected by the Project as potential mangrove habitats for *Myrmecodia beccarii* within the Project area would not be directly affected by clearing. It is also highly unlikely that these habitat areas would be significantly affected by changes to surface and groundwater hydrology as a result of the Project. It is therefore considered unlikely that the Project would impact this species.

Table 11 Significant Impact Assessment – *Myrmecodia beccarii*

Will the proposed works...	**Ant Plant (*Myrmecodia beccarii*)** : Vulnerable
....lead to a long-term decrease in the size of an important population of a species?	*Myrmecodia beccarii* is known from coastal woodlands between Cooktown and Ingham and the northern Cape York Peninsula between Weipa and the tip of Cape York. *Myrmecodia beccarii* was not identified within the Project area and distribution within adjoining areas is not well known, although the species was recently located in a permanent groundwater seepage area near Weipa (pers. obs.). *Myrmecodia beccarii* is known from a variety of habitats on Cape York including *Melaleuca* wetlands, coastal closed forest, mangroves and swamp forest on permanent groundwater seepages. If a population of *Myrmecodia beccarii* occurs within the Project area it would be considered an important population under the intent of the EPBC Act since the species is little known with no specimen records from western Cape York. The closest record for the species is from Weipa with no known records of the species south of the Project area. The Project area would represent a distributional limit for the species. Any isolated population in the Project area would be regarded as an important population as it would represent: • key source populations either for breeding or dispersal; • population that is necessary for maintaining genetic diversity; and/or • population that is near the limit of the species range. (i.e. there are no other records of the species on the west coast of Cape York south of Weipa). Significant areas of potential wetland, mangrove and coastal vine forest habitat occur within the Project area. Targeted threatened surveys were undertaken in a number of *Melaleuca* wetland, coastal vine forest, and semi permanent groundwater seepage forest habitats within the Project area but the species was not located and it is not anticipated that the species occurs in these habitats within the Project area. Mangrove areas were less intensively surveyed and may provide habitat for the species. Mangrove habitats within the Project area would not be directly affected by clearing

Will the proposed works...	**Ant Plant (*Myrmecodia beccarii*)** : Vulnerable
	associated with the Project and it is also highly unlikely that these habitat areas would be significantly affected by changes to surface and groundwater hydrology as a result of the Project. It is not anticipated that a long-term decrease in the size of any important population of *Myrmecodia beccarii* present within the Project area would occur.
....reduce the area of occupancy of an important population?	It is not anticipated that the area of any important population of *Myrmecodia beccarii* that may be present within the Project area would be reduced.
....fragment an existing important population into two or more populations?	*Myrmecodia beccarii* has a naturally patchy and restricted distribution associated with the restricted habitats it occupies. Populations of *Myrmecodia beccarii* on Cape York are therefore naturally fragmented and not sensitive to disturbance of sub optimal habitat between patches of preferred habitat. The Project would therefore not lead to fragmentation of important populations of *Myrmecodia beccarii*.
....adversely affect habitat critical to the survival of a species?	The Project area does not include any critical habitat areas for *Myrmecodia beccarii* that are listed under the EPBC Act or identified in Recovery Plans. The species is known to occur at a number of other locations on Cape York.
....disrupt the breeding cycle of an important population?	It is not anticipated that any important population of *Myrmecodia beccarii* that may be present would be adversely affected by the Project. Consequently, disruption of any important populations of *Myrmecodia beccarii* that may be present within the Project area is not expected to occur.
....modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?	Potential mangrove habitat for *Myrmecodia beccarii* within the Project area would not be adversely affected by the Project. The Project would not affect numerous other populations of the species reported from elsewhere on Cape York. A decline in the species as a result of the Project is not expected.
....result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?	The Project area is currently predominantly free of serious weeds and invasive species; however a number of significant environmental weeds occur in the surrounding region. The preferred habitat of *Myrmecodia beccarii* is susceptible to weed invasion due to the moist nature which is often favoured by invasive species. Of particular concern is the potential introduction of Rubber Vine (*Cryptostegia grandiflora*). Proposed mitigation measures include a weed management program which would include preventative measures and control measures for weeds within the Project area. Riparian areas including groundwater discharge areas would be one of the habitats targeted by the program. These mitigation measures would be effective in managing the impacts of weeds on *Myrmecodia beccarii* (if present). The Project is not anticipated to lead to the spread of invasive weeds within the habitat of *Myrmecodia beccarii*.
.....introduce disease that may cause the species to decline?	Disease is not known as a threat to this species. It is not anticipated that the Project would represent a threat with respect to the introduction of disease.
....interfere substantially with the recovery of the species?	Potential mangrove habitat for *Myrmecodia beccarii* within the Project area would not be adversely affected by the Project. There are numerous other populations of the species reported from elsewhere on Cape York. It is not anticipated that the Project would interfere with the recovery of the species.

4.1.5 Beach Nightshade (*Solanum dunalianum)*

The Beach Nightshade was not recorded within the Project area. Any occurrence of the species within the Project area would be considered an important population. The Beach Nightshade is expected to be restricted to more mesic habitats, particularly coastal vine forest and vine forest on bauxite within the Project area. Consequently, it is highly unlikely populations of this plant would occur in areas subject to mining operations or infrastructure development within the Project area. Indirect impacts from the Project, such as the changes to surface and sub-surface hydrology, are not expected to lead to significant impact on any potential Beach Nightshade populations. Therefore it is considered unlikely that the Project would impact the species.

Table 12 Significant Impact Assessment – Beach Nightshade

Will the proposed works...	**Beach Nightshade (*Solanum dunalianum*)**: Vulnerable
....lead to a long-term decrease in the size of an important population of a species?	The Beach Nightshade is known from two Torres Strait islands and between Weipa and Mapoon on western Cape York Peninsula, however it is expected to be more widespread on Cape York (Landsberg and Clarkson 2004). The species was not found in the Project area during targeted surveys, however for the purposes of the impact assessment it is assumed that it is likely to occur in the Project area in the vicinity of coastal vine forest and possibly vine forest on bauxite. Any occurrence of the species is considered an important population under the intent of the EPBC Act since the species is little known with few existing records for the mainland, and any known occurrence of the species is regarded as: • key source populations either for breeding or dispersal; • populations that are necessary for maintaining genetic diversity; and/or • populations that are near the limit of the species range. If present, Beach Nightshade would be expected to be restricted to the margins of vine forest. These habitats would not be disturbed by mining or development of infrastructure. Furthermore, indirect effects from the Project due to changes to surface and sub-surface hydrology are not expected to lead to significant impacts as an environmental buffer system and measures to emulate pre disturbance drainage characteristics in the post-mining landscape would be implemented. The Project would not lead to a long-term decrease in the size of the Beach Nightshade population.
....reduce the area of occupancy of an important population?	In line with the above, habitats supporting the Beach Nightshade would not be adversely affected by the Project and consequently, the area of occupancy of Beach Nightshade within the Project area would not be reduced.
....fragment an existing important population into two or more populations?	Reduction in the area of the Beach Nightshade would not occur as a result of the Project and the population of this species would not be fragmented.
....adversely affect habitat critical to the survival of a species?	The Project area does not include any critical habitat areas for the Beach Nightshade that are listed under the EPBC Act or identified in Recovery Plans. The species is probably widespread on Cape York.
....disrupt the breeding cycle of an important population?	Vine forest habitat would not be affected by the Project and there would be no effect on the breeding cycle of the species.
....modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?	The vine forest habitat that supports the species would not be adversely affected by the Project thus a decline in the species is not anticipated. The proposed fire management plan would favour the species by effectively reducing the impacts of the current fire regime on the fire-sensitive vine forest habitats.
....result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?	The Project area is currently predominantly free of serious weeds and invasive species; however, a number of significant environmental weeds occur in the surrounding region. The peripheral vine forest habitats of the Beach Nightshade are favoured by weed invasion as the moist nature of the vine forest edge supports weed establishment. A number of smothering and ground cover weed species pose a threat, including Rubber Vine (*Cryptostegia grandiflora*) Hyptis (*Hyptis suaveolens*) and Stylo (*Stylosanthes* spp.). Proposed mitigation measures include a weed management program which would include preventative measures and control measures for weeds within the Project area. These mitigation measures would be effective in managing the impacts of weeds on the Beach Nightshade. The Project is not anticipated to lead to the establishment of invasive weeds within the habitat of the Beach Nightshade.
.....introduce disease that may cause the species to decline?	Disease is not known as a threat to this species. It is not anticipated that the Project would represent a threat with respect to the introduction of disease.
....interfere substantially with the recovery of the species?	The Project would not lead to impacts on the Beach Nightshade and would consequently not interfere with the recovery of the species.

4.1.6 Spathoglottis plicata

Spathoglottis plicata was not recorded within the Project area. As the regional population size of *Spathoglottis plicata* is relatively small, if this species was to occur within the disturbance footprint of the Project area, it would be regarded as an important population. The relevant impacts on this species within the Project area include the disturbance of potential habitat for this species within the proposed water supply dam footprint, and potential isolated localised minor effects in habitat areas adjacent to mining areas due to changes in hydrology associated with removal of bauxite. However, these potential impacts are unlikely to be significant as more extensive areas of similar suitable habitat occur elsewhere throughout the Project area in areas that would not be disturbed by mining and infrastructure, and potential changes in hydrology would be limited through implementation of the proposed environmental buffer system and post mining rehabilitation measures.

Table 13 Significant Impact Assessment – *Spathoglottis plicata*

Will the proposed works...	***Spathoglottis plicata:*** Vulnerable
....lead to a long-term decrease in the size of an important population of a species?	*Spathoglottis plicata* is known from Cape York peninsula between Cooktown and the Jardine River and in the Asia Pacific region. *Spathoglottis plicata* has not been recorded from surveys within the Project area but suitable habitat occurs in the Project area, including riparian gallery forest, Melaleuca wetlands, and seasonally inundated grassy areas. If a population of *Spathoglottis plicata* occurs within the Project area it would be considered an important population under the intent of the EPBC Act since the species is little known, with only one record from western Cape York (near Weipa). Any additional known occurrence of the species would be regarded as significant because it would represent: • key source populations either for breeding or dispersal; • populations that are necessary for maintaining genetic diversity; and/or • populations that are near the limit of the species range. *Spathoglottis plicata* may occur within the footprint of the proposed water supply dam (Dam C), although targeted surveys within the dam footprint did not locate the species. Suitable habitat for the species also occurs elsewhere within the Project area in areas that would not be disturbed by mining and infrastructure. Habitat areas adjacent to mining areas may be subject to isolated localised minor effects due to changes in hydrology associated with the removal of bauxite. However, these effects would be limited by proposed mitigation measures including spatial buffering of riparian and wetland areas and the use of reconstructed surface drainage and detention areas in mine pits to recharge shallow groundwater aquifers. Significant indirect impacts on the species as a result of hydrological changes are not anticipated. Should *Spathoglottis plicata* occur within the footprint of the water supply dam, a long term decrease in the size of the local population may occur; however, there is no current evidence to suggest the species is present in this area.
....reduce the area of occupancy of an important population?	Should *Spathoglottis plicata* occur within the proposed footprint of the water supply dam then the area of occupancy of the species within the Project area would be reduced; however, there is no current evidence to suggest the species is present in this area.
....fragment an existing important population into two or more populations?	It is not anticipated that *Spathoglottis plicata* would occur as discrete populations within the Project area. Disturbance of *Spathoglottis plicata* occurred within the proposed footprint of the water supply dam this would not be expected to fragment any other population that may be present within the Project area.
....adversely affect habitat critical to the survival of a species?	The Project area does not include any critical habitat areas for *Spathoglottis plicata* that are listed under the EPBC Act or identified in Recovery Plans.
....disrupt the breeding cycle of an important population?	Should *Spathogolottis plicata* occur within the proposed footprint of the water supply dam, then the breeding cycle of the species would be disrupted within that area; however, there is no current evidence to suggest the species is present in this area.
....modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?	The Project would disturb potential habitat for this species within the proposed water supply dam footprint; however, more extensive areas of similar suitable habitat occur elsewhere throughout the Project area. The proposed feral animal control program would reduce pig numbers in the Project area and would most likely reduce damage levels to potentially occurring populations of *Spathoglottis plicata* during the dry season. Furthermore, the fire management program would effectively reduce the impacts of fire to potential habitat areas. If the species occurrence is restricted to the proposed Dam C footprint then the species would experience a decline; however, if present within the Project area it is regarded as unlikely that

Will the proposed works...	***Spathoglottis plicata:*** Vulnerable
	the species would be restricted to these areas given the availability of more extensive areas of similar suitable habitat associated with the main drainage systems of Norman Creek, Ward River and Winda Winda Creek.
....result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?	The Project area is currently predominantly free of significant weeds and invasive species; however a number of significant environmental weeds occur in the surrounding region. The moist nature of wetland and seasonally inundated habitats favoured by *Spathoglottis plicata* puts them at risk of invasion by weed species. Of particular concern is Rubber Vine (*Cryptostegia grandiflora*). Proposed mitigation measures include a rigorous weed management program which would include preventative measures and control measures for weeds within the Project area. These mitigation measures would be effective in managing the impacts of weeds on *Spathoglottis plicata*. The Project is not anticipated to lead to the establishment of invasive weeds within any potential habitat of *Spathoglottis plicata*.
.....introduce disease that may cause the species to decline?	Disease is not known as a threat to this species. It is not anticipated that the Project would represent a threat with respect to the introduction of disease.
....interfere substantially with the recovery of the species?	It is not anticipated that the species, if present in the Project area, would be restricted to the proposed Dam C footprint given the occurrence of more extensive areas of similar suitable habitat throughout the Project area, and consequently it is unlikely the Project would interfere substantially with recovery of the species.

4.1.7 Summary of Threatened Flora Habitat Impacts

The conceptual 40-year mine plan, proposed infrastructure, and vegetation mapping of the Project area are shown in Figures 6, 6a, 6b, 6c and 6d. The proposed mining areas would avoid riparian and other sensitive habitats by the establishment of an environmental buffer system. **Table 14** summarises the areas of potential habitat REs, for each threatened flora species that would be directly disturbed by Project activities based on interaction with the 40-year mine plan, the proposed Dam C, and the location of Project infrastructure. For each potential habitat RE that would be disturbed, **Table 14** also indicates the areas of RE to be removed relative to the overall Project area, the Weipa Plateau subregion, and the wider Cape York Bioregion.

Indirect Impacts

The five Threatened riparian flora species (*Calophyllum bicolor,* Cooktown Orchid, Chocolate Tea Tree Orchid*,* Ant Plant*,* and *Spathoglottis plicata*) may be locally affected to some degree by changes to surface and groundwater hydrology as described in Section 7.10.1 of the EIS**.** Potential impacts from alterations to hydrology on habitats supporting these species would be localised and would not change the catchment-wide occurrence of different riparian, wetland and mangrove habitats, or the overall availability of potential habitat for most of these species. One species, *Calophyllum bicolor,* would be potentially more susceptible to alterations to groundwater discharge rates as it grows only in association with permanent groundwater seepage areas (which have not been identified within the Project area) within rainforest. However, this species was not detected at five semi-permanent spring heads with suitable habitat located close to proposed mining areas that were visited during targeted surveys. Nor was it present at six other seepage areas which lacked suitable habitat. The species may occur in other unsurveyed isolated patches of suitable habitat at wetland margins closer to the coast on the lower reaches of the main drainage systems. The proposed environmental buffer system would minimise hydrological impacts on groundwater seepage zones particularly in lower catchment areas where the species may occur.

Cooktown Orchid, has been confirmed in the Project area within coastal vine forest areas on sand, and Beach Nightshade also potentially occurs in this habitat. Vine forest patches on coastal dunes are unlikely to be affected by changes to groundwater as the coastal dune complexes are not influenced by shallow aquifers or groundwater discharge. Consequently, indirect impacts on threatened flora occurring in coastal vine forest are not anticipated.

Table 14 Habitat Disturbance for Threatened Flora Species

RE	Description	Approx. area to be disturbed (ha)				Total mapped area in Project area (ha)	Proportion to be disturbed in Project area	Area in Weipa Plateau subregion# (ha)	Proportion of area in subregion to be disturbed#	Area in Cape York Bioregion# (ha)	Proportion of area in bioregion to be disturbed #	Projected remnant extent in bioregion as proportion of current extent#
		Mining area	Dam C	Infra-structure	Total							
Calophyllum bicolor												
3.3.5	Evergreen notophyll vine forest. Occurs on alluvia on major watercourses	0	7.9	0.3	**8.2**	29	28.8%	22,498	<0.1%	54,065	<0.1%	>99.9%
TOTAL					**8.2**							
Cooktown Orchid *(Dendrobium bigibbum)*												
3.1.1a	Closed forest of *Rhizophora stylosa* ± *Bruguiera gymnorhiza*. Occurs as outer mangroves. *Rhizophora stylosa* (Red Mangrove) often completely dominates, forming a very even, closed canopy (5–30m tall).	0	0	0.04	**0.04**	481	<0.01%	30,293	<0.01%	68,381	<0.01%	>99.99%
3.1.1c	Tall, buttressed trees of *Heritiera littoralis* (Looking Glass Mangrove) dominate a fairly even canopy (21–28m tall). Other tree species are frequently present in the canopy and a shrub layer (1.5–3.5m tall) is often present. In places, *Melaleuca cajuputi* (Cajuput Tree) is the most frequent canopy species.	0	0	0	**0**	122	0%	-	-	-	-	-
3.2.2	Semi-deciduous vine thicket to vine forest on beach dunes and ridges	0	0	0	**0**	380	0%	-	-	-	-	-
3.3.5	Evergreen notophyll vine forest. Occurs on alluvia on major watercourses	0	7.9	0.3	**8.2**	29	28.8%	22,498	<0.1%	54,065	<0.1%	>99.9%
3.5.4	Semi-deciduous notophyll vine forest in small patches on northern plateaus	0	0	0	**0**	56	0%	-	-	-	-	-
TOTAL					**8.2**							
Chocolate Tea Tree Orchid *(Dendrobium johannis)*												

RE	Description	Approx. area to be disturbed (ha)				Total mapped area in Project area (ha)	Proportion to be disturbed in Project area	Area in Weipa Plateau subregion# (ha)	Proportion of area in subregion to be disturbed#	Area in Cape York Bioregion# (ha)	Proportion of area in bioregion to be disturbed #	Projected remnant extent in bioregion as proportion of current extent#
		Mining area	Dam C	Infra-structure	Total							
3.2.3	Melaleuca dealbata +/- Acacia crassica open forest in dune swales on the west coast	0	0	0	**0**	227.7	0%	-	-	-	-	-
3.3.14a	*Melaleuca saligna* ± *M. viridiflora, Lophostemon suaveolens* woodland on drainage swamps.	0	0	0	**0**	434	0%	-	-	-	-	-
3.3.5	Evergreen notophyll vine forest. Occurs on alluvia on major watercourses	0	7.9	0.3	**8.2**	29	28.8%	22,498	<0.1%	54,065	<0.1%	>99.9%
3.3.9	*Lophostemon suaveolens* open forest. Occurs on streamlines, swamps and alluvial terraces	0	52.6	3.6	**56.2**	2,164	3.4%	24,750	0.2%	47,167	0.1%	99.9%
3.3.21	*Corymbia clarksoniana* ± *Syzygium eucalyptoides* woodland. Lower slopes of sand ridges and in drainage depressions	0	115.3	5	**120.3**	1,596	7.5%	11,629	1.0%	38,214	0.3%	99.7%
TOTAL					**184.7**							

RE	Description	Approx. area to be disturbed (ha)				Total mapped area in Project area (ha)	Proportion to be disturbed in Project area	Area in Weipa Plateau subregion# (ha)	Proportion of area in subregion to be disturbed#	Area in Cape York Bioregion# (ha)	Proportion of area in bioregion to be disturbed #	Projected remnant extent in bioregion as proportion of current extent#
		Mining area	Dam C	Infra-structure	Total							
Ant Plant *(Myrmecodia beccarii)*												
3.1.1a	Closed forest of *Rhizophora stylosa* ± *Bruguiera gymnorhiza*. Occurs as outer mangroves. *Rhizophora stylosa* (Red Mangrove) often completely dominates, forming a very even, closed canopy (5–30m tall).	0	0	0.04	**0.04**	481	<0.01%	30,293	<0.01%	68,381	<0.01%	>99.99%
3.1.1c	Tall, buttressed trees of *Heritiera littoralis* (Looking Glass Mangrove) dominate a fairly even canopy (21–28m tall). Other tree species are frequently present in the canopy and a shrub layer (1.5–3.5m tall) is often present. In places, *Melaleuca cajuputi* (Cajuput Tree) is the most frequent canopy species.	0	0	0	**0**	122	0%	-	-	-	-	-
3.1.3	*Ceriops tagal* ± *Avicennia marina* low closed forest. Extensive on intertidal areas.	0	0	0	**0**	472	0%	-	-	-	-	-
3.3.5	Evergreen notophyll vine forest. Occurs on alluvia on major watercourses	0	7.9	0.3	**8.2**	29	28.8%	22,498	<0.1%	54,065	<0.1%	>99.9%
3.3.14a	*Melaleuca saligna* ± *M. viridiflora, Lophostemon suaveolens* woodland on drainage swamps.	0	0	0	**0**	434	0%	-	-	-	-	-
TOTAL					**8.2**							

RE	Description	Approx. area to be disturbed (ha)				Total mapped area in Project area (ha)	Proportion to be disturbed in Project area	Area in Weipa Plateau subregion# (ha)	Proportion of area in subregion to be disturbed#	Area in Cape York Bioregion# (ha)	Proportion of area in bioregion to be disturbed #	Projected remnant extent in bioregion as proportion of current extent#
		Mining area	Dam C	Infra-structure	Total							
Beach Nightshade *(Solanum dunalianum)**												
3.2.2	Semi-deciduous vine thicket to vine forest on beach dunes and ridges	0	0	0	**0**	380	0%	-	-	-	-	-
TOTAL					**0***							
Spathoglottis plicata												
3.2.3	Melaleuca dealbata +/- Acacia crassica open forest in dune swales on the west coast	0	0	0	**0**	227.7	0%	-	-	-	-	-
3.3.5	Evergreen notophyll vine forest. Occurs on alluvia on major watercourses	0	7.9	0.3	**8.2**	29	28.8%	22,498	<0.1%	54,065	<0.1%	>99.9%
3.3.9	*Lophostemon suaveolens* open forest. Occurs on streamlines, swamps and alluvial terraces	0	52.6	3.6	**56.2**	2,164	3.4%	24,750	0.2%	47,167	0.1%	99.9%
3.3.14a	*Melaleuca saligna* ± *M. viridiflora, Lophostemon suaveolens* woodland on drainage swamps.	0	0	0	**0**	434	0%	-	-	-	-	-
3.3.21	*Corymbia clarksoniana* ± *Syzygium eucalyptoides* woodland. Lower slopes of sand ridges and in drainage depressions	0	115.3	5	**120.3**	1,596	7.5%	11,629	1.0%	38,214	0.3%	99.7%
TOTAL					**184.7**							

All RE spatial data based on analysis of V6 RE data and adjusted with ground-surveyed mapping by RTA within and adjacent to the Project area.

* If present, Beach Nightshade may also occur in the margins of this RE3.5.2. This area has not been calculated, however the proposed vegetation buffer system would minimize impact to these areas.

Cooktown Orchid potentially occurs in vine forest on bauxite. Vine forest areas on bauxite may be susceptible to effects related to changes in groundwater hydrology following mining; however, any effects would be minimised by the proposed environmental buffer system which would prevent mining in close proximity to vine forest areas. Observations over a number of years of similar vine forest areas within other mining areas near Weipa suggest deleterious effects on vine forest communities have not occurred where appropriate environmental buffers have been implemented. It is anticipated there would not be any adverse impacts on threatened flora occurring within vine forest patches from Project-related disturbance.

Cooktown Orchid also occurs in mangrove areas predominantly along the landward edge of mangrove forest. These mangrove areas would not be directly affected by clearing and are not anticipated to experience any indirect effects via changes to hydrology.

4.2 Mitigation Measures – Threatened Flora

The disturbance of sensitive non-*Eucalyptus tetrodonta* vegetation by mining would be avoided by the development of an environmental buffer system and the exclusion of mining from within the designated buffers and the non-*Eucalyptus tetrodonta* communities themselves. The environmental buffer system would also assist in minimising impacts to the hydrological regime of these areas adjacent to mining operations. The vegetation to be buffered by Darwin Stringybark (*Eucalyptus tetrodonta*) woodland would comprise riparian, wetland, estuarine, vine forest and coastal vegetation on sand. Prior to clearing, surveys would be carried out to define the boundaries of mapped sensitive vegetation types in the field and assess the presence or absence of significant ecological features such as threatened flora and fauna in and around the sensitive vegetation types. Buffer distances would then be set based on the findings of the surveys and managed to ensure that disturbance does not inadvertently occur within the buffer zones (refer Section 7.9.2 of the EIS).

A fire management program would be developed in cooperation with the Traditional Owners to address aspects of the current fire regime within the Project area that are detrimental to fire sensitive flora and vegetation communities. The aim of the program would be to minimise impacts on targeted fire sensitive flora and vegetation communities. This program and other mitigation measures associated with potential indirect impacts on vegetation are discussed further in Section 7.10.2 of the EIS. All the threatened flora species occurring in riparian and wetland situations and vine forest habitats would be favoured by the proposed fire management program, which would promote a fire regime more favourable for fire-sensitive species.

The implementation of the Project would provide an opportunity to implement a feral pig control program in targeted locations within the Project area in consultation with Traditional Owners (refer Section 16.3.2 of the EIS). This program would lead to improved conditions of wetland and riparian habitats. The riparian gallery forest of freshwater streams and adjoining colluvial areas are currently heavily disturbed by feral pigs throughout the year, causing extensive damage to native vegetation within these habitats. The proposed targeted feral animal management program would reduce damage to vegetation in these areas and to any of the threatened flora species that may be present. The proposed targeted feral animal management program is described further in Section 7.10.2 of the EIS.

4.3 Potential Impacts on Threatened Terrestrial Fauna

Individual significant impact assessments are provided in **Table 15** to **Table 18** for each of the EPBC Act listed threatened fauna species that were assessed as possible or confirmed inhabitants of the Project area. Potential impacts and proposed mitigation strategies for these threatened fauna species are presented below and more detailed information is presented in Sections 7.17 and 7.18 of the EIS.

A summary of potential RE habitats for each threatened terrestrial fauna species and estimated disturbance to each RE from Project activities is presented in **Table 19**.

4.3.1 Red Goshawk (*Erythrotriorchis radiates)*

The Red Goshawk was not recorded in the Project area during numerous general and targeted surveys, but ample suitable habitat exists for the species. The Red Goshawk is anticipated to utilise

Darwin Stringybark open forest as part of its extensive home range. If present, it is likely the species would establish a home range centred on a riparian, wetland or coastal locality but include extensive areas of Darwin Stringybark open forest. It is unlikely that progressive removal of Darwin Stringybark open forest for mining would significantly adversely affect any potentially occurring populations with respect to the availability of foraging areas as it is a highly mobile species that could access other habitat areas. Re-colonisation of prey fauna within rehabilitated mine areas would reinstate potential foraging habitat in these areas, although the productivity in these areas is unlikely to be as high as for undisturbed habitat.

The species has a preference for nesting in tall trees within 1km of permanent water (Aumann and Baker-Gabb 1991, DEWHA 2009c, NPWS 2002), which suggests Darwin Stringybark woodlands within 1km of permanent water could be used for nesting. Consequently, it is possible that nests of the species could be within proposed mining areas. Red Goshawk breeding pairs can use the same nest site in successive years (EPA 2006), therefore, clearing of an unoccupied nest could lead to reproductive disruption in subsequent breeding seasons (Mr. Greg Czechura pers. comm.) as the adult birds would have to select a site for and build another nest. More significantly, if a nest with eggs or chicks was disturbed during clearing, mortality of those individuals would occur plus potential disruption to the adults' subsequent breeding season.

Re-nesting by Red Goshawk after nests have failed or been cleared, or nesting in different areas seasonally to be closer to target prey is known to occur (refer Section 7.15.4 of the EIS). Aumann and Baker-Gabb (1991) reported that nests were placed at the top of trees in exposed areas, in dead trees, and in dead sections of living trees. Given these nesting habits and the frequency of cyclones in northern Australia, it is likely there would be some natural loss of nests or nest trees due to cyclones within the Project area, and intentional removal of nests would be analogous to natural nest attrition.

With respect to the likelihood of a nest of the species intersecting with mining area, consideration of the proposed mine plan for the Project indicates that for the large majority of the mid to lower reaches of the main drainage systems (Winda Winda Creek, Norman Creek and Ward River) the mining area is located more than 1km from permanent water or seasonally inundated wetlands or watercourses supporting riparian gallery forest.

This is also the case for the northern part of the Project area where the proposed mining area is almost exclusively located greater than 1km from permanent water or seasonally inundated wetlands or watercourses supporting riparian gallery forest. Consequently the probability of a nest intersecting with proposed mining areas is low. However, additional mitigation measures to avoid nest disturbance are proposed in **Section 5.4**.

As the regional population size of this species is relatively small, if the Red Goshawk was to occur within the disturbance footprint of the Project area, it would be regarded as an important population. The relevant impact on the Red Goshawk within the Project area is the reduction of potential foraging habitat through clearing of Darwin Stringybark open forest for mining. However, considering sufficient foraging habitat would remain undisturbed to support the species, it is considered unlikely that the action would significantly impact the species.

Table 15 Significant Impact Assessment – Red Goshawk (*Erythrotriorchis radiatus*)

Will the proposed works...	**Red Goshawk (*Erythrotriorchis radiatus*) - Vulnerable**
....lead to a long-term decrease in the size of an important population?	The Red Goshawk occurs in coastal and sub coastal habitats from northern NSW to the Kimberley, although it has declined significantly in the southern part of its range. The species was not recorded in the Project area during general and targeted surveys. As the regional population size of this species is relatively small, if the Red Goshawk was to occur within the disturbance footprint of the Project area, it would be regarded as an important population. However, if the species is present within the Project area, sufficient foraging habitat would remain undisturbed to support the species. The proposed mitigation measures would avoid disturbance of active nests. A long term decrease in any population of the species is unlikely to occur as a result of the Project.
....reduce the area of occupancy of an important population?	The key habitats for the species would be largely unaffected by the Project and sufficient foraging habitat would remain undisturbed to support the species. The area of occupancy of any population of the species if present would not be reduced.

Will the proposed works...	**Red Goshawk (*Erythrotriorchis radiatus*) - Vulnerable**
....fragment an existing important population into two or more populations?	The majority of key habitats for the species would not be affected and sufficient foraging habitat would remain undisturbed to support the species. Given the high mobility of the species, any population present would not be fragmented.
....adversely affect habitat critical to the survival of a species?	The Project area does not include any critical habitat areas for the Red Goshawk that are listed under the EPBC Act or identified in Recovery Plans, nor is the Project area regarded as critical habitat for the species given it's similarity to other potential habitat areas on northern Cape York Peninsula.
....disrupt the breeding cycle of an important population?	Proposed mitigation measures would avoid disturbance of active nests and consequently the breeding cycle of the species would not be disrupted.
....modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?	The key habitats for the species would be largely unaffected by the Project and sufficient foraging habitat would remain undisturbed to support the species. Consequently, the species is unlikely to decline as a result of the Project.
....result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?	The Project is unlikely to lead to the introduction of any invasive fauna that could affect the species. Proposed control measures for weeds would avoid the spread of invasive weeds within the habitat of the Red Goshawk.
.....introduce disease that may cause the species to decline?	Disease is not known as a threat to this species. It is not anticipated that the Project would represent a threat with respect to the introduction of disease.
....interfere substantially with the recovery of the species?	The Project is not expected to interfere with the recovery of the Red Goshawk.

4.3.2 Masked Owl (*Tyto Novaehollandiae*)

The Masked Owl was not recorded within the Project area. A population of Masked Owl, if present in the Project area, could be regarded as an important population as the species is now rare on Cape York Peninsula with limited recent records.

The relevant impact of the Project on the Masked Owl within the Project area would be the disturbance of suitable habitat from construction of the proposed water supply dam. However, the Masked Owl habitat areas within the proposed dam footprint are not regarded as especially significant for foraging or breeding. Given that the habitat loss would comprise a minor proportion (less than 10%) of the overall extent of this habitat within the Project area, and that this species would also utilise other undisturbed habitat types, the overall impact of the loss of habitat within the dam footprint is unlikely to be significant for this species. Therefore, it is considered unlikely that the Project would significantly impact the species.

Table 16 Significant Impact Assessment – Masked Owl (*Tyto Novaehollandiae*)

Will the proposed works...	**Masked Owl (*Tyto Novaehollandiae*)** - Vulnerable
....lead to a long-term decrease in the size of an important population of a species?	The northern race of the Masked Owl occurs between Townsville and the Kimberley region with other races extending down the east coast to Tasmania. The Masked Owl has been recorded in the Weipa area although the habitat within which it was recorded is unclear. The species was not recorded during surveys within the Project area. A population of Masked Owl, if present in the Project area could be regarded as an important population as the species is now rare on Cape York Peninsula with limited recent records. It is not expected that the Project would lead to a long term decrease in the population as the key potential habitats for the species would be largely unaffected by the Project.

Will the proposed works...	**Masked Owl (*Tyto Novaehollandiae*)** - Vulnerable
....reduce the area of occupancy of an important population?	The key potential habitats for the species would be largely unaffected by the Project and therefore the area of occupancy of the species (if present) is unlikely to be reduced.
....fragment an existing important population into two or more populations?	Key habitats for the species would not be significantly affected by the Project and given the high mobility of the species, any population present would not be fragmented.
....adversely affect habitat critical to the survival of a species?	The Project area does not include any critical habitat areas for the Masked Owl that are listed under the EPBC Act or identified in Recovery Plans. If the species is present, the area could be regarded as including critical habitat given the recent decline of the species within Queensland; however, key habitats for the species would not be significantly affected by the Project and habitat critical to the survival of the species is unlikely to be adversely affected.
....disrupt the breeding cycle of an important population?	Key habitats for the species would not be significantly affected by the Project and disruption to the breeding cycle of any population present is unlikely.
....modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?	Key habitats for the species would be largely unaffected by the Project and consequently the species, if present, is unlikely to decline as a result of the Project.
....result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?	The Project is unlikely to lead to the introduction of any invasive fauna that could affect the species. Proposed control measures for weeds would avoid the spread of invasive weeds within the habitat of the Masked Owl.
.....introduce disease that may cause the species to decline?	Disease is not known as a threat to this species. It is not anticipated that the Project would represent a threat with respect to the introduction of disease.
....interfere substantially with the recovery of the species?	The Project is not expected to interfere with the recovery of the Masked Owl.

4.3.3 Northern Quoll (*Dasyurus hallucatus*)

The Northern Quoll was not recorded within the Project area during targeted surveys. As the regional population size of this species is thought to be relatively small, if the Northern Quoll was to occur within the disturbance footprint of the Project area, it would be regarded as an important population. The relevant potential impact of the Project on the Northern Quoll within the Project area, were it to occur, would be the disturbance of suitable habitat from construction of the proposed water supply dam. However, the Northern Quoll habitat areas within the proposed dam footprint are not regarded as especially significant for foraging or breeding. Given that the habitat loss would comprise a minor proportion (less than 10%) of the overall extent of this habitat within the Project area, and that this species would also utilise other undisturbed habitat types, the overall impact of the loss of habitat within the proposed dam footprint is unlikely to be significant for this species. It is unlikely that progressive removal of Darwin Stringybark open forest for mining would significantly adversely affect access between non-Darwin Stringybark habitats, should this species occur. It is considered unlikely that the Project would significantly impact the species.

Table 17 Significant Impact Assessment – Northern Quoll (*Dasyurus hallucatus*)

Will the proposed works...	**Northern Quoll (*Dasyurus hallucatus*)** - Endangered
....lead to a long-term decrease in the size of a population?	The Northern Quoll is distributed from south east Queensland across northern Australia to the Pilbara but has declined in many parts of this range. The Northern Quoll historically occurred in Darwin Stringybark open forest and associated habitats within the Weipa area prior to the arrival of the Cane Toad in the 1980's. Although numerous records exist for Northern Quoll in the region surrounding Weipa, the majority of these are historical, and no other confirmed sightings are available for the area around Weipa after 1990. The species has not been recorded within the Project area. If the species is present within the Project area sufficient foraging habitat would remain undisturbed to support the species. A long term decrease in any population of the species present is unlikely to occur as a result of the Project.
....reduce the area of occupancy of the species?	Although a substantial area of Darwin Stringybark open forest would be disturbed by the Project the majority of this habitat would remain undisturbed and other habitats utilised by the species would be largely unaffected. Sufficient habitat would remain to support the species, if it was to occur within the Project area, and the area of occupancy of any population of the species present would not be reduced.
....fragment an existing population into two or more populations?	The main riparian habitat corridors and cross catchment habitat connections would be retained within the Project area, and given the high mobility of the species, any population present would not be fragmented.
....adversely affect habitat critical to the survival of a species?	The Project area does not include any critical habitat areas for the Northern Quoll that are listed under the EPBC Act or identified in Recovery Plans, nor is the Project area regarded as critical habitat for the species given it's similarity to other potential habitat areas on northern Cape York Peninsula.
....disrupt the breeding cycle of a population?	The breeding cycle of the species (if present) would not be disrupted.
....modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?	Although a substantial area of Darwin Stringybark open forest would be disturbed by the Project the majority of this habitat would remain undisturbed and other habitats utilised by the species would be largely unaffected; consequently, the species is unlikely to decline as a result of the Project if it was to occur within the Project area.
....result in invasive species that are harmful to an endangered species becoming established in the endangered species' habitat?	The Project is unlikely to lead to the introduction of any invasive fauna that could affect the species. Proposed control measures for weeds would avoid the spread of invasive weeds within the habitat of the Northern Quoll.
.....introduce disease that may cause the species to decline?	Disease is not known as a threat to this species. It is not anticipated that the Project would represent a threat with respect to the introduction of disease.
....interfere with the recovery of the species?	The Project is not expected to interfere with the recovery of the Northern Quoll.

4.3.4 Bare-rumped Sheathtail Bat (*Saccolaimus saccolaimus nudicluniatus*)

The Bare-rumped Sheathtail Bat was not recorded during surveys within the Project area. Habitat for this species is poorly known and the habitats within the Project area that may be favoured by the species are uncertain. Records from elsewhere on Cape York Peninsula indicate that riparian gallery forest, vine forest and adjacent woodland, including Darwin Stringybark woodland, may be favoured. Much of this habitat suite would fall within proposed environmental buffer areas in the Project area; however, the species could also utilise Darwin Stringybark woodland within proposed disturbance areas.

If the species is present within the Project area it is highly likely that it would also be present in the extensive areas of similar bauxite plateau ecosystem that dominate the western half of northern Cape York Peninsula.

The relevant impacts of the Project on the Bare-rumped Sheathtail Bat within the Project area would be the disturbance of suitable breeding habitat from construction of the proposed water supply dam, and reduction of potential foraging habitat through clearing of Darwin Stringybark open forest for

mining. However, the proposed mitigation measures would avoid disturbance of breeding activity and avoid impacts on individuals that may be present within the Dam C footprint, and the majority of habitat where the species is most likely to occur within the Project area would be protected within environmental buffers. Although a substantial area of Darwin Stringybark open forest would be disturbed by the Project, the majority of this habitat within the Project area would remain undisturbed. Therefore it is unlikely that a significant impact on the species would occur as a result of the Project.

Table 18 Significant Impact Assessment – Bare-rumped Sheathtail Bat (*Saccolaimus saccolaimus nudicluniatus*)

Will the proposed works ...	**Bare-rumped Sheathtail Bat (*Saccolaimus saccolaimus nudicluniatus*): Critically Endangered**
....lead to a long-term decrease in the size of a population?	The current occurrence of this species within the Project area and disturbance areas is not known. Based on the nearest records of the species from Cape York Peninsula it is likely that the species would focus habitat utilisation on riparian or vine forest areas and adjacent woodland including Darwin Stringybark. These habitat mosaics would be largely protected within the environmental buffer system and not subject to disturbance, apart from at the proposed Dam C. Proposed mitigation measures would avoid impacts on breeding activity and impacts on individuals in this area, and would allow individuals to relocate to adjoining similar habitat. If the species is present within the Project area, targeted mitigation measures would avoid impacts on individuals, and the environmental buffer system would protect the majority of the habitat mosaic where the species is most likely to occur, and a long-term decrease in any population of the species present is unlikely to occur.
....reduce the area of occupancy of the species?	The key habitats for the species would be largely unaffected by the Project and the area of occupancy of any population of the species, if present, would not be reduced.
....fragment an existing population into two or more populations?	Key habitats for the species would not be significantly affected by the Project and, given the high mobility of the species, any population present would not be fragmented.
....adversely affect habitat critical to the survival of a species?	The Project area does not include any critical habitat areas for the Bare-rumped Sheathtail Bat that are listed under the EPBC Act or identified in Recovery Plans, nor is the Project area regarded as critical habitat for the species given its similarity to other potential habitat areas on northern Cape York Peninsula.
....disrupt the breeding cycle of a population?	Mitigation measures would ensure that breeding activity is not affected within the habitat areas where the species is most likely to occur and disruption to the breeding cycle of any population present is unlikely.
....modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?	Although a substantial area of Darwin Stringybark open forest would be disturbed by the Project the majority of this habitat within the Project area would remain undisturbed and other habitats more likely to be utilised by the species would be largely unaffected; consequently, the species is unlikely to decline as a result of the Project.
....result in invasive species that are harmful to an endangered species becoming established in the endangered species' habitat?	The Project is unlikely to lead to the introduction of any invasive fauna that could affect the species. Proposed control measures for weeds would effectively avoid the spread of invasive weeds within the habitat of the Bare-rumped Sheathtail Bat.
.....introduce disease that may cause the species to decline?	Disease is not known as a threat to this species. It is not anticipated that the Project would represent a threat with respect to the introduction of disease.
....interfere with the recovery of the species?	The Project is not expected to interfere with the recovery of the Bare-rumped Sheathtail Bat.

4.3.5 Summary of Threatened Terrestrial Fauna Habitat Impacts

Table 19 summarises the areas of REs that provide both potential foraging and potential breeding habitat, for each threatened terrestrial fauna species to be directly disturbed by the Project, based on interaction with the 40-year mine plan, proposed Dam C, and the location of Project infrastructure. For each potential habitat RE that would be disturbed, **Table 19** also indicates the areas of RE to be removed relative to the overall Project area, the Weipa Plateau subregion, and the wider Cape York Bioregion.

Indirect Impacts

The potential effect on vegetation communities and habitat of hydrological change resulting from mining, operation of the water supply dam on Norman Creek, and water extraction from the Ward River is regarded as being minor (refer to Section 7.10.1 of the EIS), apart from localised effects (particularly immediately downstream of the dam). The environmental buffer system as described in Section 7.9.2 of the EIS would ensure hydrological changes would not significantly alter the overall availability or utilisation of habitats by threatened fauna. Consequently, significant impacts on threatened fauna are unlikely to occur.

4.4 Mitigation Measures – Threatened Fauna

The Red Goshawk, Masked Owl and Northern Quoll were not confirmed within the Project area, however, if these species do occur within the Project are, they may utilise some areas that would be disturbed by mining operations. All of these species could potentially utilise habitats along creeks within the Project area, including the creek where the proposed water supply dam would be built.

Impacts of habitat removal associated with the Project on the overall habitat landscape for threatened fauna and in particular their movement patterns would be mitigated by retention of the coastal margin vegetation buffer and remnant vegetation not disturbed by the mine plan. This network of retained habitat would to a large extent maintain habitat functionality and the pre-disturbance fauna movement regime.

The Red Goshawk was not recorded within the Project area although the open forests of the Project area and adjacent habitats constitute likely habitat for this species. Targeted surveys for Red Goshawk nests would be undertaken within the footprint of the water supply dam up to 1km from riparian gallery forest, and in sections of the mining plan located within 1km of permanent water supporting riparian gallery forest, paperbark wetland, seasonally inundated paperbark wetlands, seasonal watercourses supporting riparian gallery forest, or within 1km of an estuary. Surveys would be completed as soon as practicable prior to vegetation clearing. If any active Red Goshawk nests are found within proposed disturbance areas, a 200m buffer around the nesting tree would be established and the nest monitored until completion of the breeding season, after which vegetation clearing activities would resume.

If a nest is found in an area to be cleared it is considered likely that a breeding pair would find another location for nesting in the subsequent breeding season (refer Section 7.15.4 of the EIS). Aumann and Baker-Gabb (1991) made several management recommendations to manage threats to the Red Goshawk. One recommendation was that when egg collection from a nest is strongly suspected, in an area where nest sites are not limiting, that the branch supporting the nest be removed during the non-breeding period to encourage the pair to re-nest at a new location. The proposed mitigation strategy for this Project to clear nest trees at the end of the breeding season and encourage the birds to re-nest in another location is consistent with this recommendation.

The Bare-rumped Sheathtail Bat was not recorded within the Project area although the Dam C footprint supports a habitat mosaic similar to that where the species has previously been recorded on Cape York; i.e. riparian gallery forest and alluvial/colluvial woodland with adjacent Darwin Stringybark woodland. The species is reported to breed during the wet season with a colony containing juveniles reported as late as April in the Northern Territory (Schulz & Thompson 2007). Targeted pre-clearing surveys would be undertaken to determine the presence of the species within the Dam C disturbance area, and if present, disturbance of habitat trees would be avoided until after the breeding season (i.e. clearing to commence no earlier than May and be completed by end of November). If the species

Table 19 Habitat Disturbance for Threatened Terrestrial Fauna Species

RE	Description	Approx. area to be disturbed (ha)				Total mapped area in Project area (ha)	Proportion to be disturbed in Project area	Area in Weipa Plateau subregion# (ha)	Proportion of area in subregion to be disturbed#	Area in Cape York Bioregion# (ha)	Proportion of area in bioregion to be disturbed#	Projected remnant extent in bioregion as proportion of current extent#
		Mining area	Dam C	Infra-structure	Total							
Masked Owl *(Tyto novaehollandiae kimberli)*												
3.2.2	Semi-deciduous vine thicket to vine forest on beach dunes and ridges	0	0	0	**0**	380	0%	-	-	-	-	-
3.2.3	Melaleuca dealbata +/- Acacia crassica open forest in dune swales on the west coast	0	0	0	**0**	227.7	0%	-	-	-	-	-
3.3.5	Evergreen notophyll vine forest. Occurs on alluvia on major watercourses	0	7.9	0.3	**8.2**	29	28.8%	22,498	<0.1%	54,065	<0.1%	>99.9%
3.3.9	*Lophostemon suaveolens* open forest. Occurs on streamlines, swamps and alluvial terraces	0	52.6	3.6	**56.2**	2,164	3.4%	24,750	0.2%	47,167	0.1%	99.9%
3.3.14a	*Melaleuca saligna* ± *M. viridiflora, Lophostemon suaveolens* woodland on drainage swamps.	0	0	0	**0**	434	0%	-	-	-	-	-
3.5.4	Semi-deciduous notophyll vine forest. Occurs as small patches on northern plateaus.	0	0	0	**0**	56	0%	-	-	-	-	-
				TOTAL	**64.4**							
Northern Quoll (*Dasyurus hallucatus)**												
3.2.2	Semi-deciduous vine thicket on coastal dunes and beach ridges	0	0	0	**0**	380	0%	-	-	-	-	-
3.3.9	*Lophostemon suaveolens* open forest. Occurs on streamlines, swamps and alluvial terraces.	0	52.6	3.6	**56.2**	2,164	3.4%	24,750	0.2%	47,167	0.1%	99.9%
3.3.14a	*Melaleuca saligna* ± *M. viridiflora, Lophostemon*	0	0	0	**0**	434	0%	-	-	-	-	-

	suaveolens woodland on drainage swamps.											
3.3.21	*Corymbia clarksoniana* ± *Syzygium eucalyptoides* woodland. Lower slopes of sand ridges and in drainage depressions.	0	115.3	5	**120.3**	1,596	7.5%	11,629	1.0%	38,214	0.3%	99.7%
3.5.4	Semi-deciduous notophyll vine forest in small patches on northern plateaus	0	0	0	**0**	56	0%	-	-	-	-	-
3.5.22c	*Corymbia clarksoniana* + *Erythrophleum chlorostachys* + *Corymbia* spp. + *Eucalyptus* spp. woodland on plains.	57.4	85.9	11.7	**155**	3,120	5.0%	166,592	0.1%	291,098	<0.1%	>99.9%
				TOTAL	**331.5 ***							
Bare-rumped Sheathtail Bat *Saccolaimus saccolaimus nudicluniatus*												
3.2.10c	*Eucalyptus tetrodonta, Corymbia clarksoniana* ± *E. brassiana* woodland on stabilised dunes.	0	0	0	**0**	537	0%	-	-	-	-	-
3.3.5	Evergreen notophyll vine forest. Occurs on alluvia on major watercourses	0	7.9	0.3	**8.2**	29	28.8%	22,498	<0.1%	54,065	<0.1%	>99.9%
3.3.9	*Lophostemon suaveolens* open forest. Occurs on streamlines, swamps and alluvial terraces	0	52.6	3.6	**56.2**	2,164	3.4%	24,750	0.2%	47,167	0.1%	99.9%
3.3.21	*Corymbia clarksoniana* ± *Syzygium eucalyptoides* woodland. Lower slopes of sand ridges and in drainage depressions.	0	115.3	5	**120.3**	1,596	7.5%	11,629	1.0%	38,214	0.3%	99.7%
3.3.49b	*Melaleuca viridiflora* low open woodland on low plains	0	0	0.5	**0.5**	315	0.2%	120,899	<0.1%	722,201	<0.1%	>99.9%
3.3.61	*Panicum spp., Fimbristylis spp.* tussock grassland on coastal alluvial plains.	0	0	0	**0**	7	0%	-	-	-	-	-
3.5.2	*Eucalyptus tetrodonta, Corymbia nesophila* tall woodland on deeply weathered plateaus and	0	0	0	**0**	87,465	33.1%	668,673	4.3%	791,008	3.7%	96.3%

	remnants.											
3.5.4	Semi-deciduous notophyll vine forest. Occurs as small patches on northern plateaus.	0	0	0	**0**	56	0%	-	-	-	-	-
3.5.11	*Eucalyptus tetrodonta, Corymbia nesophila* woodland on lower slopes of plains and rises.	0	0	0	**28.2**	602	4.7%	101,356	<0.1%	179,280	<0.1%	>99.9%
3.5.22c	*Corymbia clarksoniana* + *Erythrophleum chlorostachys* + *Corymbia* spp. + *Eucalyptus* spp. woodland on plains.	57.4	85.9	11.7	**155**	3,120	5.0%	166,592	0.1%	291,098	<0.1%	>99.9%
3.7.3	*Eucalyptus cullenii* ± *E. tetrodonta* woodland on erosional escarpments and plains. Occurs on erosional escarpments and plains on the edge of the bauxite plateaus.	0	0	0	**0**	245	0%	-	-	-	-	-
				TOTAL	**64.4**							
Red Goshawk *(Erythrotriorchis radiates)*												
Nest trees are restricted to trees taller than 20m located within 1km of, and often beside, permanent water. The large majority of mining is located more than 1km from permanent water or seasonally inundated wetlands or watercourses supporting riparian gallery forest. The probability of a nest intersecting with proposed mining areas is low, however mitigation measures are proposed to minimise this potential impact. Small areas of riparian gallery forest and associated alluvial/colluvial woodland habitat that provide potential habitat would be disturbed within the footprint of the water supply dam, which represents less than 10% of this habitat type within the Project area. The species hunts in open forests and gallery forests, however sufficient foraging habitat would remain undisturbed to support the species.												

All RE spatial data based on analysis of V6 RE data and adjusted with ground-surveyed mapping by RTA within and adjacent to the Project area.

* Other habitat types (including RE3.5.2) would be used for access between the key habitat types.

is present, all potential roost trees would also be identified within the Dam C disturbance area and pushed over in a manner that would allow any individuals present to leave the roosts unharmed.

In addition, the proposed fire and feral animal management programs described in Section 7.10.2 of the EIS will deliver positive benefits for threatened fauna in undisturbed areas.

4.5 Potential Impacts on Threatened Estuarine and Marine Fauna

The potential impacts and proposed mitigation strategies pertaining to estuarine and marine species known to occur (four species) and likely to occur (six species) within the Project area are discussed below.

4.5.1 Potential Impacts on Marine Turtles

The following aspects of the Project may affect marine turtles:

- altered above-water, night-time light regime;
- boat strike;
- disturbance from boating and shipping activities including alienation from habitat;
- direct impact from suction dredging activities;
- loss of foraging habitat from dredging activities;
- creation of a turbidity plume from dredging activities, and subsequent deposition and re-suspension of fine sediments on feeding habitats;
- the introduction of hard substrate (e.g. piles); and
- acoustic impacts from pile driving activities on turtles.

These potential impacts are discussed below. Individual significant impact assessments for the six turtle species known or likely to occur are provided in **Table 20** to **Table 25**.

Table 35 summarises the potential habitats within the Project area for each threatened and migratory estuarine and marine fauna species, including marine turtles, and **Table 36** summarises the amount of each habitat type to be impacted by Project activities.

Altered Above-Water Night-Time Light Regime

An altered above-water night-time light regime associated with the proposed port is anticipated to cause the largest potential impact as it can affect nesting adult female turtles and hatchlings. Marine turtle species that utilise beaches in the vicinity of the proposed port for nesting may potentially be affected by the construction and operation of the port and associated infrastructure. Lights at a nesting beach can result in turtle hatchlings heading inland rather than into the ocean, with subsequent mortality. A modified lighting regime may elicit an impact, with illumination of salt spray adjacent to a nesting beach being sufficient to alter sea finding behaviour (Dr Colin Limpus pers. comm.). Offshore lighting may result in hatchlings aggregating under the light and becoming a focus for predatory fish. Australian examples exist where the impacts of artificial lighting on turtles have been mitigated in part. At Thevnard Island (North West Shelf) light impacts were mitigated from offshore petroleum production by minor shielding, re-positioning, and in some cases, time-switching of the lights. It is difficult however, to mitigate the impacts of a changed lighting regime in its entirety.

Boat Strike Boating and Shipping Disturbance and Habitat Alienation

There is the possibility of impacts on marine turtles from both boat strike from fast moving vessels and alienation from habitat by boating activity. These impacts are relevant primarily at the proposed port site. The barge/ferry terminals are not in areas that have habitat likely to be frequently utilised by marine turtles. Therefore the operation of the ferry is predicted to pose a low risk.

Review of the Queensland Marine Wildlife Stranding and Mortality Database annual reports from 1999-2004 (most recent), does not indicate that there are any significant number of dead turtles with boat strike markings from the Weipa or Western Cape York region. Most incidences are from Moreton Bay and Townsville. This situation is unlikely to change as a result of Project construction or operation.

Unlike the Dugong, there is no available information to demonstrate that boating activity alienates marine turtles from their habitat although this cannot be discounted. Marine turtles are known to co-exist in areas with very high levels of boating activity (e.g. southern bay islands of Moreton Bay).

Direct Impact from Dredging Activities

The use of self propelled TSHD has the potential to entrain marine turtles during dredging activities. Entrainment by CSDs is less likely due to the slow rate of progress of dredging. Bucket type dredges, such as those that would potentially be used for Embley and Hey River dredging activities, do not pose an entrainment hazard to turtles.

Loss of Foraging Habitat from Dredging Activities

Seagrass provides foraging habitat for some marine turtle species. The absence of seagrass at the proposed port site and proposed new spoil ground ensure that port dredging would not reduce marine turtle seagrass foraging habitat.

The Hornibrook Terminal and Hey River Terminal dredge footprints do not contain seagrass, however, it may occur in the wider vicinity as isolated patches. Isolated patches of seagrass have been identified within or immediately adjacent to the proposed dredge footprint at the Humbug barge terminal. The area of seagrass within the Humbug barge terminal dredge footprint is conservatively estimated to be 1250m^2 which represents about 0.003% of the seagrass meadows within the Weipa region which is not significant in terms of a marine turtle foraging resource.

Turbid Plume Generation and Sediment Deposition/Resuspension on Feeding Habitat

The creation of a turbidity plume from dredging activities, and subsequent deposition and re-suspension of fine sediments can potentially impact foraging habitat of marine turtles. The diverse reef assemblages provide a food source for marine turtles, particularly Hawksbill Turtles which prefer sponges, seagrass and algae. Approximately 71ha of sponge/soft coral habitat occurs between Boyd Point and Pera Head (inclusive). It is predicted that deposition would be at its greatest between these two locations and may locally affect feeding preferences for marine turtles. It is estimated that 117ha of similar habitat which would not be affected by the turbidity plume associated with dredging activities occurs between Pera Head and Thud Point, with more likely to occur at inshore reef areas south of Thud Point and north of Boyd Point, so regional impacts to feeding habitats are not predicted.

At the barge/ferry terminals in the Embley and Hey Rivers, minor capital dredging is proposed. The area of seagrass to be disturbed is not significant in terms of a marine turtle foraging resource. Given the minor scale and short duration of dredging at each of the barge/ferry terminals it is unlikely marine turtle foraging areas would be significantly affected by turbidity plumes from barge/ferry terminal dredging.

The overall risk to marine turtles from restriction of food availability as a result of the Project is low.

Introduction of Hard Substrate

The width of the jetty structure that crosses the beach would be 10.9m which is a very small proportion of the beach length (5.81km between Boyd Point and Pera Head). Once the jetty is constructed, turtles would still have access to the area under the jetty, except where the foundations for the two piles on the beach (81m^2 each) are located. Therefore the impact from the construction and operation of the jetty related to removal of habitat for nesting of turtles is considered minor. Bell (2003) also identifies that marine turtles co-exist with port infrastructure, with green and flatback turtles nesting within port limits of Lucinda and Abbot Point.

The introduction of hard surfaces such as jetty pilings would provide a long-term surface upon which a range of sessile flora and fauna may establish and present local feeding opportunities to turtle species, particularly those that prefer reef-type foraging habitats. Sessile organisms likely to establish include solitary and colonial ascidians, sponges, soft corals and macroalgae, which present possible food sources for Hawksbill and Flatback Turtles.

Establishment of sessile organisms on the artificial surfaces is likely to take several years and experience successional development of different assemblages over time, beginning with a few pioneering species before increasing in complexity. While this may provide local benefits in the long-term it would not compensate for localised reduction in food resources over the reef areas in the short

to medium term during port development capital dredging.

Acoustic Impacts from Pile Driving Activities on Turtles

There is limited data on the potential underwater noise impacts to marine turtles from pile driving activities, however SVT (2009) conducted underwater noise modelling and assessment for pile driving activities proposed for the Cape Lambert Port B Development in Western Australia. The following conclusions were made regarding marine turtles:

- physical injury would be likely to occur at peak pressure levels greater than 222dB re 1µPa at a sound exposure level (SEL) of 198dB re 1µPa2s;
- hearing damage may occur at peak pressure levels greater than 222dB re 1µPa;
- avoidance behaviour was estimated to occur at peak pressure levels greater than 120dB re 1µPa based on the auditory bandwidth of turtles; and
- there is no supporting literature to establish acceptable levels of continuous noise to prevent threshold shift in marine turtles.

More information on the potential underwater acoustic impacts on threatened marine fauna is provided in Section 10.2.5 of the EIS. Refer to Section 4.5.2 for underwater noise mitigation measures for marine turtles associated with pile driving activities.

Hawksbill Turtle (*Eretmochelys imbricate*)

The Hawksbill Turtle (*Eretmochelys imbricata*) is known to nest on the beaches in the vicinity of the Project area and feed in the surrounding waters. Reef habitat is likely to provide significant local foraging habitat. The overall risk to the Hawksbill Turtle from restriction of food availability due to dredging activities is low. Boating and shipping activities are also predicted to pose a low risk to the Hawksbill Turtle. The use of turtle exclusion devices on self propelled trailing suction hopper dredges is now standard equipment on such dredgers and minimises the potential to entrain marine turtles during dredging activities.

The relevant impact of the Project on the Hawksbill Turtle is hatchling disorientation due to the construction and operation of the port and associated infrastructure. An altered above-water night time light regime is anticipated to cause an impact as it can affect adult female turtles and hatchlings. A lighting plan would be implemented to minimise long-term adverse impacts from hatchling disorientation. A feral pig control program would be implemented between Pera Head and Boyd Point to reduce nest predation and enhance turtle population survivorship. It is considered that this measure would be capable of producing an overall increase in hatchling numbers. The Project-related impacts on the Hawksbill Turtle are not expected to be significant and the Project is not expected to interfere with the recovery of this species.

Table 20 Significant Impact Assessment – Hawksbill Turtle (*Eretmochelys imbricate)*

Will the proposed works...	**Hawksbill Turtle (*Eretmochelys imbricate*) - Vulnerable**
.... lead to a long term decrease in the size of an important population of a species?	Hawksbill Turtles occurring in the vicinity of the Project area do not constitute a geographically distinct regional population or local population that occurs within a particular bioregion. The impacting processes are not of a sufficient scale or magnitude to lead to a long-term decrease in an important population of this species.
.... reduce the area of occupancy of an important population?	Globally, the Hawksbill Turtle is a widely distributed species. The Project development and operation would not reduce the area of occupancy of the Hawksbill Turtle in any ecologically meaningful way.
....fragment an existing important population into two or more populations?	The Project development and operation would not create any barriers to movement for Hawksbill Turtles.
....adversely affect habitat critical to the survival of a species?	The creation of a turbidity plume from dredging activities, and subsequent deposition and re-suspension of fine sediments could potentially impact on diverse reef assemblages which provide a food source for Hawksbill Turtles. While decreased light availability from turbid plumes may have an impact on hard corals, any reduction in their immediate availability over the reef area would be buffered by the diversity of other foods available to Hawksbill Turtles

Will the proposed works...	**Hawksbill Turtle (*Eretmochelys imbricate*) - Vulnerable**
	that are not as sensitive to light or suspended solids changes, such as sponges, seagrass and algae. The constructed jetty would provide a surface for potential food sources (e.g. algae and sponges) to grow in the long term.
....disrupt the breeding cycle of an important population?	Low density Hawksbill Turtle nesting occurs in the Project area but it does not represent a critical breeding area, so no significant disruption is likely. Implementation of a lighting plan designed to minimise above-water lighting disorientation to hatchlings would minimise potential disruption to local breeding success. Hatchling survivorship would be enhanced through reduction in feral pig numbers by the proposed feral pig control program in the vicinity of the proposed port development.
....modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?	While foraging habitat would be impacted as a result of a turbidity plume from proposed port dredging activities, and subsequent deposition and re-suspension of fine sediments, the impact is not of a sufficient scale to affect the survival of any marine turtle species.
....result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?	It is considered unlikely that an invasive species that is harmful to Hawksbill Turtles would be introduced due to the development or operation of the Project marine infrastructure. Population survivorship would be enhanced through ghost-net removal and feral pig control measures. Currently feral pigs are the primary factor reducing the success of sea turtle reproduction (hatchling emergence). RTA would work with Traditional Owners and DERM to develop and implement measures to reduce feral pig numbers in the Pera Head to Boyd Point area.
.....introduce disease that may cause the species to decline?	Disease is not known as a threat to this species. It is considered unlikely that a disease harmful to the Hawksbill Turtle would be introduced due to the development or operation of Project marine infrastructure.
....interfere with the recovery of the species?	There is a recovery plan in place for all marine turtle species found in Australia. Use of turtle deflectors on trailing suction hopper dredgers would minimise potential for entrainment of turtles during development and maintenance dredging of the port area. Implementation of a lighting plan would minimise the risks of local breeding impacts from hatchling disorientation. Recovery of turtle species would be enhanced through removal of ghost netting on beaches in the vicinity of the proposed port development and reduction of feral pig numbers. The Project is not expected to interfere with the recovery of the species.

Flatback Turtle (*Natator depressus*)

The Flatback Turtle (*Natator depressus*) is known to nest on the beaches in the vicinity of the Project area and feed in the surrounding waters. Foraging habitats for the species are shallow coastal environments including rocky reef and sedimentary habitats. The overall risk to the Flatback Turtle from restriction of food availability due to dredging activities is low. Boating and shipping activities are also predicted to pose a low risk to the Flatback Turtle. The use of turtle exclusion devices on self propelled trailing suction hopper dredges is now standard equipment on such dredgers and minimises the potential to entrain marine turtles during dredging activities.

The relevant impact of the Project on the Flatback Turtle within the Project area is hatchling disorientation due to the construction and operation of the port and associated infrastructure. The beaches of western Cape York represent an area of medium density nesting activity for the Flatback Turtle. An altered above-water night time light regime is anticipated to cause an impact as it can affect adult female turtles and hatchlings. A lighting plan would be implemented to minimise long-term adverse impacts from hatchling disorientation. A feral pig control program would be implemented between Pera Head and Boyd Point to reduce nest predation and enhance turtle population survivorship. It is considered that this measure is capable of producing an overall increase in hatchling numbers. The Project related impacts on the Flatback Turtle are not expected to be significant and the Project is not expected to interfere with the recovery of this species.

Table 21 Significant Impact Assessment – Flatback Turtle (*Natator depressus*)

Will the proposed works...	**Flatback Turtle (*Natator depressus*)**: Vulnerable
....lead to a long term decrease in the size of an important population of a species?	Flatback Turtles occurring in the vicinity of the Project area do not constitute a geographically distinct regional population or local population that occurs within a particular bioregion. The Project aspects with the greatest potential for long-term impact and decrease in local Flatback Turtle activity are dredging and onshore lighting. The use of turtle deflectors on trailing suction hopper dredgers and implementation of a lighting plan would minimise the risk of any long-term population decline.. Population survivorship would be enhanced through ghost-net removal and reducing feral pig numbers which currently cause major reductions in egg and hatchling survivorship. No significant long term impact to an important population is expected as a result of the Project.
.... reduce the area of occupancy of an important population?	The Project development and operation would not reduce the area of occupancy of the Flatback Turtle in any ecologically meaningful way.
....fragment an existing important population into two or more populations?	The Project development and operation would not create any barriers to movement for Flatback Turtles.
....adversely affect habitat critical to the survival of a species?	Some local feeding habitat would be impacted by the turbidity plume from proposed port dredging activities, and subsequent deposition and re-suspension of fine sediments. However suitable feeding habitats are found throughout coastal areas of the Gulf of Carpentaria.
....disrupt the breeding cycle of an important population?	Medium density Flatback Turtle nesting occurs in the Project area but does not represent a critical breeding area, therefore no significant disruption is likely. Implementation of a lighting plan designed to minimise above-water lighting disorientation to hatchlings would minimise potential disruption to local breeding success. Hatchling survivorship would be enhanced through reduction in feral pig numbers in the vicinity of the proposed port development.
....modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?	While habitat would be disturbed as a result of dredging of the proposed port area, the impact would not be of a sufficient scale to affect the survival of any marine turtle species.
....result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?	It is considered unlikely that an invasive species that is harmful to Hawksbill Turtles would be introduced due to the development or operation of Project marine infrastructure. Population survivorship would be enhanced through ghost-net removal and feral pig control measures. Currently feral pigs are the primary factor reducing the success of sea turtle reproduction (hatchling emergence). RTA would work with Traditional Owners and DERM to develop and implement measures to reduce feral pig numbers in the Pera Head to Boyd Point area.
.....introduce disease that may cause the species to decline?	Disease is not known as a threat to this species. It is not anticipated that the Project would represent a threat with respect to the introduction of disease.
....interfere with the recovery of the species?	There is a recovery plan in place for all marine turtle species found in Australia. Use of turtle deflectors on trailing suction hopper dredgers would minimise potential for entrainment of turtles during development and maintenance dredging of the proposed port area. Implementation of a lighting plan would minimise the risks of local breeding impacts from hatchling disorientation. Recovery of turtle species occurring in the area would be enhanced through removal of ghost netting on beaches in the vicinity of the proposed port development and reduction of feral pig numbers. The Project is not expected to interfere with the recovery of the species.

Olive Ridley Turtle (*Lepidochelys olivacea)*

The Olive Ridley Turtle (*Lepidochelys olivacea*) is known to nest on the beaches in the vicinity of the Project area and feed in the surrounding waters. The overall risk to the Olive Ridley Turtle from restriction of food availability due to dredging activities is low. Boating and shipping activities are also predicted to pose a low risk to the Olive Ridley Turtle. The use of turtle exclusion devices on self propelled trailing suction hopper dredges is now standard equipment on such dredgers and minimises the potential to entrain marine turtles during dredging activities.

The relevant impact of the Project on the Olive Ridley Turtle is hatchling disorientation within the Project area due to the construction and operation of the port and associated infrastructure. Nesting of the Olive Ridley Turtle in the Project area, and throughout western Cape York, is of low density. An altered above-water night time light regime is anticipated to cause an impact as it can affect adult female turtles and hatchlings. A lighting plan would be implemented to minimise long-term adverse impacts from hatchling disorientation. A feral pig control program would be implemented between Pera Head and Boyd Point to reduce nest predation and enhance turtle population survivorship. It is considered that this measure would be capable of producing an overall increase in hatchling numbers. The impacts on the Olive Ridley Turtle are not expected to be significant and the Project is not expected to interfere with the recovery of this species.

Table 22 Significant Impact Assessment – Olive Ridley Turtle (*Lepidochelys olivacea)*

Will the proposed works...	**Olive Ridley Turtle (*Lepidochelys olivacea)***: Endangered
... lead to a long-term decrease in the size of a population?	Low density nesting has been historically recorded from a number of locations including the eastern Gulf of Carpentaria; however, there is some uncertainty whether nesting still occurs on Western Cape York. The Project aspects with the greatest potential for long-term impact and decrease in local Olive Ridley Turtle activity are dredging and onshore lighting (assuming turtle nesting continues to occur on western Cape York and in the vicinity of the port development Project area). The use of turtle deflectors on trailing suction hopper dredgers and implementation of a lighting plan would minimise the risk of any long term population decline. Implementation of a lighting plan would minimise long-term impacts from hatchling disorientation. Population survivorship would be enhanced through ghost-net removal and reducing feral pig numbers which currently cause major reductions in egg and hatchling survivorship. The impacting processes are not of a sufficient scale or magnitude to lead to a long-term decrease in the population size of this species.
... reduce the area of occupancy of the species?	The Project development and operation would not reduce the area of occupancy of the Olive Ridley Turtle in any ecologically meaningful way.
... fragment an existing population into two or more populations?	The Project development and operation would not create any barriers to movement for Olive Ridley Turtles or fragment an existing population.
adversely affect habitat critical to the survival of a species?	While some local feeding habitat would be impacted as a result of turbidity plume from proposed port dredging activities, and subsequent deposition and re-suspension of fine sediments, the impact would not be of a sufficient scale to affect the survival of any marine turtle species.
... disrupt the breeding cycle of a population?	There is uncertainty as to whether Olive Ridley nesting continues to occur on Western Cape York. Implementation of a lighting plan would minimise above-water lighting disorientation to hatchlings and impacts to local breeding success, should nesting still occur in the Project area. Hatchling survivorship would be enhanced through reduction in feral pig numbers in the vicinity of the proposed port development.
... modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?	While habitat would be disturbed as a result of dredging of the port area, the impact would not be of a sufficient scale to affect the survival of any marine turtle species.
... result in invasive species that are harmful to an endangered species becoming established in the endangered species' habitat?	It is considered unlikely that an invasive species that is harmful to Olive Ridley Turtles would be introduced due to the development or operation of Project marine infrastructure. Population survivorship would be enhanced through ghost-net removal and feral pig control measures. Currently feral pigs are the primary factor reducing the success of sea turtle reproduction (hatchling emergence). RTA would work with Traditional Owners and DERM to develop and implement measures to reduce feral pig numbers in the Pera Head to Boyd Point area.
... introduce disease that may cause the species to decline?	Disease is not known as a threat to this species. It is considered unlikely that a disease harmful to the Olive Ridley Turtle would be introduced due to the development or operation of Project marine infrastructure.
... interfere with the recovery of the species?	There is a recovery plan in place for all marine turtle species found in Australia. Use of turtle deflectors on trailing suction hopper dredgers would minimise potential for entrainment of turtles during development and maintenance dredging of the port area. Implementation of a lighting plan would minimise the risks of local breeding impacts from hatchling disorientation. Recovery of turtle species occurring in the area would be enhanced through removal of ghost netting on beaches in the vicinity of the port development and the reduction of feral pig

Will the proposed works...	**Olive Ridley Turtle (*Lepidochelys olivacea*)**: Endangered
	numbers. The Project is not expected to interfere with the recovery of the species.

Leatherback Turtle (*Dermochelys coriacea*)

The Leatherback Turtle (*Dermochelys coriacea*) has not been recorded nesting in eastern Australia since 1996 and is rarely found in Queensland. Leatherback Turtles are considered likely to occur in the Project area, potentially using it for foraging. However, the Leatherback Turtle is generally recognised as principally utilising offshore pelagic areas for foraging, therefore coastal waters like the proposed port are not considered key habitat. The overall risk to the Leatherback Turtle from restriction of food availability due to dredging activities is low. Boating and shipping activities are also predicted to pose a low risk to the Leatherback Turtle. The use of turtle exclusion devices on self propelled trailing suction hopper dredges is now standard equipment on such dredgers and would minimise the potential to entrain marine turtles during dredging activities. The Leatherback Turtle is unlikely to be impacted by the Project.

Table 23 Significant Impact Assessment– Leatherback Turtle (*Dermochelys coriacea*)

Will the proposed works...	**Leatherback Turtle (*Dermochelys coriacea*)**: Endangered
....lead to a long-term decrease in the size of a population?	It is unlikely that this species utilises Project area beaches for nesting as the leatherback turtle has not been recorded nesting in eastern Australia since 1996 and they are rarely found in Queensland. The impacting processes are not of a sufficient scale or magnitude to lead to a long-term decrease in the size of a population, particularly where their occurrence is normally rare.
....reduce the area of occupancy of the species?	Globally, the Leatherback Turtle occupies a broad latitudinal range, from tropical to sub-tropical waters. The Project would not reduce the area of occupancy of the Leatherback Turtle in any ecologically meaningful way.
....fragment an existing population into two or more populations?	The Project development and operation would not create any barriers to movement for Leatherback Turtles.
....adversely affect habitat critical to the survival of a species?	While foraging habitat may be impacted as a result of the turbidity plume from port dredging activities, and subsequent deposition and re-suspension of fine sediments, the impact is not of a sufficient scale to affect the survival of any marine turtle species. Suitable feeding habitats are found throughout coastal areas of the Gulf of Carpentaria. The constructed jetty would provide a surface for potential food sources (e.g. ascidians) to grow in the long term.
....disrupt the breeding cycle of a population?	Nesting is not known to occur in the vicinity of the Project area, so no disruption to breeding cycle would result.
....modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?	While habitat would be disturbed as a result of dredging of the port area, the impact would not be of a sufficient scale to affect the survival of any marine turtle species.
....result in invasive species that are harmful to an endangered species becoming established in the endangered species' habitat?	It is considered unlikely that a disease harmful to the Leatherback Turtle would be introduced due to the development or operation of Project marine infrastructure.
.....introduce disease that may cause the species to decline?	Disease is not known as a threat to this species. It is considered unlikely that a disease harmful to the Leatherback Turtle would be introduced due to the development or operation of Project marine infrastructure.
....interfere with the recovery of the species?	There is a recovery plan in place for all marine turtle species found in Australia. Use of turtle deflectors on suction hopper dredgers would minimise potential for entrainment of turtles during development and maintenance dredging of the port area. The Project is not expected to interfere with the recovery of the species.

Loggerhead Turtle (*Caretta caretta)*

The Loggerhead Turtle (*Caretta caretta*) is likely to be transient in the Project area, using it for foraging or resting, but highly unlikely for nesting. Surveys have found no nests in the Project area. The overall risk to the Loggerhead Turtle from restriction of food due to dredging activities availability is low. Boating and shipping activities are also predicted to pose a low risk to the Loggerhead Turtle. The use of turtle exclusion devices on self propelled trailing suction hopper dredges is now standard equipment on such dredgers and would minimise the potential to entrain marine turtles during dredging activities. The Loggerhead Turtle is unlikely to be impacted by the Project.

Table 24 Significant Impact Assessment– Loggerhead Turtle (*Caretta caretta)*

Will the proposed works...	**Loggerhead Turtle (*Caretta caretta)***: Endangered
....lead to a long-term decrease in the size of a population?	It is likely that this species would be transient in the Project area, using it for foraging or resting, but highly unlikely for nesting. The impacting processes associated with the Project would not be of a sufficient scale or magnitude to lead to a long-term decrease in the size of a population, particularly in an area where individuals would be transient.
....reduce the area of occupancy of the species?	Globally, the Loggerhead Turtle is a circum-tropical species. The Project would not reduce the area of occupancy of the loggerhead turtle in any ecologically meaningful way.
....fragment an existing population into two or more populations?	The Project development and operation would not create any barriers to movement for Loggerhead Turtles.
....adversely affect habitat critical to the survival of a species?	While some feeding habitat would be disturbed as a result of proposed dredging of the port area, suitable feeding habitats are found throughout coastal areas of the Gulf of Carpentaria.
....disrupt the breeding cycle of a population?	Nesting is not known to occur in the vicinity of the Project area, being centred principally in Queensland's south-east. No disruption to breeding cycles would occur.
....modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?	While habitat would be disturbed as a result of dredging of the port area, the impact is not of a sufficient scale to affect the survival of any marine turtle species.
....result in invasive species that are harmful to an endangered species becoming established in the endangered species' habitat?	It is considered unlikely that an invasive species that is harmful to Loggerhead Turtles would be introduced due to the development or operation of Project marine infrastructure.
.....introduce disease that may cause the species to decline?	Disease is not known as a threat to this species. It is considered unlikely that a disease harmful to the Loggerhead Turtle would be introduced due to the development or operation of Project marine infrastructure.
....interfere with the recovery of the species?	There is a recovery plan in place for all marine turtle species found in Australia. Use of turtle deflectors on suction hopper dredgers would minimise potential for entrainment of turtles during development and maintenance dredging for the port area. The Project is not expected to interfere with the recovery of the species.

Green Turtle (*Chelonia mydas*)

Green Turtles are likely to forage in the Project area, including the Embley and Hey Rivers where seagrass beds occur, but do not nest in the Project area. They feed principally on seagrass and seaweeds, although juveniles are also carnivorous. The overall risk to the Green Turtle from restriction of food availability due to dredging activities is low. Boating and shipping activities are also predicted to pose a low risk to the Green Turtle. The use of turtle exclusion devices on self propelled trailing suction hopper dredges is now standard equipment on such dredgers and would minimise the potential to entrain marine turtles during dredging activities. The Green Turtle is unlikely to be impacted by the Project.

Table 25 Significant Impact Assessment – Green Turtle (*Chelonia mydas*)

Will the proposed works...	**Green Turtle (*Chelonia mydas*):** Vulnerable
.... lead to a long term decrease in the size of an important population of a species?	Green Turtles occurring in the vicinity of the Project area do not constitute a geographically distinct regional population or local population that occurs within a particular bioregion. The Project aspect with the greatest potential for long-term impact and decrease in local Green Turtle activity is dredging. The use of turtle deflectors on trailing suction hopper dredgers would minimise the risk of any long term population decline. The removal of 0.1ha of seagrass from the Humbug barge terminal berth area would not impact Green Turtle feeding resources with more significant seagrass meadows occurring elsewhere in the Weipa region. The impacting processes would not be of a sufficient scale or magnitude to lead to a long-term decrease in an important population of this species.
.... reduce the area of occupancy of an important population?	The Project development and operation would not reduce the area of occupancy of the Green Turtle in any ecologically meaningful way.
....fragment an existing important population into two or more populations?	The Project development and operation would not create any barriers to movement for Green Turtles.
....adversely affect habitat critical to the survival of a species?	The Project area does not include any critical habitat areas for the species.
....disrupt the breeding cycle of an important population?	Surveys have found no nests in the Project area. Disruption to the life cycle of marine turtles is not anticipated as a result of the Project.
....modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?	Very minor removal of seagrass from the Humbug barge terminal berth area would not impact Green Turtle feeding resources with more significant seagrass meadows occurring elsewhere in the Weipa region.
....result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?	It is considered unlikely that an invasive species that is harmful to Green Turtles would be introduced due to the development or operation of Project marine infrastructure.
.....introduce disease that may cause the species to decline?	Disease is not known as a threat to this species. It is considered unlikely that a disease harmful to the Green Turtle would be introduced due to the development or operation of Project marine infrastructure.
....interfere with the recovery of the species?	There is a recovery plan in place for all marine turtle species found in Australia. Use of turtle deflectors on trailing suction hopper dredgers would minimise potential for entrainment of turtles during development and maintenance dredging of the port area.

4.5.2 Proposed Mitigation Strategies – Threatened Marine Turtles

Altered Above-Water Night Time Light Regime

Design and operational guidelines for mitigating lighting impacts on turtle hatchings associated with coastal development have been developed (Witherington and Martin 1996). These guidelines are designed more for residential developments and roads than the proposed development of the port, but some general principles are relevant and would be utilised where applicable. Australian examples exist where the impacts of artificial lighting on turtles have been mitigated in part. At Thevnard Island (North West Shelf), light impacts were mitigated from offshore petroleum production by minor shielding, re-positioning, and in some cases, time-switching of the lights. It is difficult however, to mitigate the impacts of a changed lighting regime in its entirety. A lighting plan for the port is considered an important part of both construction and operation environmental management. Turtle sensitive lighting approaches would also need to consider safety requirements, navigation requirements and the need to minimise light spill on turtle sensitive areas. A lighting plan has been developed with consideration of the following.

- Ensuring overall lighting is minimised to that which is essential for safe and efficient operation of the facility.
- Ensuring non-essential lighting would be switched off or dimmed when there are no ships at berth or being piloted in the area.
- Shielding and/or recessing of lights to minimise light spill.
- Installation of long wavelength lights.
- Any other lighting options that further reduce impacts to marine turtles while allowing for the safe and efficient operation of the proposed port facility.

The lighting plan is detailed in **Table 26.**

Table 26 Lighting Plan

Facility	Description	Mitigation measures
Phase: Design		
Shiploader	Lighting would only be in use when shiploading. Only equipment would be lit. Lighting would be required to enable a worker to enter cabin. When in use, light would be required for conveyor belts, transfer shoots and discharge point to the hull. Shiploader height would be approximately 8-10m above top of wharf level.	• Long wave length lighting (low pressure sodium or equivalent) would be used in the design. • Unnecessary lights would be able to be turned off when not in use and usage of lights would be minimised to that required for safe operation would be used in the design.
Wharf deck	The access walkway and conveyor bends would be illuminated as needed.	• Long wave length lighting (low pressure sodium or equivalent) would be included in the design. • Unnecessary lights would be able to be turned off when not in use and usage of lights would be minimised to that required for safe operation would be included in the design. • Shielding, height (keep low) and direction of lights would be designed to minimise light spill.
Jetty	The access walkway and roadway would be illuminated as needed.	• Long wave length lighting (low pressure sodium or equivalent) would be included in the design. • Unnecessary lights would be able to be turned off when not in use and usage of lights would be minimised to that required for safe operation would be included in the design. • Shielding, height (keep low) and direction of lights would be designed to minimise light spill.
Dolphin walkway	The access walkway would be illuminated as needed.	• Long wave length lighting (low pressure sodium or equivalent) would be included in the design. • Unnecessary lights would be able to be turned off when not in use and usage of lights would be minimised to that required for safe operation would be included in the design. • Shielding, height (keep low) and direction of lights would be designed to minimise light spill.
Tug berth	The access berth and walkways would be illuminated as needed.	• Long wave length lighting (low pressure sodium or equivalent) would be included in the design. • Unnecessary lights would be able to be turned off when not in use and usage of lights would be minimised to that required for safe operation would be used in the design. • Shielding, height (keep low) and direction of lights would be designed to minimise light spill.
Tug boat	Sufficient lighting would be allowed for in the design to ensure safe movement around deck of the tug.	• The design would ensure that there would be limited usage of lights to that required for safe operation.
Bulk Carrier (decks)	Sufficient lighting would be allowed for in the design to ensure safe movement around deck of bulk carrier.	• The design would ensure that there would be limited usage of lights to that required for safe operation.

Facility	Description	Mitigation measures
Navigation Lights	Lighting design must meet the requirements of Queensland Department Transport and Main Roads, however RTA would work to implement mitigation measures wherever possible.	• Flashing lights would be included in the design.
Emergency lighting throughout wharf / tug berth area	Would be designed to be only used as needed.	• Unnecessary lights would be able to be turned off when not in use and usage of lights would be minimised to that required for safe operation would be included in the design.
Stockpile area	No lighting would be required, machine (stacker/reclaimer) lighting would be sufficient.	• No tower flood lighting would be included in the design(stacker / reclaimer mounted lights are sufficient).
Stacker/ reclaimer	Stacker would operate continuously - machinery would be lit. Reclaimer would operate when ship loading - machinery would be lit.	• Long wave length lighting (low pressure sodium or equivalent) would be included in the design. • Unnecessary lights would be able to be turned off when not in use and usage of lights would be minimised to that required for safe operation would be included in the design. • Shielding, height (keep low) and direction of lights would be designed to minimise light spill. • Vegetation buffer of *Eucalyptus tetrodonta* forests estimated at up to 25 - 30m high at 200m width (between stacker/ reclaimer and port).
Beneficiation plants	Would be operated continuously - machinery and work area would be lit.	• Shielding, height (keep low) and direction of lights would be designed to minimise light spill. • Vegetation buffer of *Eucalyptus tetrodonta* forests estimated at up to 25 - 30m high at 200m width (between beneficiation plant and port).
Phase: Construction and Operation		
All	Administrative controls would be implemented to minimise the potential for impact.	• Standard ground clearing management procedures would be implemented to retain vegetation buffer. • Training of the workforce would be conducted regarding potential impacts and management measures. • Access would be limited to beach areas • Standard incident reporting procedure for sea turtle incidents, hazards or near misses would be implemented. • Lighting requirements as per design would be maintained. • Reactive monitoring for deposition and light.

Note: Embley River and Hey River are not nesting areas for marine turtles, so lighting impacts from barge/ferry terminals are not potential impacts.

RTA proposes an adaptive approach to work with the Traditional Owners and DERM to minimise the impacts of changes to the light regime during both the construction and operation phases of the proposed port on marine turtles, while still allowing for a safe working environment. Overall, without mitigation, a changed light regime is predicted to pose a high risk to marine turtles; however programs designed to reduce the other primary threats (feral pigs and ghost nets) are described below to minimise negative impact on local marine turtle nesting activity.

Threat Reduction

RTA is committed to working with the DERM to reduce threats to marine turtles particularly in the proposed port area and assist with marine turtle research programs. RTA has placed sand temperature loggers near Boyd Point as part of a DERM research project to examine the potential impacts of climate change on marine turtle populations. RTA would document any strandings of marine turtles (e.g. animals entangled in ghost nets) and report these to DERM for inclusion in the Wildlife Stranding database and would remove any ghost nets found in the vicinity of the proposed port development.

RTA would work with the Traditional Owners and DERM to develop and implement measures to reduce feral pig numbers in the Pera Head to Boyd Point area. Currently feral pigs are the primary

factor reducing the success of sea turtle reproduction (hatchling emergence). RTA would work with DERM to evaluate whether relocating nests is appropriate. A monitoring program would be developed in conjunction with the Traditional Owners and DERM with consideration of turtle nesting activities (number, type, predation, success), behaviour (hatchling activity) and incident reporting.

Direct Impact from Dredging Activities

The use of self propelled trailing suction hopper dredges has the potential to entrain marine turtles during dredging activities. The use of turtle exclusion devices on the suction heads is now standard equipment on such dredgers and would minimise the potential for entrainment. Any trailing suction hopper dredges contracted for the port area dredging (and future maintenance dredging) would be required to have turtle exclusion devices fitted.

Turbid Plume Generation and Sediment Deposition/Resuspension on Feeding Habitat

Monitoring of turbidity (expressed as Nephelometric Turbidity Units-equivalent, NTU-e), deposition and light (photo-synthetically active radiation, PAR) would be undertaken at Boyd Point, Pera Head and Thud Point reef areas and at a control location outside the extent of the modelled dredge plume during dredging activities associated with the Project.

Total Suspended Solids (TSS) would be estimated based on the relationship between NTU-e and TSS. The objective of this monitoring is to validate the turbidity plume modelling and assist in identifying extended periods of high turbidity, high TSS and low PAR availability which can lead to coral stress. In-situ water quality loggers, like those used to collect background data for the present study, would continue to be used during the proposed monitoring program. Monitoring would begin a month prior to dredging and extend until two months after the completion of dredging. Loggers would be either downloaded fortnightly or telemetry linked to allow for remote download so that data can be regularly reviewed.

Monitoring of hard corals is proposed at Boyd Point, Pera Head and reefs south to Thud Point. The objective of this is to identify when corals become stressed due to low light conditions or are being impacted by sediment deposition. Due to the presence of potentially dangerous marine life, the proposed monitoring would involve the use of fixed point photoquadrats that can be deployed from a boat rather than line transects. Fixed point quadrat sites would initially require manual establishment with star pickets driven into the reef and would be buoyed at the surface with a line that would enable a frame and camera assembly to be lowered down from a boat, subject to a safety risk review. Monitoring would be undertaken at two water depths at three locations at Thud Point, Pera Head and Boyd Bay reefs. Sites would be located based on the results of plume dispersion and deposition modelling, and the presence of representative coral cover. Fixed point quadrats would be photographed so a historical sequence of coral condition could be established and reviewed for indicators such as colour change, bleaching and tissue necrosis. Surveys would be undertaken on spring tides when water clarity is likely to be greatest, following tidal flushing of inshore sediment build-up during neap tidal periods. Should signs of unacceptable coral stress become apparent, opportunities for the manipulation of dredging operations would be reviewed to best allow corals a period of respite and a return to more favourable conditions.

The final design of the reactive monitoring program would be prepared in consultation with DSEWPaC and DERM and incorporated into a Dredge Management Plan. The Dredge Management Plan would include:

- validation of plume dispersion modelling predictions (first 6-8 weeks);
- marine water quality monitoring (loggers – TSS, light (PAR) and deposition); and
- coral health monitoring (fixed impact and control sites).

A monitoring response protocol, including management triggers, would be developed as part of the Dredge Management Plan.

Mitigation of Acoustic Impacts from Pile Driving Activities

To minimise the potential underwater noise impacts on marine turtles during pile driving activities, it is proposed that a "soft start" approach be used to disperse marine fauna (including marine turtles) in the vicinity of these activities prior to normal pile driving. The "soft start" involves commencing pile driving with a partial capacity strike, prior to normal pile driving. It is proposed that an exclusion zone

surrounding pile driving activities be established and monitored prior to normal pile driving commencing and during normal pile driving. Normal pile driving activities would not commence or be temporarily suspended if turtles are observed within the exclusion zone. Pile driving activities would not recommence until turtles are considered to be outside the exclusion zone. The extent of the exclusion zone would be defined based on further literature review and quantitative analysis of the potential underwater noise impacts from pile driving relating to threatened marine fauna. The final extent of the exclusion zone would be defined in consultation with DSEWPaC.

4.5.3 Potential Impacts on Sharks and Sawfish

The Green Sawfish (*Pristis zijsron*), Dwarf Sawfish (*Pristis clavata*), Freshwater Sawfish (*Pristis microdon*), and Speartooth Shark (*Glyphis sp.)* have not been recorded in surveys of the Project area but are considered likely to occur in the estuarine and lower brackish reaches of the Project area's main drainage systems. Although these species are likely to occur within the Project area, the extent of these habitats within the Project area that would be disturbed is limited to a small area. Refer to **Table 5** for an assessment of the potential for these species to occur within Project related disturbance.

If present, these species could potentially be affected by:

- physical disturbance of sedimentary habitats and fauna from dredging for the barge/ferry terminals in the Embley and Hey Rivers; and
- creation of a turbidity plume, spoil deposition and re-suspension of fine sediments.

The fish assemblage is currently exposed to periodic but significant physical disturbance and elevated turbidity during extreme weather events. Fish species are also mobile and as such can move away from any local areas that are affected by a disturbance (e.g. dredging and dredge spoil deposition). Given the minor scale and short duration of dredging, at each of the barge/ferry terminal facilities it is unlikely that habitat in the Embley and Hey Rivers would be significantly affected.

The Project is predicted to pose a low risk to the three sawfish and one shark species. An assessment of the significance of impacts on these species is provided in **Tables 27**, **28 and 29**.

Table 35 summarises the potential habitats within the Project area for each threatened and migratory estuarine and marine fauna species, including Sharks and Sawfish, and **Table 36** summarises the amount of each habitat type to be impacted by Project activities.

Dwarf Sawfish (*Pristis clavata*)

Dwarf Sawfish (*Pristis clavata*) has not been recorded in surveys of the Project area but it is considered likely to occur in the estuarine and lower brackish reaches of the Project area's main drainage systems which include the proposed disturbance footprints of the barge/ferry terminals on the Hey and Embley Rivers. This species is considered unlikely to occur within or above the proposed footprint of Dam C on a freshwater tributary of Norman Creek. Any population within the Project area is likely to be locally important on the basis that individuals occupy restricted areas and travel only short distances.

Relevant impacts on Dwarf Sawfish within the Project area are disturbance of relatively minor areas of habitat as a result of dredging and operation of barge/ferry terminal areas. While habitat would be disturbed as a result of dredging and operation of barge/ferry terminal areas, given the minor scale and short duration of dredging, the impact would not be of a sufficient scale to significantly decrease the availability or quality of shallow muddy habitat, as there is abundant similar habitat in elsewhere within the Project area. Barges and ferries docked within the terminal areas may present temporary blocks to movement but this would not likely result in fragmentation as vessels would move several times per day. These impacts are unlikely to significantly impact the local population or survival of the species as a whole.

Table 27 Significant Impact Assessment– Dwarf Sawfish (*Pristis clavata*)

Will the proposed works...	**Dwarf Sawfish (*Pristis clavata*)**: Vulnerable
.... lead to a long term decrease in the size of an important population of a species?	Dwarf Sawfish inhabit shallow (2–3m) coastal waters and estuarine habitat, moving into marine waters after the wet, and during the wet season enter estuarine or fresh waters to breed. The Dwarf Sawfish appears to move only small distances and occupy only a relatively restricted area and so reflect the definition of important populations at the local level. The Project is unlikely to result in a long term decrease in the size of a local Dwarf Sawfish population if it is present. The only shallow water (2-3m) development relates to the barge/ferry terminals where minor dredging would be required to a depth of approximately 2m. The proposed port area works in those shallow depths may relate only to piling as dredging starts at -11m LAT depth.
.... reduce the area of occupancy of an important population?	The minor works proposed in the shallows of the Project area would not cause any significant reduction in the area of a local population.
....fragment an existing important population into two or more populations?	Barges and ferries docked within the terminal areas may present temporary blocks to movement but this would not likely result in fragmentation as vessels would move several times per day.
....adversely affect habitat critical to the survival of a species?	The minor works proposed in the shallows of the Project area would not adversely affect habitat to the extent that it significantly impacts the local population or survival of the species as a whole.
....disrupt the breeding cycle of an important population?	The development and operation of the port and barge/ferry terminal areas is unlikely to disrupt the breeding cycle of the Dwarf Sawfish which is thought to move into marine waters after the wet season, and during the wet season enter estuarine or fresh waters to breed. The infrastructure or activities associated with the Project are unlikely to present a significant barrier to movement.
....modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?	While some habitat would be disturbed as a result of dredging and operation of barge/ferry terminal areas, the impact is not of a sufficient scale to significantly decrease the availability or quality of shallow muddy habitat as there is abundant similar habitat elsewhere within the Project area.
....result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?	It is considered unlikely that an invasive species that is harmful to Dwarf Sawfish would be introduced due to the development or operation of Project marine infrastructure.
.....introduce disease that may cause the species to decline?	It is considered unlikely that a disease harmful to the Dwarf Sawfish would be introduced due to the development or operation of Project marine infrastructure.
....interfere with the recovery of the species?	Threats to the Dwarf Sawfish include fishing pressure, habitat degradation and Australian Indigenous harvesting. The low reproductive rate and late maturation common to sawfish likely limits the ability of the species to recover from these threats. The Project would not result in any substantial interference with the recovery of this species.

Green Sawfish (*Pristis zijsron)*

The Green Sawfish (*Pristis zijsron)* has not been recorded in surveys of the Project area but it has been recorded from Albatross Bay. The Project area, including the port development area and barge/ferry terminals in the Embley and Hey Rivers, contain suitable habitat for the species and it is considered likely to occur in these areas. This species is considered unlikely to occur within or above the proposed footprint of Dam C on a freshwater tributary of Norman Creek.

The relevant impact on the Green Sawfish within the Project area is disturbance of relatively minor areas of habitat as a result of dredging and operation of barge/ferry terminal areas and proposed port area. While some local habitat would be impacted as a result of proposed dredging activities in the Embley and Hey Rivers, and proposed port area, abundant suitable habitats are found throughout coastal areas of the Gulf of Carpentaria and northern Australia. Therefore, the Project is unlikely to significantly impact the survival of the Green Sawfish.

Table 28 Significant Impact Assessment– Green Sawfish (*Pristis zijsron)*

Will the proposed works...	**Green Sawfish (*Pristis zijsron*)**: Vulnerable
.... lead to a long term decrease in the size of an important population of a species?	The Australian population of the Green Sawfish is considered to be unfragmented and occurs throughout northern Australia (Stevens *et al.* 2005). The impacting processes associated with the Project are not of a sufficient scale or magnitude to lead to a long-term decrease in an important population of this species given that there is abundant suitable habitat available to it.
.... reduce the area of occupancy of an important population?	Given the extent of suitable habitat in northern Australia, the Project development and operation would not reduce the area of occupancy of the Green Sawfish in any ecologically meaningful way.
....fragment an existing important population into two or more populations?	The Project development and operation would not create any barriers to movement for the Green Sawfish.
....adversely affect habitat critical to the survival of a species?	While some local habitat would be impacted as a result of proposed dredging activities in the Embley and Hey Rivers, and proposed port area, suitable habitats are found throughout coastal areas of the Gulf of Carpentaria and northern Australia.
....disrupt the breeding cycle of an important population?	Development and operation of the barge/ferry terminals would not be at a sufficient scale or magnitude to lead to significant disruption to the Green Sawfish population which is considered to occupy much of coastal northern Australia. Pupping is believed to occur in coastal or estuarine areas.
....modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?	While some habitat may be impacted as a result of dredging of the barge/ferry terminals, the impact associated with the Project is not of a sufficient scale to affect the survival of the Green Sawfish.
....result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?	It is considered unlikely that an invasive species that is harmful to the Green Sawfish would be introduced due to the development or operation of Project marine infrastructure.
.....introduce disease that may cause the species to decline?	It is considered unlikely that a disease harmful to the Green Sawfish would be introduced due to the development or operation of Project marine infrastructure.
....interfere with the recovery of the species?	Globally the threats to the Green Sawfish include fishing pressure, shark finning, habitat degradation and Australian Indigenous harvesting. The low reproductive rate and late maturation of the Green Sawfish limits the ability of the species to recover from these threats (Stevens *et al.* 2005). The Project would not result in any substantial interference with the recovery of this species.

Freshwater Sawfish *(Pristis microdon)*

This species may occur in estuarine and the lowermost freshwater reaches within the Project area. Suitable habitat is present in the brackish reaches of Norman Creek and the Ward River, though generally low abundance of all elasmobranchs species has been observed at these sites. It is considered that it is possible that this species occurs within the proposed disturbance areas of the barge/ferry terminals on the Hey and Embley Rivers, but is unlikely to occur within and above the proposed footprint of Dam C on a freshwater tributary of Norman Creek. Potential habitat for this species is unlikely to be significantly impacted by the Project and there is abundant habitat within the Project area. Therefore the Project is unlikely to impact this species.

Speartooth Shark (*Glyphis* sp. A)

This species may occur in estuarine and the lowermost freshwater reaches within the Project area. Records exist for the Wenlock River and similar habitat is present within the Project site, though generally low abundances of all elasmobranchs species have been observed in areas of potential habitat within the Project area. However, based on the assessment of likelihood in **Table 5**, it is considered that the Speartooth Shark is unlikely to occur in either the proposed disturbance areas of the barge/ferry terminals on the Hey and Embley Rivers or within and above the proposed footprint of Dam C on a freshwater tributary of Norman Creek. Potential habitat for this species is unlikely to be significantly impacted by the Project and there is abundant habitat within the Project area. Therefore the Project is unlikely to impact this species.

Table 29 Significant Impact Assessment– Freshwater Sawfish and Speartooth Shark

Will the proposed works...	**Freshwater Sawfish *(Pristis microdon)* and Speartooth Shark (Glyphis sp. A)**
....lead to a long-term decrease in the size of a population?	A long term decrease in any population of these species if present is unlikely to occur.
....reduce the area of occupancy of the species?	Sufficient habitat would remain to support these species, if present within the proposed disturbance areas, and the area of occupancy of any population of the species present would not be reduced.
....fragment an existing population into two or more populations?	Any population present would not be fragmented. Evidence suggests that both species would not travel upstream of the proposed Dam C footprint on a freshwater tributary of Norman Creek (refer to **Table 5**).
....adversely affect habitat critical to the survival of a species?	The Project area or areas that would be disturbed within the Project area does not include any critical habitat areas for these species. As summarised in **Table 5**, both species are unlikely to travel upstream of the proposed Dam C footprint on a freshwater tributary of Norman Creek. Therefore the freshwater environment in the freshwater tributary upstream of Dam C would not be considered critical breeding habitat for either species.
....disrupt the breeding cycle of a population?	The breeding cycle of these species (if present within proposed disturbance areas) would not be disrupted. As summarised in **Table 5**, both species are unlikely to travel upstream of the proposed Dam C footprint on a freshwater tributary of Norman Creek. Therefore the freshwater environment in the freshwater tributary upstream of Dam C would not be considered critical breeding habitat for either species.
....modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?	These species (if present) are unlikely to decline as a result of the Project related disturbance. Evidence suggests that both species would not travel upstream of the proposed Dam C footprint on a freshwater tributary of Norman Creek (refer to **Table 5**). The impacts on potential habitat associated with dredging activities and clearing of 400m^2 of mangroves associated with the ferry/barge terminals on the Hey and Embley Rivers are considered minor and would not to be to the extent that would cause a decline of either of these species if they are present. The size of the vessels proposed to enter the Embley River as a result of the Project would actually decrease in number, which would result in a positive impact. There is no evidence to suggest that large vessels pose a threat to sawfish or the Speartooth Shark species or that large vessels would cause a decline in these species. .
....result in invasive species that are harmful to an endangered species becoming established in the endangered species' habitat?	The Project is unlikely to lead to the introduction of any invasive fauna that could affect these species. RTA would conduct routine monitoring of the port for marine pests, similar to that currently undertaken for Port of Weipa high-risk areas.
.....introduce disease that may cause the species to decline?	Disease is not known as a threat to these species. It is not anticipated that the Project would represent a threat with respect to the introduction of disease.
....interfere with the recovery of the species?	The Project is not expected to interfere with the recovery of these species.

4.5.4 Proposed Mitigation Strategies – Sharks and Sawfish

No specific mitigation measures are required for sharks and sawfish, as the Project is predicted to pose a low risk to the three sawfish and one shark species.

Mitigation measures for impacts to catchment hydrology, elevated sediment and contaminant loads, and loss of aquatic habitat connectivity are provided in Section 8.14.2, Section 8.15.2, and Section 8.16.2 of the EIS, respectively. Mitigation of dredging impacts is discussed in Section 6.9.2.8 of the EIS and monitoring in Section 6.9.3.1 of the EIS.

4.6 Potential Impacts on EPBC Listed Migratory Species - Avian

Overall, the migratory species possible, likely or confirmed as occurring within the Project area predominantly utilise habitats that would be located within environmental buffers and not directly affected by Project related activities. The relevant impact on avian migratory species within the

Project area is the disturbance of small areas of riparian habitat that provide potential habitat for species such as the Red Goshawk (*Erythrotriorchis radiatus*) within the footprint of the water supply dam. However, less than 10% of the area of this habitat type within the Project area would be affected, therefore, significant impacts on migratory avian fauna are unlikely.

The migratory birds that are likely to occur or are confirmed as occurring in the Project area comprise a range of species including mainly trans-equatorial migratory waders, and wetland and woodland species that undergo more local migratory movements. Whilst the waders fly from the northern hemisphere in large flocks, and the Gulf of Carpentaria is a main flight path for their entry to Australia, the birds themselves make only limited use of the Project area as it does not provide the extensive productive mudflats required by these species for feeding. It is not anticipated that large flocks of these species would fly at low levels across the Project area, preferring instead to travel along the shoreline and out to sea. There is very little chance of these species colliding with infrastructure, including powerlines and port facilities. The remaining migratory species do not move through the Project area in mass movements but may utilise natural movement corridors such as riparian corridors and the coastline. Once again, the chance of large numbers of birds colliding with infrastructure is minimal given the high visibility of most project infrastructure and minimal suspended infrastructure across riparian corridors, wetlands and the shoreline (refer to Section 2.7.5 of the EIS for description of powerlines).

Disturbance to foreshore and beach strand habitats at the location of the proposed port would be very minor and is not expected to have any adverse direct affect on the usage of the area by migratory avian fauna. Most of the shorebirds confirmed as present, likely to occur or possibly occurring in the Project area utilise foreshore, tidal flat and beach habitats and/or mangrove and estuary habitats. Only 0.3 ha of foreshore habitats and only 400 square metres of mangrove habitat (0.008% of that mangrove community within the Project area) would be directly disturbed by the Project, which is a minor proportion of these habitats in the area.

Indirect impacts on migratory shorebirds during the operational phase from lighting, noise or movement associated with the port facility and Hey Point ferry terminal are also unlikely to lead to significant impacts on migratory shorebirds given the very low incidence of these species within the Project area, and the capacity of most shorebirds to adapt to such disturbance.

An assessment of the significance of impacts on EPBC Act listed migratory avian species assessed as possible, likely or confirmed inhabitants of the Project area is provided in **Table 30**. Migratory avian species have been grouped together for the purpose of the assessment.

No specific mitigation measures are required for migratory avian fauna, as no significant impacts on migratory avian fauna are anticipated. However, the fauna impact mitigation strategies described in Section 7.17.2 of the EIS would minimise impacts on migratory fauna and areas of potential habitat.

Table 30 Significant Impact Assessment– migratory avian species

Will the proposed works...	**Refer to Table 6 for a list of the migratory avian species covered by this assessment**
... substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species;	The migratory species confirmed as present, likely or possible to occur within the Project area predominantly utilise habitats that would be located within environmental buffers and not directly affected by mining and only minimally affected by infrastructure development. The vast majority of habitats utilised by these species would be unaffected by the Project and substantial modification of any important habitats present is not expected to occur.
... result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species;	The Project is unlikely to lead to the introduction of any invasive fauna that could affect migratory species. Proposed control measures for weeds would avoid the spread of invasive weeds within habitats of the migratory species.
... seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a	Serious disruption to the life cycle of any migratory species confirmed as present, likely or possibly occurring within the Project area is not anticipated.

Will the proposed works...	**Refer to Table 6 for a list of the migratory avian species covered by this assessment**
migratory species.	

4.7 Potential Impacts on Non-Avian Migratory Fauna

4.7.1 Potential Impacts on Estuarine Crocodile

Estuarine Crocodiles are present in all freshwater and marine habitats in the Project area and surrounds including freshwater swamps and streams well inland. Overall, the species is widespread and numerous within the Project area. It occupies and feeds within the freshwater reaches of Norman Creek, Winda Winda Creek and the Ward River during the wet season, with nests also located in the reaches on all three systems. Field surveys located one nest within the footprint of the proposed water supply dam (Dam C), shown in **Figure 7**. Areas suitable for Estuarine Crocodile habitat in and around the Project area are shown in Figure 7-13 of the EIS, including the approximate extent of potential freshwater nesting habitat within the Project area. The potential freshwater nesting habitat totals 71.3km of stream reach on Winda Winda Creek, Norman Creek and tributaries, and Ward River and tributaries. The length of potential nesting habitat that would be disturbed by the proposed Dam C footprint comprises 6.7km, representing approximately 9% of the total extent of the freshwater nesting habitat within the Project area. Additional nesting habitat could occur on stream levees in estuary areas, and therefore the total occurrence of nesting habitat is likely to be greater.

It is unclear whether the impoundment related to the proposed Dam C would affect access of breeding females to potential habitat upstream and whether juveniles potentially hatched upstream of the impoundment would be exposed to increased mortality rates in traversing to lower reaches as streamflows recede in the dry season. There is a possibility that the impoundment may provide a permanent aquatic habitat area that assists juvenile recruitment.

Changes to hydrology downstream of Dam C may result in a localised reduction of water levels and flow rate during the breeding season. This may further alienate small reaches of breeding habitat for Estuarine Crocodiles immediately downstream of the Dam C due to less favourable (lower) water levels within the channel which may not provide sufficiently deep water to accommodate breeding females. Overall, the availability of potential freshwater nesting habitat for the Estuarine Crocodile would be reduced as a result of the development of Dam C. While this may have a localised effect on reproductive rates of the species, it is not anticipated that total breeding effort within the Project area would be significantly affected.

Minor changes to streamflow would occur within the Ward River downstream of the proposed pump location between July and the following wet season. Pumping would only occur if streamflow is above 1000L/s and the extraction rate would not exceed 20% of flow at any time; therefore flows would be within the natural inter-annual variation, with natural streamflow re-established prior to the Estuarine Crocodile laying and hatching. Consequently, breeding effort of the Estuarine Crocodile within the area downstream of the pump location is not anticipated to be significantly affected.

Further information on potential impacts on the Estuarine Crocodile is presented in Section 7.15.5 and Section 7.20.2 of the EIS.

The only relevant impact on Estuarine Crocodiles within the Project area is reduction in availability of potential freshwater nesting habitat due to direct disturbance from the construction of Dam C and potential for changes to hydrology downstream of the proposed Dam C and downstream of the proposed pump on Ward River.

An assessment of the significance of impacts on the Estuarine Crocodile is provided in **Table 31**. The proposed Project is not expected to interfere with the recovery of the species.

Table 31 Significant Impact Assessment– Estuarine Crocodile

Will the proposed works...	**Estuarine Crocodile *(Crocodylus porosus)***
... substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species;	The Estuarine Crocodile which has been confirmed as present within the Project area predominantly utilise habitats that would be located within riparian areas (environmental buffers) and not directly affected by mining and only minimally affected by infrastructure development. The vast majority of habitats utilised by this species would be unaffected by the Project and substantial modification of any important habitats present is not expected to occur.
... result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species;	The Project is unlikely to lead to the introduction of any invasive fauna that could affect the Estuarine Crocodile.
... seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.	Habitat is predominantly riparian areas with the exception of migration to new areas. Serious disruption to the life cycle of this migratory species is not anticipated as primary habitat is located within environmental buffers with minimal infrastructure development.

No specific mitigation measures are required for the Estuarine Crocodile, as no significant impacts are anticipated. Pumping from the Ward River would only occur if streamflow is above 1000L/s and the extraction rate would not exceed 20% of flow at any time. An environmental flow release from the proposed Dam C is proposed (refer to EIS Section 5.2.3).

Estuarine Crocodile nest predation and habitat destruction by feral pigs is discussed in Section 7.15.5 of the EIS. The implementation of the Project would provide an opportunity to implement a pig control program in targeted locations within the Project area, which would lead to improved conditions of wetland and riparian habitats.

Table 32 summarises the areas of the potential habitat REs for the Estuarine Crocodile, to be directly disturbed by the Project, based on interaction with the 40-year mine plan, proposed Dam C, and the location of Project infrastructure. For each potential habitat RE that would be disturbed, **Table 32** also indicates the areas of RE to be removed relative to the overall Project area, the Weipa Plateau subregion, and the wider Cape York Bioregion.

Table 32 Regional Ecosystem Habitat Disturbance for Estuarine Crocodile

RE	Description	Approx. area to be disturbed (ha)				Total mapped area in Project area (ha)	Proportion to be disturbed in Project area	Area in Weipa Plateau subregion# (ha)	Proportion of area in subregion to be disturbed#	Area in Cape York Bioregion# (ha)	Proportion of area in bioregion to be disturbed #	Projected remnant extent in bioregion as proportion of current extent#
		Mining area	Dam C	Infra-structure	Total							
3.1.1a	Closed forest of *Rhizophora stylosa* ± *Bruguiera gymnorhiza*. Occurs as outer mangroves. *Rhizophora stylosa* (Red Mangrove) often completely dominates, forming a very even, closed canopy (5–30m tall).	0	0	0.04	**0.04**	481	<0.01%	30,293	<0.01%	68,381	<0.01%	>99.99%
3.1.1c	Tall, buttressed trees of *Heritiera littoralis* (Looking Glass Mangrove) dominate a fairly even canopy (21–28m tall). Other tree species are frequently present in the canopy and a shrub layer (1.5–3.5m tall) is often present. In places, *Melaleuca cajuputi* (Cajuput Tree) is the most frequent canopy species.	0	0	0	**0**	122	0%	-	-	-	-	-
3.1.3	*Ceriops tagal* ± *Avicennia marina* low closed forest. Extensive on intertidal areas.	0	0	0	**0**	472	0%	-	-	-	-	-
3.1.5	*Sporobolus virginicus* closed tussock grassland. Occurs on coastal plains.	0	0	0	**0**	4	0%	-	-	-	-	-
3.1.6	Sparse herbland or bare saltpans. Associated with salt plains and saline flats.	0	0	0	**0**	633	0%	-	-	-	-	-
3.3.9	*Lophostemon suaveolens* open forest. Occurs on streamlines, swamps and alluvial terraces	0	52.6	3.6	**56.2**	2,164	3.4%	24,750	0.2%	47,167	0.1%	99.9%
3.3.14a	*Melaleuca saligna* ± *M.*	0	0	0	**0**	434	0%	-	-	-	-	-

RE	Description	Approx. area to be disturbed (ha)				Total mapped area in Project area (ha)	Proportion to be disturbed in Project area	Area in Weipa Plateau subregion# (ha)	Proportion of area in subregion to be disturbed#	Area in Cape York Bioregion# (ha)	Proportion of area in bioregion to be disturbed #	Projected remnant extent in bioregion as proportion of current extent#
		Mining area	Dam C	Infra-structure	Total							
	viridiflora, Lophostemon suaveolens woodland on drainage swamps.											
3.3.50a	*Melaleuca viridiflora* ± *Petalostigma pubescens* low open woodland on low plains.	0	0	0	**0**	986	0%	-	-	-	-	-
3.3.60a	*Themeda arguens, Dichanthium sericeum* closed tussock grassland on marine plains.	0	0	0	**0**	188	0%	-	-	-	-	-
3.3.63	Closed sedgeland dominated by *Eleocharis dulcis*. Occurs on seasonally flooded marine plains.	0	0	0	**0**	152	0%	-	-	-	-	-
3.3.64	Baloskion tetraphyllum subsp. meiostachyum open sedgeland in drainage swamps in dunefields	0	0	0	**0**	185	0%	-	-	-	-	-
3.3.65	Ephemeral lakes and lagoons on alluvial plains and depressions.	0	0	0	**0**	66	0%	-	-	-	-	-
3.5.22c	*Corymbia clarksoniana* + *Erythrophleum chlorostachys* + *Corymbia* spp. + *Eucalyptus* spp. woodland on plains.	57.4	85.9	11.7	**155**	3,120	5.0%	166,592	0.1%	291,098	<0.1%	>99.9%
				TOTAL	**211.2**							

All RE spatial data based on analysis of V6 RE data and adjusted with ground-surveyed mapping by RTA within and adjacent to the Project area.

Table 35 summarises the potential habitats within the Project area for each threatened and migratory estuarine and marine fauna species, including the Estuarine Crocodile, and **Table 36** also summarises the amount of each habitat type to be impacted by Project activities.

4.7.2 Potential Impacts on Dugong

Dugongs have the potential to be affected by:

- loss of foraging habitat from dredging activities;
- creation of a turbidity plume from dredging activities, and subsequent deposition and re-suspension of fine sediments;
- boat strike;
- direct impact from dredging activities;
- disturbance from boating and shipping activities including alienation from habitat; and
- acoustic impacts.

The Hornibrook Terminal and Hey River Terminal dredge footprints do not contain seagrass, however, it may occur in the wider vicinity as isolated patches. Isolated patches of seagrass have been identified within or immediately adjacent to the proposed dredge footprint at the Humbug barge terminal. The area of seagrass within the Humbug barge terminal dredge footprint is conservatively estimated to be 1,250m^2 which represents about 0.003% of the seagrass meadows within the Weipa region and is not significant in terms of a Dugong foraging resource. Given the minor scale and short duration of dredging, at each of the barge/ferry terminal facilities it is unlikely that Dugong foraging areas would be significantly affected by turbidity plumes.

Seagrass is absent from both the proposed port site and proposed new spoil ground location. Therefore Dugong foraging habitat would not be directly disturbed by port dredging and spoil disposal nor affected by turbidity plumes from port dredging.

It is commonly accepted that vessel speed and water depth are the main factor affecting the risk of boat strikes. The risk of boat strike is higher in shallower water. The operation of the ferry from Hornibrook Terminal to Hey River Terminal is predicted to pose a moderate risk to Dugongs in the Embley estuary.

Slow moving displacement vessels such as bulk carriers, barges and tugs do not pose a boat strike risk and as such are not considered a risk in the operational phase of either the port area or in the Embley and Hey Rivers. Dredgers are similarly slow moving, however, mitigation strategies would be employed during dredging to prevent direct impact on Dugong from dredging activities (refer **Section 5.7.3**).

As well as direct impacts from boat strike, boating activities have been implicated in the disturbance and alienation of Dugongs from their feeding habitats along the Queensland east coast (Hodgson and Marsh 2007). There is no Dugong feeding habitat in the vicinity of the proposed wharf and shipping channel so the risk of strike by bulk carriers at the port and the risk of alienation from habitat is low.

While Dugongs may move through the proposed Port area when periodically migrating between feeding areas, the proposed port and port activities do not represent a barrier to migration that is likely to result in any meaningful impact on Dugong populations in the region. Overall, Project-related vessel movements are likely to have a low risk of impact on Dugong in the vicinity of proposed port.

Dugong are potentially sensitive to underwater noise, and construction activities such as pile driving have the potential to temporarily drive Dugongs from the area or cause physical damage to their auditory systems (refer to Section 10.2.5 of the EIS). The proposed port area is not suitable Dugong habitat, and as such, it is predicted that an avoidance response to underwater construction activities would pose a low risk of impact to Dugongs at this site. Seagrass beds are typically present in the lower reaches of the Embley River (refer to Section 6.3.4 of the EIS), therefore, an avoidance response to construction activities in the Embley estuary pose a moderate risk of impact to Dugongs. However, pile driving would be a one-time event of short duration (approximately 15 days). Risk from physical damage to the auditory system from pile-driving activities would be minimised where possible through a "soft-start" approach and the use of exclusion zones. "Soft-start" refers to the increasing of pile energy gradually over a period of time.

The relevant impacts to Dugongs within the Project area are boat strike from operation of the ferry from Hornibrook Terminal to Hey River Terminal in the Embley River, and temporary avoidance of habitat due to construction activities in the Embley River. These impacts pose a moderate risk to Dugongs in the Project area. Mitigation measures to reduce the risk of these impacts are described in **Section 5.7.3**. Impacts from loss of foraging habitat, and alienation from habitat due to underwater construction activities in the proposed port area are unlikely.

An assessment of the significance of impacts on the Dugong is provided in **Table 33**.

Table 35 summarises the potential habitats within the Project area for each threatened and migratory estuarine and marine fauna species, including Dugong, and **Table 36** summarises the amount of each habitat type to be impacted by Project activities.

Table 33 Significant Impact Assessment– Dugong (Dugong dugon)

Will the proposed works...	**Dugong *(Dugong dugon)***
... substantially modify, destroy or isolate an area of important habitat for a migratory species;	The construction of the wharf would involve pile driving. The underwater noise that would be generated by the hammer hitting the top of the pile would be of short term duration and therefore can be described as impulsive noise. The time taken to drive each pile would depend on the hardness of the seabed in each location. There is potential for marine animals in an area close to the piling to incur hearing damage as a result of the piling. It is anticipated that the construction activity would deter most marine mammals from the immediate area, however for precautionary purposes, it is proposed that a "soft-start" approach would be used to disperse animals in the vicinity prior to normal pile driving. The "soft-start" involves commencing pile driving with a partial capacity strike, or giving a warning with an underwater airgun prior to normal pile driving. The minor area of seagrass that may be impacted by dredging at the Humbug Terminal is not significant in terms of a Dugong foraging resource and is not considered to be an area of important Dugong habitat.
... result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species;	It is considered unlikely that an invasive species that is harmful to Dugong would be introduced due to the development or operation of the Project. RTA would conduct routine monitoring of the port for marine pests, similar to that currently undertaken for Port of Weipa high-risk areas.
... seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.	Refer to the above for management of potential acoustic impacts during construction. Of all potential impacts, boat strike from operation of the ferry from Hornibrook Terminal to Hey River Terminal is anticipated to represent the highest risk. RTA would operate the ferry in a manner that would minimise the impacts to Dugong. Transit lanes would be defined and implemented to reduce the overall area of disturbance from vessel activities. Serious disruption to the life cycle of an ecologically significant population of Dugong within the Project area is not anticipated.

4.7.3 Proposed Mitigation Strategies - Dugong

The key potential impacts on Dugong are boat strike from operation of the ferry from Hornibrook Terminal to Hey River Terminal and acoustic impacts from construction activities.

Transit lanes would be defined along the ferry route from Hornibrook Terminal to Hey River Terminal to reduce the overall area of disturbance from vessel activities. Where possible, these transit lanes would follow the deepest water and avoid significant meadows of seagrasses.

RTA would ensure that before beginning TSHD dredging and dumping activities during daylight hours, a check would be undertaken using binoculars from a high observation platform, for Dugongs and whales within a monitoring zone (approximately 300 metres of any point on the dredging/dumping run about to be commenced). If any Dugong or whales are sighted in the monitoring zone, dredging/dumping activities would not commence until after the last Dugong or whale is observed to leave the monitoring zone; or alternatively the dredge would to move to another area of the dredge or disposal site to maintain a minimum distance of 300 metres between the vessel and any Dugong or whale. CSDs are essentially stationary during dredging, and do not pose a risk to Dugong or whales.

Any injury or death of a Dugong or cetacean from dredging would be documented and reported within 24 hours of the incident to DERM and DSEWPaC and further monitoring and/or management requirements discussed.

It is anticipated that the construction activity would deter most marine mammals from the immediate area, however for precautionary purposes, it is proposed that a "soft-start" approach would be used to disperse animals in the vicinity prior to normal pile driving. The "soft-start" involves commencing pile driving with a partial capacity strike, prior to normal pile driving. It is proposed that an exclusion zone surrounding pile driving activities be established and monitored prior to normal pile driving commencing and during normal pile driving. Normal pile driving activities would not commence or be temporarily suspended if threatened marine fauna are observed within the exclusion zone. Pile driving activities would not recommence until threatened marine fauna are considered to be outside the exclusion zone. The extent of the exclusion zone would be defined based on further literature review and quantitative analysis of the potential underwater noise impacts from pile driving relating to threatened marine fauna. The final extent of the exclusion zone would be defined in consultation with DSEWPaC.

4.7.4 Potential Impacts on Migratory Cetaceans

This section addresses impacts on migratory cetaceans namely the Indo-Pacific Humpback Dolphin (*Sousa chinensis*), Australian Snubfin Dolphin (*Orcaella heinsohni*), and Bryde's Whale (*Balaenoptera edeni*).

The following aspects of the Project may affect migratory cetaceans:

- acoustic impacts;
- boat strike;
- direct impact from dredging activities; and
- disturbance from boating and shipping activities including alienation from habitat.

A number of human caused marine noises can be highly intensive and detectable to cetaceans at ranges of several kilometres (Gordon and Moscrop 1996). Cetaceans have been found to avoid some human sound sources for ranges of several kilometres, temporarily abandoning valuable habitat in the process (Tyack 2008). Jefferson *et al.* (2009) identified that Indo-Pacific Humpback Dolphins avoid areas during pile driving but return once construction ceases. Such short-term responses by dolphins to pile driving and other construction activities would be expected from the Project, but no significant long-term impacts are predicted.

In Australia, dolphin species co-exist with coastal development including extensive port facilities (Hale *et al.* 1998). The most important area for Indo-Pacific Humpback Dolphins in Moreton Bay is the Port of Brisbane (Hale *et al.* 1998). Indo-Pacific Humpback Dolphins and Australian Snubfin Dolphins are also associated with port infrastructure at Cleveland Bay, Townsville (Parra 2006). Bottlenose Dolphins also inhabit inshore areas where significant amounts of recreational vessel and commercial water-based activities occur including Moreton Bay (Chilvers *et al.* 2005), Richmond and Clarence Rivers (NSW) (Fury and Harrison 2008), and Port Stephens and Jervis Bay (NSW) (Möller *et al.* 2002).

The potential for boat strike on whales would be similar for Dugong in the coastal waters of the Gulf of Carpentaria, given their size and similar mobility. Whales do not inhabit the estuarine areas of the Embley and Hey Rivers. The slow moving displacement vessels that would operate in the proposed port area do not pose a boat strike risk to whales.

Similarly to Dugong, despite dredgers being slow moving displacement vessels, mitigation strategies would be employed during dredging to prevent direct impact on cetaceans from dredging activities (refer **Section 5.7.5**).

The potential for boat strike on dolphins would be less than for Dugongs. Similar to Dugongs, strike by slow moving displacement vessels operating in the proposed port area and Embley and Hey Rivers does not pose a risk. The ferry that would operate in the Embley and Hey Rivers presents a low risk of strike, compared to the moderate risk for Dugong, on the basis that dolphins are more agile and able to better react to and avoid approaching vessels.

The potential impacts of disturbance from boating and shipping activities and possible alienation from

habitat are considered minor, particularly given that preferred pelagic foraging habitats are not located in the Embley and Hey Rivers where the ferry would provide transportation services.

The only relevant impact to migratory cetaceans within the Project area would be the temporary avoidance of areas due to pile driving. Impacts from boat strike and alienation from habitat due to boating and shipping activities are unlikely.

An assessment of the significance of impacts on all EPBC Act listed migratory cetaceans that are known or likely to occur within the Project area are considered together in **Table 34** as the impacting processes are the same and the likely responses are similar.

Table 35 summarises the potential habitats within the Project area for each threatened and migratory estuarine and marine fauna species, including migratory cetaceans, and **Table 36** summarises the amount of each habitat type to be impacted by Project activities.

Table 34 Significant Impact Assessment– Indo-Pacific Humpback Dolphin, Australian Snubfin Dolphin and Bryde's Whale

Will the proposed works...	**Indo-Pacific Humpback Dolphin (*Sousa chinensis*), Australian Snubfin Dolphin (*Orcaella heinsohni*) and Bryde's Whale (*Balaenoptera edeni*)**
... substantially modify, destroy or isolate an area of important habitat for a migratory species;	Cetaceans may be impacted by: disturbance from boating and shipping activities including alienation from habitat, acoustic impacts, boat strike and creation of an offshore turbidity plume during dredging. The construction of the wharf would involve pile driving. The underwater noise generated by the hammer hitting the top of the pile would be of short term duration and therefore can be described as impulsive noise. The time taken to drive each pile would depend on the hardness of the seabed in each location. There is potential for marine animals in an area close to the piling to incur hearing damage as a result of the piling. It is anticipated the construction activity would deter most marine mammals from the immediate area, however for precautionary purposes, it is proposed that a "soft-start" approach would be used to disperse animals in the vicinity prior to normal pile driving. The "soft-start" involves commencing pile driving with a partial capacity strike, or giving a warning with an underwater airgun prior to normal pile driving. Construction of the proposed port, operation and spoil disposal are not anticipated to substantially modify important habitat for the migratory species confirmed as known or possible to occur within the Project area.
... result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species;	The Project is unlikely to lead to the introduction of any invasive fauna that could affect migratory species. RTA would conduct routine monitoring of the port for marine pests, similar to that currently undertaken for Port of Weipa high-risk areas.
... seriously disrupt the lifecycle (breeding, feeding, migration or resting behavior) of an ecologically significant proportion of the population of a migratory species.	Dolphins present within the Project area are not identified as representing a significant proportion of the population of their respective species. The Project area is not preferred habitat for Bryde's Whale and any occurrence would be sporadic. They are highly unlikely to occur in the Embley and Hey Rivers. There is the potential for alienation of cetaceans in the immediate vicinity of the port and barge/ferry terminal areas primarily during construction activities, particularly during pile driving for the bulk loading wharf. Soft-start pile driving procedures are proposed to limit disturbance during pile driving activities. Disturbance in estuarine areas would be minor and not represent any substantial barrier to the movement of dolphins. Dolphins and whales would not be restricted in their movement around port area wharf construction. No significant impact to the lifecycle of dolphins is likely. No meaningful disruption to the lifecycle of Bryde's Whale would occur as a result of the Project given that the Project area is not preferred habitat and any occurrence would be sporadic.

4.7.5 Proposed Mitigation Strategies – Migratory Cetaceans

RTA would ensure that before beginning trailing suction hopper dredging and dumping activities during daylight hours, a check would be undertaken using binoculars from a high observation platform, for Dugongs and whales within a monitoring zone (approximately 300 metres of any point on the dredging/dumping run about to be commenced). If any Dugong or whales are sighted in the

monitoring zone, dredging/dumping activities would not commence until after the last Dugong or whale is observed to leave the monitoring zone; or alternatively the dredge would to move to another area of the dredge or disposal site to maintain a minimum distance of 300 metres between the vessel and any Dugong or whale. Cutter suction dredges are essentially stationary during dredging, and do not pose a risk to Dugong or whales. Any injury or death of a Dugong or cetacean from dredging would be documented and reported within 24 hours of the incident to DERM and DSEWPaC and further monitoring and/or management requirements discussed.

It is anticipated that the construction activity would deter most marine mammals from the immediate area, however for precautionary purposes it is proposed that a "soft-start" approach would be used to disperse animals in the vicinity prior to normal pile driving. The "soft-start" involves commencing pile driving with a partial capacity strike, prior to normal pile driving. It is proposed that an exclusion zone surrounding pile driving activities be established and monitored prior to normal pile driving commencing and during normal pile driving. Normal pile driving activities would not commence or be temporarily suspended if threatened marine fauna are observed within the exclusion zone. Pile driving activities would not recommence until threatened marine fauna are considered to be outside the exclusion zone. The extent of the exclusion zone would be defined based on further literature review and quantitative analysis of the potential underwater noise impacts from pile driving relating to threatened marine fauna. The final extent of the exclusion zone would be defined in consultation with DSEWPaC.

4.7.6 Summary of Threatened and Migratory Estuarine and Marine Fauna Habitat Impacts

Table 35 summarises the potential habitats within the Project area for each threatened and migratory estuarine and marine fauna species, and **Table 36** summarises the amount of each habitat type to be impacted by Project activities.

Table 35 Summary of Threatened and Migratory Estuarine and Marine Species' Habitat

Species	Habitat
Hawksbill Turtle (*Eretmochelys imbricata*)	Foraging habitat: Rocky reef and coral reef habitats. Feeds on algae, seagrass and sponges (Limpus 2009a).
Flatback Turtle (*Natator depressus*)	Foraging habitat: Shallow coastal environments including rocky reef and sedimentary habitats. Feeds on a wide variety of soft-bodied animals including soft corals, sea pens, sea cucumbers, jellyfish and other large plankton (Limpus 2007).
Olive Ridley Turtle (*Lepidochelys olivacea*)	Principally shallow unvegetated coastal environments. Principally feeds on gastropod molluscs and crabs (Limpus 2008b).
Leatherback Turtle (*Dermochelys coriacea*)	Oceanic environments from the sea surface to the seabed. Principally feeds on colonial ascidians such as *Pyrosoma* spp., jellyfish such as *Catostylus* spp. and other soft-bodied invertebrates (Limpus 2009b).
Loggerhead Turtle (*Caretta caretta*)	A wide range of intertidal and subtidal habitats including coral and rocky reefs, seagrass meadows, and unvegetated sand or mud areas. Although their diet is diverse, typical items include bivalve and gastropod molluscs and crabs (Limpus 2008a).
Green Turtle (*Chelonia mydas*)	Foraging habitat: Shallow coastal area, in particular seagrass beds including the Embley and Hey Rivers. Feeds on seagrass and seaweeds, although juveniles are also carnivorous (Brand-Gardner *et al.* 1999).
Dwarf Sawfish (*Pristis clavata*)	Dwarf Sawfish inhabit shallow (2–3m) coastal waters and estuarine habitat, moving into marine waters after the wet season, and during the wet season enter estuarine or fresh waters to breed. They feed principally on schooling fish, particularly mullet. This species has not been recorded in surveys of the Project area but is considered likely to occur in the estuarine and lower brackish reaches of the Project area's main drainage systems. Preferred habitat identified on the basis of capture locations include open estuarine

Species	Habitat
	channels and silty sand flats lacking structure with fine substrates (mainly silt), high turbidity and often with low dissolved oxygen.
Green Sawfish (*Pristis zijsron*)	Green Sawfish inhabit estuaries, river mouths, embayments and along muddy and sandy beaches. They feed primarily on shoaling fish, baitfish, prawns, molluscs and small crustaceans. Sawfish may move into marine waters after the wet, and during the wet season enter estuarine or more fresh waters to breed (Peverell 2005). This species has not been recorded in surveys of the Project area but it has been recorded from Albatross Bay. The Project area, including the port development area and barge/ferry terminals in the Embley and Hey Rivers, contain suitable habitat for the species.
Freshwater Sawfish *(Pristis microdon)*	Preferred habitat is mud bottoms of river embayments and estuaries, but they are also found well upstream (Allen 1997). They are usually found in turbid channels of large rivers over soft mud bottoms (Allen 1991) more than 1m deep, but they will move into shallow waters when traveling upstream or while hunting prey (Wilson 1999). This species may occur in estuarine and the lowermost freshwater reaches within the Project area. Suitable habitat is present in the brackish reaches of Norman Creek and the Ward River.
Speartooth Shark (*Glyphis* sp. A)	Relatively shallow, upper freshwater, and possibly brackish, reaches of rivers and associated floodplains. Seem to be particularly adapted to low oxygen environments. This species may occur in estuarine and the lowermost freshwater reaches within the Project area.
Estuarine Crocodile (*Crocodylus porosus*)	Mangrove and estuaries provide year round foraging and shelter habitat. Foraging and nesting habitat for the Estuarine Crocodile occurs within freshwater reaches of Norman Creek, Winda Winda Creek and the Ward River during the wet season, including within the footprint of Dam C and on the Ward River downstream of the proposed pump location.
Dugong (*Dugong dugon*)	Dugong almost solely consume seagrass, however, Dugongs prefer seagrasses that are early or "pioneer" species, particularly species of the genera *Halophila* and *Halodule* (DEWHA 2010d). The long, strap-like seagrass *Enhalus acoroides* that dominates the seagrass beds of the Embley and Hey Rivers, is not a preferred species in the Dugong diet.
Indo-Pacific Humpback Dolphin (*Sousa chinensis*) Australian Snubfin Dolphin (*Orcaella heinsohni*).	The Indo-Pacific Humpback Dolphin and Australian Snubfin Dolphin usually inhabit shallow coastal waters less than 20m deep and are often associated with tidal riverine and estuarine systems, enclosed bays and coastal lagoons (Corkeron *et al.* 1997; Hale *et al.* 1998; Jefferson 2000; Parra 2006).
Bryde's Whale (*Balaenoptera edeni*)	The coastal form of Bryde's whale appears to be limited to the 200m depth contour, moving along the coast in response to availability of suitable prey (Best *et al.* 1984). The offshore form is found in deeper water (500 to 1000m). It is highly unlikely they would venture into estuarine habitats of the Embley and Hey Rivers.

Table 36 Summary of Estuarine and Marine Habitat Disturbance

Habitat Type	Habitat Area to be disturbed
Seagrass	Within or immediately adjacent to the proposed dredge footprint at Humbug Wharf a conservative estimate of less than 1.84kg dry weight seagrass biomass may be directly extracted during dredging, based on seagrass area of 1250m^2 within the dredge area. The 1250m^2 area represents about 0.003% of the seagrass meadows within the Weipa region based, on 2008 and 2009 data (Chartrand and Rasheed 2009; McKenna and Rasheed 2010).
Reefs	No reefs within the proposed port development footprint would need to be removed for dredging or wharf construction. Overall, dredging is predicted to reduce the area of favourable light conditions over hard coral habitat by approximately 32ha (14% of the 230ha of hard coral from Boyd Point to Thud point) in the short term.
Sponge/soft coral	Approximately 71ha of sponge/soft coral habitat occurs between Boyd Point and Pera Head (inclusive). Sediment deposition would be at its greatest between these two locations during dredging operations. An estimated 117ha of similar habitat occurs between Pera Head and Thud Point with more likely to occur at inshore reef areas south of Thud Point and north of Boyd Point.
Mangrove and estuary	The only Project related disturbance to estuary habitat would be the construction of the barge and ferry terminals on the Embley and Hey rivers. Construction would involve some

Habitat Type	Habitat Area to be disturbed
	dredging, reclamation and piling at the barge and ferry terminals. The respective dredge footprint areas for the Hornibrook, Hey River and Humbug barge and ferry terminals are approximately 10,450m^2, 8,250m^2, and 5,420m^2. The only disturbance to mangroves would be at the Hey River barge/ferry terminal, where removal of a relatively thin band of mangroves (approximately 400m^2 which represents 0.008% of this mangrove community within the Project area) would be required.
Freshwater stream banks	The length of potential Estuarine Crocodile nesting habitat reach that would be disturbed by the proposed Dam C footprint is 6.7km, representing approximately 9% of the total extent of the potential freshwater nesting habitat for Estuarine Crocodiles within the Project area. The total potential freshwater nesting habitat available for Estuarine Crocodiles totals 71.3km of stream reach on Winda Winda Creek, Norman Creek and tributaries, and Ward River and tributaries. Additional nesting habitat could occur on stream levees in estuary areas, and therefore the total occurrence of nesting habitat is likely to be greater.
Soft sediments	The development footprints for all marine infrastructure components of the Project (port area, proposed spoil ground, Albatross Bay spoil ground, Hornibrook ferry terminal, Humbug barge terminal and Hey River barge/ferry terminal) have been confirmed by field inspection as consisting primarily of soft sediment habitats. The development footprint for the port is approximately 1,460,062m^2. The proposed new spoil ground would have a deposition area of approximately 1 km radius from the centre of disposal. The respective dredge footprint areas for the Hornibrook, Hey River and Humbug barge and ferry terminals are approximately 10,450m^2, 8,250m^2, and 5,420m^2. All dredge areas would be required to be dredged to a target depth of –2.0mLAT, corresponding to 0–2m of material being removed.

4.8 Impacts on the Commonwealth Marine Area

The following subsections address significant impact criteria relating to the Commonwealth Marine Environment, as indicated in the *EPBC Act Policy Statement 1.1 (Significant Impact Guidelines)*, and describe the impacts of the Project.

4.8.1 Marine Pest Establishment

The effect of the Project would be to shift vessel activity associated with bauxite shipments from the Port of Weipa to the proposed port between Boyd Point and Pera Head. Bauxite has been shipped from the Port of Weipa since 1963. The risk of introduction of marine pests is likely to be similar to the current risks associated with Port of Weipa operations. No pest species have become established at the Port of Weipa (PCQ 2007) and the risk of establishment at the proposed port is low.

All vessels owned and contracted by Rio Tinto would manage ballast water through a Ballast Water Management Plan which would comply with Australian mandatory requirements (the *Australian Ballast Water Management Requirements* (DAFF 2008)), and the *International Convention for the Control and Management of Ships Ballast Water and Sediments* (IMO 2004). There would be no hull cleaning at the proposed port, however pests may still be present on ships hulls. Monitoring would be undertaken to provide a means of early detection of introduced pests. RTA would complete baseline monitoring followed by three-monthly mussel larval monitoring in the vicinity the new port at such time when overseas ships are utilised. If an abnormal growth of organisms is detected, an appropriate response would be developed in consultation with relevant regulatory authorities. Monitoring procedures would follow methodology adopted by the Port of Weipa. Vessels used for port area dredging would be inspected for introduced marine pest species and cleaned if necessary prior to establishment.

It is likely that construction dredging for the port area would require the services of internationally sourced dredgers. RTA's proposes to manage the potential for introduced marine pest incursions from this source based on a risk-based approach. Initially, this would be based on a review of the ships work and maintenance history. Where operations or duration since last maintenance period are extended or the information not provided, certification from the dredging contractor by way of hull inspection clearance would be requested. Clearance of the vessel for fouling prior to its mobilisation to Australia would be considered as an item for contract, including diver or dry dock inspection. This approach is consistent with the biofouling risk assessment framework outlined within the *National*

Biofouling Guidance for Non-trading Vessels (Commonwealth of Australia, 2008).

4.8.2 Ecosystem Function or Integrity

The infaunal benthic assemblages in sub-tidal areas of the Gulf of Carpentaria consist primarily of overlapping species distributions rather than highly structured, discrete communities with well defined characteristics of the community (Long and Poiner 1994). The development footprint for the port and proposed new spoil ground consist primarily of soft sediments.

It is anticipated that the spoil ground would receive 3-4m thickness of dredge spoil from capital dredging, and an annual maintenance dredging load of about 0.4m, therefore localised smothering of sediments would be significant. These soft sediment habitats are common throughout the Gulf of Carpentaria and are not considered to be sensitive marine habitats and are therefore not areas of high importance. Any areas affected would be extremely small relative to the area of unvegetated sedimentary habitats in the region. Despite the potentially significant local impact on the infauna assemblage through smothering during capital dredging spoil disposal, physical disturbance of the dredge sites, deposition of spoil, and the re-suspension of disturbed and deposited sediment poses a low risk on a regional scale.

The Project would not disturb an important or substantial area of habitat in causing adverse impacts on ecosystem functioning or integrity in a Commonwealth marine area.

4.8.3 Affects on Marine Species

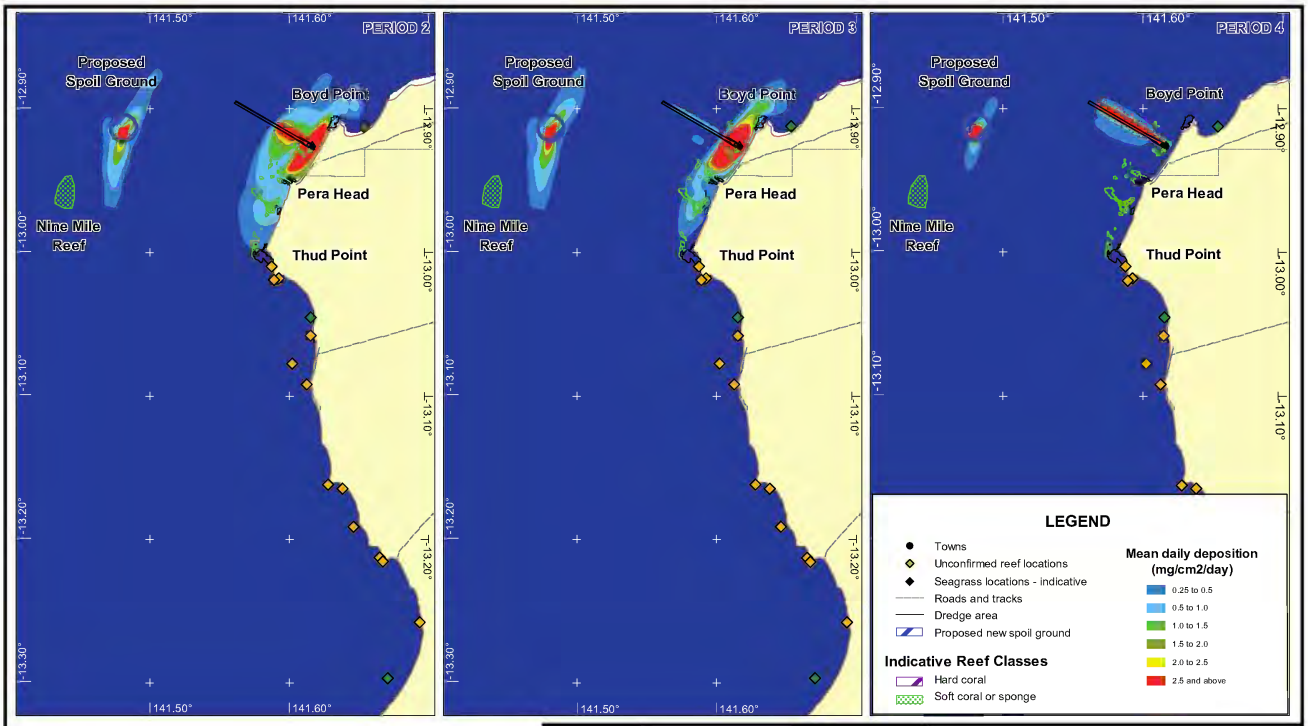
Near shore fringing reef communities in the vicinity of the proposed port area occur approximately 2km to the north-east at Boyd Point, approximately 2km to the south-west at Pera Head, and also between Pera Head and Thud Point, all within State waters. These comprise both reefs containing hard corals and low profile reefs containing soft coral/sponge assemblages. Hard corals over the reef areas include species from the following genera: *Porites*, branching *Acropora*, *Turbinaria*, *Monitipora*, *Lobophyllia*, *Platygyra*, *Pavona* and *Favia*. Satellite imagery indicates there may be numerous small reef outcrops between Thud Point and Aurukun; however their presence and characteristics were not verified via bathymetric survey or site inspection. Nine Mile Reef is located approximately 6km to the south-south-west of the proposed disposal ground in the Commonwealth marine area. The diverse reef assemblages provide a food source for marine turtles.

The creation of a turbidity plume from proposed dredging activities, and subsequent deposition and re-suspension of fine sediments, would potentially impact reef assemblages.

Three light regimes related to coral sustainability were developed based on the relationship between TSS and light: "favourable", "light limited" and "unsustainable". Using TSS values from plume dispersion modelling and reef habitat depth profiles, a prediction of impact based on benthic light availability was made for reef habitats of the study area between Boyd Point and Thud Point during inshore and offshore dredging.

Modelling indicates that 86-89% of the hard coral reef habitat area mapped around Boyd Point, Pera Head and Thud Point would maintain a "favourable" light regime throughout the dredging program and is not considered to be at risk. The remaining reefs, during the peak plume period, would experience periods of reduced light availability for durations similar to ambient light reduction events recorded at Boyd Point during field investigations. However, the predicted plume TSS concentrations would remain well below reported maximum ambient concentrations. Whilst the change in light availability is not considered sufficient to initiate an acute response, the rate at which these corals can acclimatise is not well defined, and they may remain at risk of developing sub-lethal responses to reduced light regimes. Modelling results indicate that, following the peak plume period, the receiving habitats enter a period of respite, where TSS reductions result in substantial improvements to the light climate. Given the relatively short duration of light attenuation, and general respite provided to coral reef systems after the peak plume period, these predicted light reductions are not thought to be a driver of acute impact associated with the dredging process. The analysis did not identify any coral habitats entering "unsustainable" light regimes.

Sediment deposition modelling was used to predict sediment deposition rates over key reef habitat areas for seven different dredging periods representing different dredging activities. Sediment deposition has been plotted over key habitat areas (refer **Figure 9**). During Period 2, reefs at Pera



Source Information

Indicative Seagrass Locations
Queensland Seagrass Meadows 1984-1988 Department of Primary Industries and Fisheries 2002
Coastal Habitat Resources Information System http://chrisweb.dpi.qld.gov.au/CHRIS/
Pers. Comm. Michael Rasheed, 2010

Modeled dredge plume point data provided by WorleyParsons
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0 10km
SCALE - 1 : 350,000 (at A4)
Latitude / Longitude
Geocentric Datum of Australia 1994

Rev	Date	Revision Description	ORIG	CHK	ENG	APPD
B	29/03/2011	Re-issued for review	DH	MM		
A	01/12/2010	Issued for review	JC	DH		

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Figure 9 - Dredge plume deposition model for port area dredging and disposal at proposed spoil ground (Periods 2-4)

Project No: 301001-01069	Figure: 01069-00-GM-EN-0030	Rev: B

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Head are predicted by the model to receive a median deposition rate of 3.9 – 4.4mg/cm^2/day, while reef systems south of Pera Head to Thud Point are predicted to experience median daily exposure of 2.7 – 3.4 mg/cm^2/day for the duration of the Period 2 dredging (approximately 4 weeks). These levels are higher than the recommended mean annual concentration of 3mg/cm^2/day to guard against excessive coral recruit mortality (De'ath and Fabricius 2008), but lower than the recommended daily maximum of about 15mg/cm^2/day. Similar distributions would be experienced during Period 3, though the extent of affect is markedly reduced. During Period 4, the footprint of deposition would remain relatively localised around the dredge channel. Deposition during Period 2 therefore represents a potential risk of mortality to coral recruits, however corals already established on the reef are likely to be more resilient than recruits as demonstrated by colony survival following natural events where deposition rates can be significantly higher than the recommended daily maximum level.

Approximately 71ha of sponge/soft coral habitat occurs between Boyd Point and Pera Head (inclusive). It is predicted that deposition would be at its greatest between these two locations and may locally affect feeding preferences in marine turtles. It is estimated that 117ha of similar habitat occurs between Pera Head and Thud Point, with more likely to occur at inshore reef areas south of Thud Point and north of Boyd Point, so regional impacts to feeding habitats are not predicted.

Modelling indicates that there would be negligible increase in turbidity or sediment deposition at Nine Mile Reef, and therefore habitat at Nine Mile Reef would not likely be impacted by dredging or spoil disposal.

The placement of dredged material at the proposed new offshore spoil ground has minimal potential for substantial adverse effect on marine species. The proposed spoil ground is located in an area of essentially bare soft sediments, a dominant substrate type in the Gulf of Carpentaria, which has relatively low habitat value to listed marine species or cetaceans. The proposed spoil disposal would not likely have any significant impact on fish assemblages due to their wide distribution through tropical regions. Similarly, the Project is not likely to have any significant impact on prawn species that are the key target species for the Northern Prawn Fishery as the proposed location is not suitable juvenile prawn habitat, although it may be utilised by adult prawns.

The proposed barge and ferry terminals are in State waters. The Hornibrook Terminal and Hey River Terminal dredge footprints do not contain seagrass, however, patches of seagrass may occur in the vicinity. Isolated patches of seagrass have been identified at the spring low tide level within or immediately adjacent to the proposed dredge footprint at the Humbug barge terminal. The area of seagrass within the Humbug barge terminal dredge footprint is conservatively estimated to be 1250m^2 which represents about 0.003% of the seagrass meadows within the Weipa region. Given the minor scale and short duration of dredging, it is unlikely that sediment loads would be generated over the adjacent *E. acroides* beds at a thickness that would approach critical levels. Direct and indirect impacts on seagrass from barge/ferry terminal capital dredging are unlikely to have a substantial adverse effect on a marine species or cetacean.

The disposal of dredged spoil at the existing Albatross Bay spoil ground in Commonwealth waters is unlikely to adversely affect marine species and cetaceans. Potential impacts of the Project on EPBC Act listed marine threatened and endangered species, and EPBC Act listed marine migratory species (including cetaceans) are described in **Section 5.5** and **5.7** respectively.

The Project is not expected to have a substantial adverse impact on marine species or cetaceans in the Commonwealth marine area.

4.8.4 Changes in Water Quality

The only potential sources of air emissions that could affect the airspace over Commonwealth waters are vessel exhausts and fugitive dust from land-based mining and product handling activities. These would not cause a significant impact on biodiversity, ecological integrity, social amenity or human health in the Commonwealth marine area due to the minor extent of vessel exhausts and remoteness from land activities.

The key potential impacts of dredging and spoil disposal on water quality in Commonwealth marine waters are:

- possible mobilisation of contaminants into the water column; and
- generation and migration of turbid plumes.

Sampling and analysis of the sediment material at the proposed port and barge/ferry terminals was undertaken to determine background concentrations of trace metals, nutrients and organotin concentrations. Sediment sampling, analysis and results are discussed in the following sub-sections on sediment quality. There are no chemical impediments to unconfined sea disposal of dredge spoil. Therefore no significant impact on the water quality of the Commonwealth marine area due to the mobilisation of contaminants into the water column is expected.

Background concentrations of turbidity and suspended sediment at the proposed port, new spoil ground and proposed ferry and barge facilities vary considerably over daily and seasonal timescales, which is a typical feature of inshore habitats in silty environments. The extent of this natural variation would buffer water quality impacts associated with dredging, disposal, construction and operation to some extent. Generally, habitats at the proposed port, new spoil ground and proposed ferry and barge facilities may be described as being more resilient to short-term water quality changes.

During dredging activities some sediment would become mobilised from the dredge head into the water column and disperse from the point of disturbance subject to prevailing hydrodynamic conditions.

Turbidity generated by the proposed dredging within the Embley River and Hey River would likely fall within the natural range for variability (refer Section 6.9.2 of the EIS). However, turbidity generated by dredging within the proposed Port Area between Boyd Point and Pera Head would likely exceed naturally occurring perturbations, particularly with respect to event duration. The migration and dispersion of turbid plumes during dredging at the proposed port area and disposal at the proposed new spoil ground has been predicted through modelling.

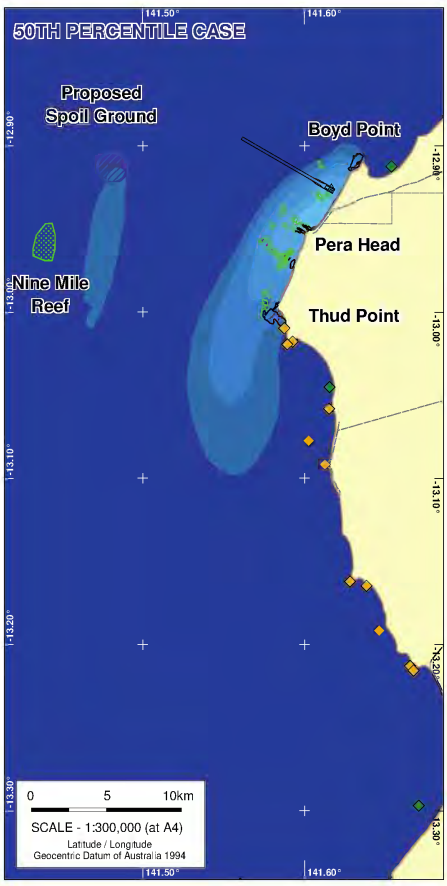
Modelled Total Suspended Solid (TSS) time series data for plume dispersion modelling from Pera Head and Boyd Point have been divided into seven distinct dredging periods. Period 1 represents an initial phase of inshore and offshore dredging of layer 1 using just a CSD and as a result TSS concentrations remain relatively low throughout this period. Period 2 represents dredging of layer 1 in the inshore area by the TSHD, while period 3 represents dredging of layer 2 in the inshore area by the TSHD. Periods 4 and 5 represent dredging of layer 3 by the TSHD in the offshore and inshore areas respectively, while periods 6 and 7 represent dredging of layer 4 by the TSHD in the offshore and inshore areas respectively.

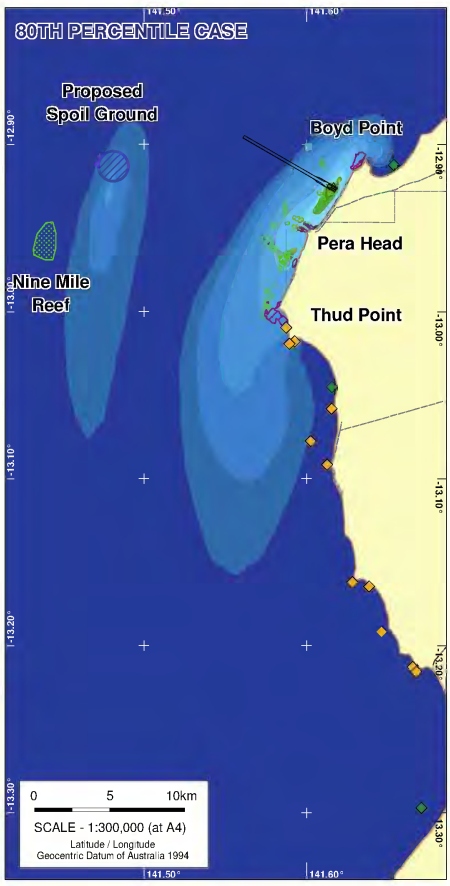
The median and 80th percentile TSS concentrations from the dredge plume dispersion model have been plotted spatially for Periods 2, 3, and 4 as representing inshore dredging (layer 1), inshore dredging (layer 2), and respite periods (offshore dredging, layer 3) respectively (refer **Figure 10a (Period 2), Figure 10b (Period 3) and Figure 10c (Period 4)**). Periods 5-7 are not shown to avoid duplication as their TSS concentrations are suitably represented by periods 3 and 4. Modelling results indicate that Commonwealth marine waters south of Thud Point would experience an increase in TSS concentrations above background during both inshore and offshore dredge operations.

Under ambient conditions, Boyd Point and Pera Head reef areas demonstrate a high variation in turbidity, driven primarily by local wind and associated wave events. For example, Pera Head data loggers deployed during 2007–2008 recorded turbidity event periods of 9 and 24 days duration at median event concentrations of 248mg/L and 127mg/L respectively. Modelled median plume concentrations from all periods remain below these event-based ambient ranges reported from reef habitats, including locations south of Pera Head.

Modelling of turbid plumes at the proposed new spoil ground, located in Commonwealth waters, identified a median TSS concentration of less than 0.5mg/L above background and a maximum of 13mg/L above background over the dredging and disposal period of 36 weeks. These concentrations at the proposed new disposal ground are relatively low due to an increased dilution within the water column (i.e. depth averaged concentration), low duration (disposal approximately every four hours) and prevailing southerly currents providing dispersion.

Ambient median (background) TSS has been measured at inshore locations as 15mg/L. The durations of TSS plume concentrations at or above 5mg/L, 10mg/L and 15mg/L above background have been extracted from the model for plume Period 2 and Period 3 (refer **Figure 11**). This is a duration based plot based on percentage occurrence of concentrations for plume Period 2 and 3. The 5mg/L case extends to 1-2km north of Thud Point during Period 2, while Period 3 it remains local to the dredge.





LEGEND

- Towns
- Unconfirmed reef locations
- Seagrass locations - indicative
- Roads and tracks
- Dredge area
- Proposed new spoil ground

Indicative Reef Classes

- Hard coral
- Soft coral or sponge

Median TSS above ambient mg/L

- 0.25 to 0.5
- 0.5 to 1
- 1 to 2
- 2 to 3
- 3 to 4
- 4 to 5
- 5 to 6
- 6 to 7
- 7 to 8
- 8 to 9
- 9 to 10
- 10 to 11
- 11 to 12
- 12 to 13
- 13 to 14
- 14 to 15
- 15 to 16

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Pers. Comm. Michael Rasheed, 2010

Modeled dredge plume point data provided by WorleyParsons Newcastle office on 19/07/2010.

Rev	Date	Revision Description	ORIG	CHK	ENG	APPD
D	28/04/2011	Re-issued for information	KM	DH		

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Figure 10a - Dredge plume dispersion model (median and 80th percentile cases) for port area dredging and disposal at proposed new spoil ground (Period 2)

Project No: 301001-01069	Figure: 01069-00-GM-EN-0010	Rev: D

Compiled by BRISBANE GEOMATICS

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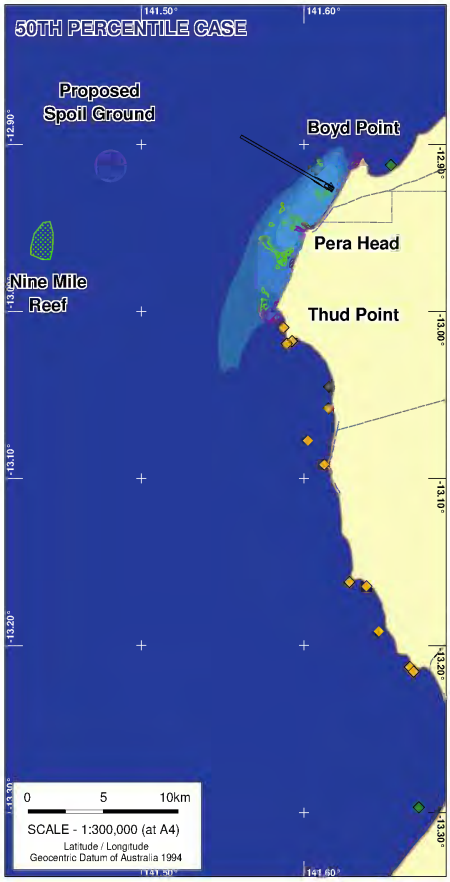

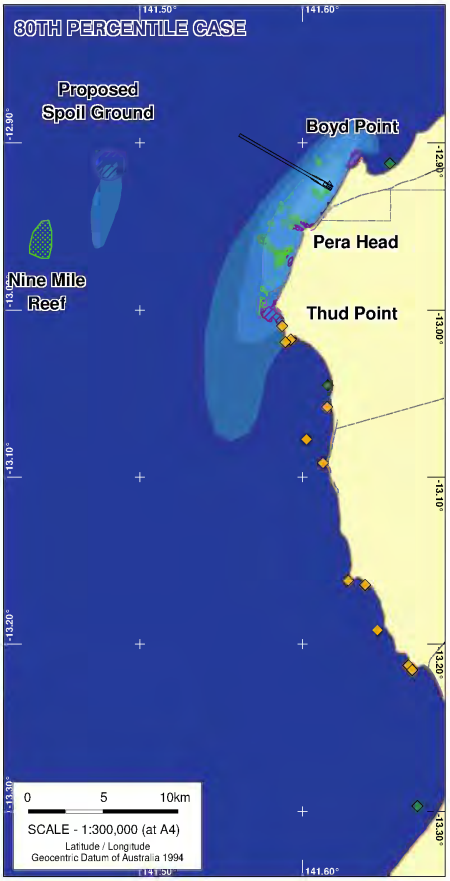

LEGEND

- Towns
- Unconfirmed reef locations
- Seagrass locations - indicative
- Roads and tracks
- Dredge area
- Proposed new spoil ground

Indicative Reef Classes

- Hard coral
- Soft coral or sponge

Median TSS above ambient mg/L

- 0.25 to 0.5
- 0.5 to 1
- 1 to 2
- 2 to 3
- 3 to 4
- 4 to 5
- 5 to 6
- 6 to 7
- 7 to 8
- 8 to 9
- 9 to 10
- 10 to 11
- 11 to 12
- 12 to 13
- 13 to 14
- 14 to 15
- 15 to 16

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Coastal Habitat Resources Information System http://chrisweb.dpi.qld.gov.au/C-HRIS/
Pers. Comm. Michael Rasheed, 2010

Modeled dredge plume point data provided by WorleyParsons Newcastle office on 19/07/2010.

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D	28/04/2011	Re-issued for information	DH	MM		

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South of the Embley Project

Figure 10b - Dredge plume dispersion model (median and 80th percentile cases) for port area dredging and disposal at the proposed new spoil ground (Period 3)

Project No: 301001-01069	Figure: 01069-00-GM-EN-0011	Rev: D

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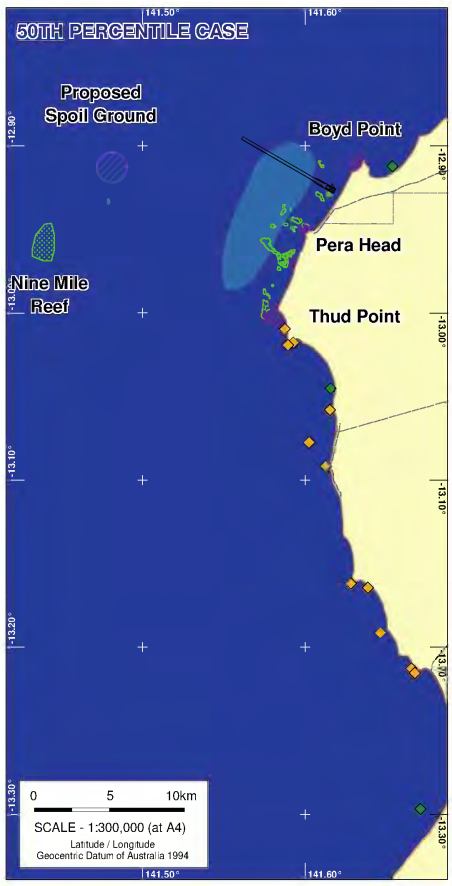

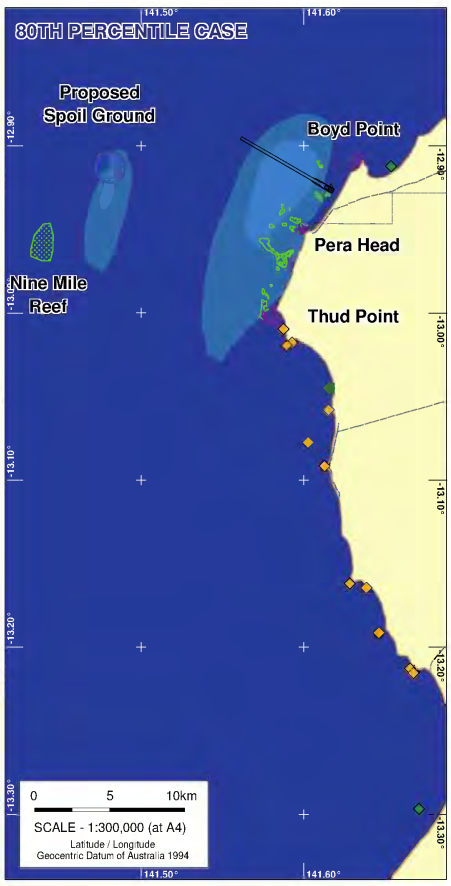

LEGEND

- Towns
- Unconfirmed reef locations
- Seagrass locations - indicative
- Roads and tracks
- Dredge area
- Proposed new spoil ground

Indicative Reef Classes

- Hard coral
- Soft coral or sponge

Median TSS above ambient mg/L

- 0.25 to 0.5
- 0.5 to 1
- 1 to 2
- 2 to 3
- 3 to 4
- 4 to 5
- 5 to 6
- 6 to 7
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Pers. Comm. Michael Rasheed, 2010

Modeled dredge plume point data provided by WorleyParsons Newcastle office on 19/07/2010.

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B	28/04/2011	Re-issued for information	KM	DH		
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Figure 10c - Dredge plume dispersion model (median and 80th percentile cases) for port area dredging and disposal at the proposed new spoil ground (Period 4)

Project No: 301001-01069	Figure: 01069-00-GM-EN-0028	Rev: B

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The 10mg/L case during Period 2 extends from Pera Head to Boyd Point, while during Period 3 it is restricted to within the immediate location of the area to be dredged. Results show that concentrations in excess of 15 mg/L are not predicted to occur beyond Pera Head or Boyd Point for any of the periods for over 5% of the time. It is only during Period 2 that TSS concentrations in excess of 15mg/L would occur for more than 5% of the time, and these concentrations would not occur for more than 20% of the time. Period 4 TSS concentrations would not exceed 5mg/L, so an exceedance figure is not presented.

Given a predicted peak plume period of approximately 25 days (approximately the same as natural event durations of 30 days), only areas identified as having a duration exceedance approaching 100% may be described as approaching the currently understood limits of natural conditions (see **Figure 11)**. Given this comparison, plume duration effects at the 15mg/L concentration beyond that encountered during ambient events would not experienced throughout any of the dredge periods.

The disposal plumes would tend to disperse along a south-southeast trajectory due to tidal currents and would not adversely affect Nine Mile reef, which is located approximately 6km south-south-west of the spoil ground. Modelling has predicted that a median TSS of less than 0.2mg/L and maximum of 1.2mg/L above background would occur over Nine Mile reef habitat. These increases are negligible given background TSS characteristics at offshore areas, as represented by existing conditions at the proposed spoil ground where TSS recorded a median of 33mg/L, mean of 135mg/L and maximum of 1056mg/L during the Project's in-situ logger program.

The material that would be dredged from the barge/ferry terminals has physical characteristics similar to Weipa shipping channel (South Channel) sediments. GHD (2005) has previously carried out an impact assessment study in relation to capital dredging of the shipping channel and placement of the material at the Albatross Bay spoil ground. The study examined impacts from capital dredging campaign involving a much larger volume (greater than 3,000,000m^3) of maintenance and capital material. It concluded that the impacts to sensitive areas, such as seagrass meadows to the north-east, from migration of material would be low because the material is predicted to migrate south towards the South Channel. Modelling of turbidity plumes identified that turbidity generated at the Albatross Bay spoil ground following release would travel a maximum of 3km within 11 hours of placement and that this would not extend to sensitive areas.

The combined volume of material that would be dredged from the Embley and Hey River dredge areas is very small compared to routine maintenance dredging at the Port of Weipa. Since the material that would be placed at the Albatross Bay spoil ground would likely migrate towards the existing shipping channel and plumes not extend to sensitive habitats, it is concluded that the potential for impact on sensitive habitats is very low. Consequently, modelling was not undertaken as part of the present study.

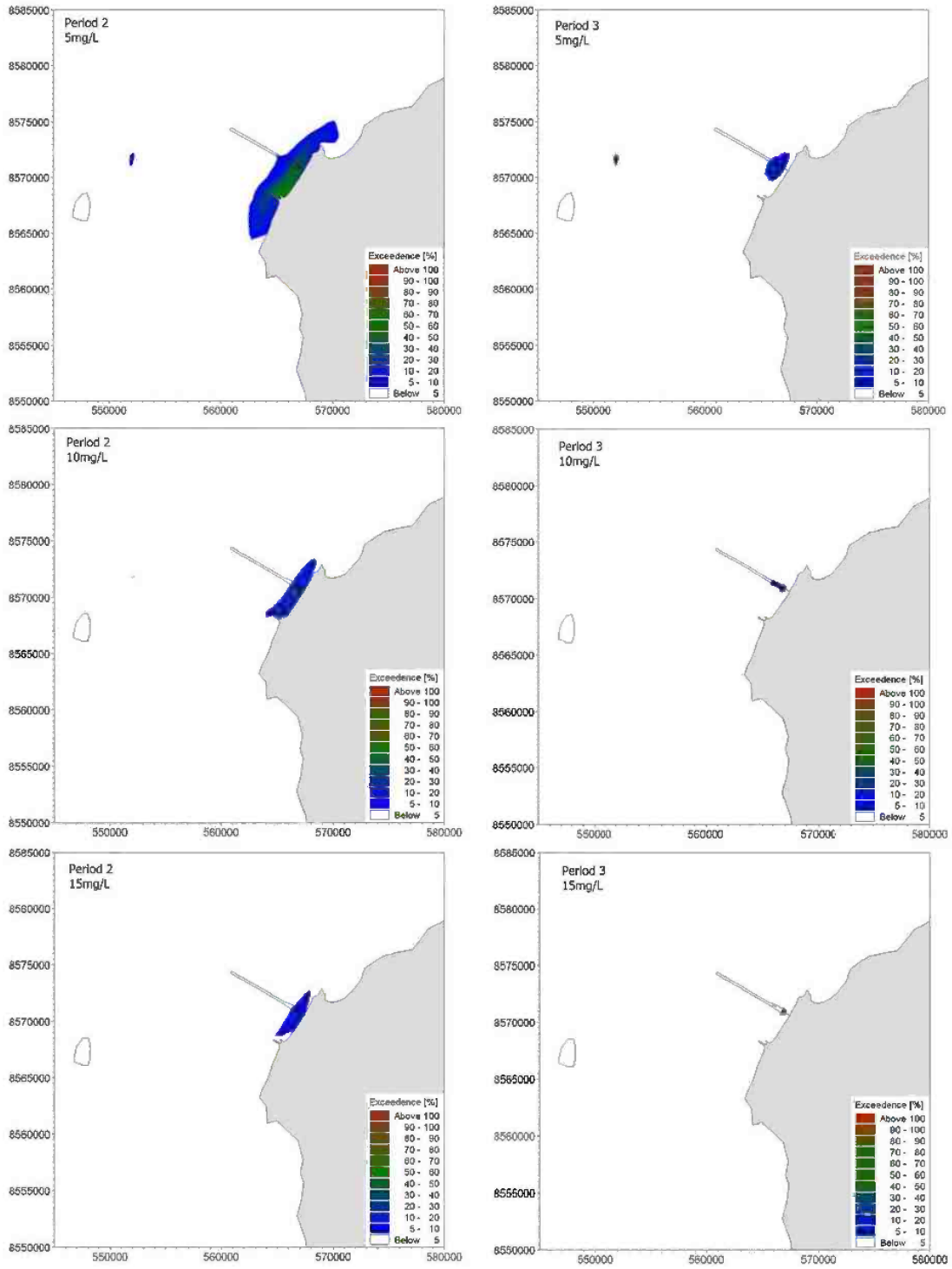

Figure 11 **Percentage exceedence plots: 5mg/L (top), 10mg/L (middle) and 15mg/L (bottom) for dredge Period 2 (left) and dredge Period 3 (right)**

4.8.5 Impacts of Turbid Plumes on Marine Habitat and Marine Fauna in Commonwealth Marine Areas

The creation of a turbidity plume, and subsequent deposition and re-suspension of fine sediments would likely to affect macrobenthic infaunal assemblages in Commonwealth marine areas at the site of the proposed port facility, new spoil ground and the Albatross Bay spoil ground. Despite the potentially significant local impact on the infauna assemblage the impacts would pose a low risk on a regional scale.

Macrobenthic infaunal assemblages can recover over time from the impacts of dredging and spoil disposal. Recovery of the macrobenthic assemblage from spoil deposition at the current Weipa spoil ground in Albatross Bay is considered to be rapid (GHD 2005). Macrobenthic infaunal assemblages in the region are exposed to periodic but significant physical disturbance and elevated turbidity occurring during extreme weather events.

The creation of a turbidity plume from dredging activities, and subsequent deposition and re-suspension of fine sediments would potentially impact on the foraging habitat of marine turtles and Dugong. However potential foraging habitat for these species (sea grass and inshore reef assemblages) does not occur in Commonwealth waters in the vicinity of the Project area.

The fish assemblage is exposed to periodic but significant physical disturbance and elevated turbidity during extreme weather events. Fish species are also mobile and as such can move away from any local areas that are affected by a disturbance (e.g. dredging and dredge spoil deposition). Physical disturbance to the proposed dredged site, deposition of spoil, and the re-suspension of disturbed and deposited sediment probably would have impacts of a minor magnitude at the proposed port facility, the proposed new spoil ground, and the ferry/barge terminals. The Project is predicted to pose a low risk to bony fishes and sharks and rays, including sawfishes.

Port site sediment quality

Sampling and analysis of the sediment material at the proposed port was undertaken in accordance with the *National Assessment Guidelines for Dredging* (NAGD) (Commonwealth of Australia 2009) to determine background concentrations of trace metals, particle size distribution, nutrients and organotin concentrations. The assessment of dredged material for the Project is also consistent with the assessment guidance described in Annex 2 of the *1996 Protocol to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter 1972* (now known as the London Protocol) and the *Waste Specific Guidelines for Assessment of Dredged Material* (IMO 2000). Sediment sampling has been undertaken in accordance with *Sampling and Analysis Plans* (SAPs) approved by DSEWPaC (formerly DEWHA). All sampling locations and results of analyses for the proposed port area are presented in Section 6 of the EIS.

Results from inshore surveys in 2007 and 2009 were pooled for the purposes of assessment against the NAGD Table 2 screening levels at the 95% confidence level of the mean (95%UCL; i.e. the upper limit of the sample mean, with 95% confidence). Results from a predominately offshore 2010 survey were assessed separately to the 2007 and 2009 sampling due to the significantly different dredge footprint areas assessed. Assessments for metal toxicity in water (via Elutriate analysis) and metals bioavailability (via dilute acid extraction (DAE)) for trace elements were undertaken in accordance with NAGD requirements.

In accordance with the potential contaminant assessment framework in the NAGD, there would be no chemical impediments to unconfined sea disposal of dredge spoil from the proposed port development site on the basis of the following.

- Despite some samples of antimony and nickel marginally exceeding respective screening levels in 2007, all contaminant substances were below respective NAGD screening levels at the 95%UCL of the mean.
- Organotins were not detected in the sediments.
- DAE metal concentrations were not above screening levels.
- Allowing for minimal dilution following disposal at the spoil ground for copper, cobalt and zinc, the dredge material would readily achieve the respective ANZECC/ARMCANZ (2000) 95% species protection level toxicant guideline values.

Periodic alterations in chemical water quality are currently experienced during event based elevations in ambient turbidity. These alterations include natural increases in nutrient and metal concentrations as fine sediments are mobilised throughout the water column. Seasonal alterations in chemical water quality are also experienced during the monsoon and cyclone periods. Impacts on chemical water quality attributable to the proposed dredging and disposal are expected to be minor in duration and extent, and well below those natural variations experienced during the wet season. No significant impact on the water quality of the Commonwealth marine area is expected.

Barge/ferry terminal dredge site sediment quality

Sediment sampling and analysis were undertaken in accordance with SAPs approved by DSEWPaC (formerly DEWHA) on sediments that would be dredged from the Hornibrook, Humbug and Hey River terminals to determine suitability for unconfined ocean disposal at the Albatross Bay spoil ground. The proposed dredge footprint, all sampling locations and results of analyses for the barge/ferry terminals are presented in Section 6 of the EIS and summarised below.

At Humbug Terminal, no contaminants in sediments exceeded NAGD screening levels for any samples, however one sample contained mercury at the screening level. Despite this, the mean and 95% UCL of the mean for all contaminants were below respective NAGD screening levels. Based on this assessment it is considered that dredge material from the Humbug Terminal area would be suitable for unconfined ocean disposal at the Albatross Bay spoil ground.

Analyses of sediment samples collected from the Hey River Terminal location, demonstrated that all but one contaminant, if present, were below respective NAGD screening level criteria. Arsenic is the exception, with three of the seven sites exceeding the NAGD screening level of 20mg/kg. The mean and the 95% UCL of the mean were also above the NAGD screening levels. Further testing of sediments identified that the arsenic had low bioavailability, with concentrations well below the NAGD screening level and minimal dilution during disposal would result in elutriate water arsenic concentrations meeting ANZECC/ARMCANZ (2000) low reliability water quality guidelines. Accordingly, the sediments that would be dredged from the Hey River Terminal area would be suitable for unconfined ocean disposal at the Albatross Bay spoil ground.

Chemical analyses of sediments that would be dredged from Hornibrook Terminal area demonstrate that potential contaminants, if present, would be below respective NAGD screening level criteria for individual samples, the mean and 95% UCL of the mean. Based on this assessment it is considered that dredge material from Hornibrook Terminal area would be suitable for unconfined ocean disposal at the Albatross Bay spoil ground.

The material that would be dredged from the barge/ferry terminals has physical characteristics similar to Weipa shipping channel (South Channel) sediments. GHD (2005) has previously carried out an impact assessment study in relation to capital dredging of the shipping channel and placement of the material at the Albatross Bay spoil ground. Based on this report, it is concluded that the potential for impact on sensitive habitats is very low. Therefore, no impact on the water quality of the Commonwealth marine area from barge/ferry terminal spoil disposal is expected.

Maintenance Dredging

Future maintenance dredging and disposal for the port site, and Embley and Hey River terminals would follow testing and reporting procedures outlined within the NAGD (Commonwealth of Australia 2009). Volumes and duration of dredging would be significantly reduced compared to the proposed capital works, and hence, the impacts anticipated would be substantially reduced.

Maintenance dredging material from the Port of Weipa inner harbour routinely passes sediment testing requirements and is suitable for unconfined sea disposal at the approved spoil ground. It is similarly expected that sediments from SoE port and barge/ferry terminal maintenance dredging would also be suitable for sea disposal.

Any future maintenance dredging at either the port site or the ferry/barge terminals would require a separate Sea Dumping Permit.

4.8.6 Accumulation of Potentially Harmful Chemicals

It is unlikely that persistent organic chemicals, heavy metals, or other potentially harmful chemicals would accumulate in the Commonwealth marine area to the extent that they impact on biodiversity,

ecological integrity, social amenity or human health as these chemicals are absent from the natural sediments. The only contaminants that could potentially be introduced due to the Project might be antifouling paints from vessels using the proposed port for loading and these contaminants would be unlikely to be present in concentrations sufficient to cause environmental harm. Future disposal of maintenance dredging materials from the proposed port and ferry and barge terminals would require approval under a Sea Dumping Permit. The Project is unlikely to increase the risk of accumulation of potentially harmful chemicals in Commonwealth marine areas.

4.8.7 Substantial Adverse Impact on Heritage Values of Commonwealth Marine Area

A search of the Australian Heritage Database centred around Boyd Point found no places of heritage value in the Commonwealth marine area, such as historic shipwrecks.

4.8.8 Risk of Accidental Spills in the Commonwealth Marine Area

The Port of Weipa is currently limited to vessels up to 90,000dwt. Cape Size vessels (185,000dwt) rather than panamax or post-panamax vessels (approx 70,000dwt and 90,000kt) would be used for the transport of bauxite from the proposed port site. Therefore, the probability of vessel incidents occurring resulting in accidental fuel, oil or chemicals into the Commonwealth Marine Area would be lower than if the proposed port was restricted to the smaller vessels. The risk of such spills associated with the Project is considered to be low for the following reasons.

- The proposed port would be remote from other shipping routes.
- There would be no bulk fuel deliveries to the proposed port.
- There would be no refuelling of bulk carriers at the proposed port.

4.8.9 Mitigation Strategies for the Commonwealth Marine Area

The following mitigation measures are proposed to reduce the impacts of dredging and spoil disposal on the Commonwealth Marine Area.

- Future maintenance dredging and disposal for the port site, and Embley and Hey River terminals, would follow testing and reporting procedures outlined within the NAGD.
- Maintenance dredging operational procedures, monitoring and reporting requirements for the port facility would be developed under Long Term Dredge Management Plans that would be required under a Sea Dumping Permit issued for maintenance dredging under the *Commonwealth Environment Protection (Sea Dumping) Act 1981*.
- The proposed method of undertaking capital dredging works for the proposed port area, using a self propelled CSD that deposits cuttings on the cut seabed area followed up by a TSHD, was selected to minimise the turbidity that would be generated through overflow, particularly for large dredging projects compared with loading straight from the CSD to hopper barges. The selected method almost halves the potential overflow period, and fines generation. Overflow would be reduced from approximately 100 hours per week to 60 hours per week. Furthermore, the hopper of the TSHD would be significantly larger than a hopper barge and would provide a greater opportunity for fines to settle during loading. Alternative methods such as bucket dredgers loading into hopper barges would result in an impractically long dredging campaign as their rate of dredging is significantly slower than CSD or TSHD. Water entrained and subsequently overflowed during suction of pre-cut and deposited dredge material would be significantly less than that entrained during cutting and pumping of sediments to a waiting hopper barge.
- To minimise potential turbidity impacts at the dredge spoil disposal sites, the following practical measures to reduce loss of bulk material into the marine environment during dredging operations would be considered:
    - ensure barge door seals are in good condition;
    - taking loaded barges to the spoil disposal area and discharging as soon as possible to minimise clays settling and adhering to the barge lining. Removing the settled clays within the barge lining generally requires sailing the barge at full speed across the spoil grounds when disposing, causing unwarranted turbidity;

  - where possible, placing a sandy silt lining (from dredge material) on the bottom of the barge before loading clays to facilitate clay discharge; and
  - developing a spoil dumping plan to aid the even distribution of material over the spoil dumping grounds.

- To mitigate potential impacts on hard corals, monitoring of turbidity, deposition and photosynthetically active radiation (PAR) is proposed to be undertaken at Boyd Point, Pera Head and Thud Point reef areas using in-situ water quality loggers. The objective of this monitoring would be to assist in identifying extended periods of high turbidity and low PAR, which could lead to coral stress. Monitoring of hard corals is proposed at Boyd Point, Pera Head and reefs south to Thud Point. The proposed monitoring would involve establishing fixed point quadrats which would be photographed so that a historical sequence of coral condition could be established and reviewed for indicators such as colour change, bleaching and tissue necrosis. The objective of this would be to identify when corals become stressed due to low light conditions or are being adversely affected by sediment deposition. Should signs of unacceptable coral stress become apparent, then dredging operations would be located to offshore in the departure channel to allow corals a period of respite and return to more favourable light conditions. The final design of the reactive monitoring program would be prepared in consultation with DSEWPaC and DERM.

- All vessels owned and contracted by RTA would be required to manage ballast water through a Ballast Water Management Plan which would comply with Australian mandatory requirements (*The Australian Ballast Water Management Requirements* (DAFF 2008)), and the *International Convention for the Control and Management of Ships Ballast Water and Sediments* (IMO 2004). Monitoring would be undertaken to provide a means of early detection of introduced pests. RTA would complete baseline monitoring followed by three-monthly mussel larval monitoring in the vicinity the new port at such time that overseas ships are utilised. If an abnormal growth of organisms is detected, an appropriate response would be developed in consultation with relevant regulatory authorities. Monitoring procedures would follow methodology adopted by the Port of Weipa. Vessels used for port area dredging would be inspected for introduced marine pest species and cleaned if necessary prior to establishment.

- Monitoring of infauna is proposed be undertaken at the new spoil ground location following capital dredging and at the proposed port to identify the extent of smothering impact, spoil migration and recovery over time. Collection of infauna was undertaken in June 2010 from 15 sites within and adjacent to the proposed new spoil ground. Identification and enumeration of these samples would provide a baseline for post-dredging impact assessment. Monitoring is also proposed for the ongoing maintenance dredging campaigns at a frequency of five years, consistent with that required for long term maintenance dredging for the Port of Weipa.

- Monitoring at the Albatross Bay spoil ground is not proposed due to the minor dredge volumes involved, particularly in comparison to far larger volumes disposed there regularly from routine maintenance dredging of the Port of Weipa.
- RTA would provide written notification to the DSEWPaC's Maritime Heritage Section of the discovery of any suspected shipwreck or shipwreck relics identified during the course of dredging and construction. Appropriate risk mitigation strategies would be developed with the Department if required.
- Monitoring of the progress of the turbidity plume would be undertaken. Should dredging-related turbidity be identified at Nine Mile Reef an investigation would be undertaken and appropriate mitigation measures implemented.

5 CONCLUSIONS

Threatened Terrestrial Flora and Fauna

The threatened flora species are likely to be encountered in non-*Eucalyptus tetrodonta* vegetation communities which would not be directly affected by bauxite mining operations. The disturbance of sensitive non-*Eucalyptus tetrodonta* vegetation by mining would be avoided by the development of an environmental buffer system and the exclusion of mining from within the designated buffers and the non-*Eucalyptus tetrodonta* communities themselves.

Impacts of habitat removal on the overall habitat landscape for fauna, and in particular faunal movement patterns, would be mitigated by retention of the coastal margin vegetation buffer and remnant vegetation not disturbed by the mine plan.

Given the limited disturbance by infrastructure of non-*Eucalyptus tetrodonta* vegetation, the proposed environmental buffer system together with the retention of remnant vegetation means that significant impacts on threatened flora and fauna species are unlikely.

Threatened Marine Fauna

The turtle species that utilise beaches in the vicinity of the proposed port for nesting (mainly Flatback Turtles) could potentially be affected by the construction and operation of the port and associated infrastructure. An altered above-water night time light regime is anticipated to cause the largest potential impact on marine turtles as it could affect adult female turtles and hatchlings. A lighting plan would be implemented to minimise long-term adverse impacts from hatchling disorientation.

Feral pig predation of nests is a significant problem in the vicinity of the proposed port. A feral pig control program would be implemented between Pera Head and Boyd Point to reduce nest predation and enhance turtle population survivorship. It is considered that this measure is capable of producing an overall increase in hatchling numbers. This is discussed in detail in Section 6.9.4.3 of the EIS. A monitoring program would be developed in conjunction with Traditional Owners and DERM with consideration of turtle nesting activities (number, type, predation, success), behaviour (hatchling activity) and incident reporting.

The creation of a turbidity plume (refer Section 6.9.2 of EIS) from dredging activities, and subsequent deposition and re-suspension of fine sediments, could potentially affect reef assemblages. These areas would be monitored and dredging adapted if required to minimise impact. Small patches of sponge reef nearest the proposed Port facility may experience significant deposition during the dredging process. Some loss of habitat at these locations may be expected which may locally affect feeding preferences in marine turtles. Similar habitat also occurs between Pera Head and Thud Point, with more likely to occur at inshore reef areas south of Thud Point and north of Boyd Point, so regional impacts to feeding habitats are not predicted.

It is anticipated that the noise from wharf and jetty construction activity would deter most marine mammals from the immediate area, however for precautionary purposes a 'soft start' approach would be used to disperse animals in the vicinity prior to normal pile driving. The 'soft start' involves commencing pile driving with a partial capacity strike, prior to normal pile driving. An exclusion zone would also be monitored prior to pile driving commencing and during pile driving. Pile driving activities would not commence or be temporarily suspended if threatened marine fauna is observed within the exclusion zone. Pile driving activities would not recommence until threatened marine fauna are considered to be outside the exclusion zone.

The Project is unlikely to have a significant impact on marine turtles given the implementation of the proposed mitigation measures.

Migratory Avian Species

The migratory bird species that are known to occur or which may occur in the Project area predominantly utilise habitats that would be located within environmental buffers and not directly affected by mining.

Given the proposed environmental buffer system and the retention of remnant vegetation, significant impacts on migratory avian species are unlikely.

Non-Avian Migratory Species

Estuarine Crocodiles are widespread and numerous in the Project area and predominantly utilise habitats that would be located within environmental buffers and not directly affected by mining. The length of potential nesting habitat reach to be disturbed by the proposed water supply dam footprint comprises approximately 9% of the total extent of freshwater nesting habitat within the Project area. While this could have a local effect on reproductive rates of the species, it is not anticipated that total breeding effort within the Project area would be significantly affected.

The main potential impact on Dugong would be boat strike from operation of the ferry from Hornibrook Terminal to Hey River Terminal. Transit lanes would be defined away from seagrass beds and in the deeper water. Short term piling activities would be carried out in the Embley and Hey River estuaries Dugongs would be expected to exhibit avoidance behaviour and impacts would be mitigated using a "soft-start" piling approach and the implementation of exclusion zones. The Project is unlikely to have a significant impact on Dugong.

The key potential impact to the Indo-Pacific Humpback Dolphin, Australian Snubfin Dolphin and Bryde's Whale (all migratory cetacean species), would be the acoustic impact from construction activities at the proposed port. A "soft-start" approach to piling would be used to disperse animals in the vicinity prior to normal pile driving as well as the implementation of exclusion zones.. The Project is unlikely to have a significant impact on migratory cetacean species.

Commonwealth Marine environment

Turbidity plumes would be present in the Commonwealth marine area during port dredging and spoil disposal at the new spoil ground and the Albatross Bay spoil ground. Total suspended solid concentrations in Commonwealth waters in the vicinity of the proposed port and spoil grounds are predicted to increase slightly above background levels during dredging. Peak plume duration during dredging is predicted to be similar to recorded natural periods of elevated turbidity. Whilst turbidity plumes and the subsequent deposition and re-suspension of fine sediments would likely have minor impacts on macobenthic infauna and fish assemblages in Commonwealth waters in the vicinity of the Project area, significant impacts are unlikely. Important habitat such as reef assemblages and seagrass do not occur in Commonwealth marine waters in locations where Project activities could cause adverse impacts.

The Project is unlikely to have a significant impact on the Commonwealth marine environment.

6 SUMMARY OF RELEVANT IMPACTS AND MITIGATION/OFFSET MEASURES

A summary of relevant impacts on the MNES and associated mitigation/offset measures described in this report is presented in **Table 37**. A description of the types of costs associated with each mitigation/offset is also provided.

Under the Queensland environmental offsets policy, the *Policy for Vegetation Management Offsets* (NRW 2007) (refer to the *Regional Vegetation Management Code for Western Bioregions*), no offsets are required under either of these Policies for clearing associated with the Project. The Project would not have a significant impact on the terrestrial MNES; therefore, offsets for terrestrial impacts are not required under the EPBC Act. A feral pig control program is proposed as an offset for potential impacts on marine turtles.

A condition of approval under the *Fisheries Act 1994* for removal of mangroves (approximately 400m^2) in the area of the Hey River barge/ferry terminal may include a requirement to provide a compensatory measure as an offset (refer EIS Section 6.9.3.2 for further discussion).

A cross reference table which links the requirements of Commonwealth Tailored EIS Guidelines with the corresponding section of the EIS where those requirements have been addressed is provided in **Table 38**.

Table 37 Summary of Relevant Impacts and Mitigation/Offset Measures

Relevant impact	Potentially Affected MNES	Mitigation measure/Offset	Cost
Disturbance of suitable riparian habitat from construction of the proposed Dam C (minor impact)	Red Goshawk (*Erythrotriorchis radiatus*) – note this species was not found during EIS surveys Masked Owl (*Tyto Novaehollandiae*) – note this species was not found during EIS surveys Northern Quoll (*Dasyurus hallucatus*) – note this species was not found during EIS surveys Bare-rumped Sheathtail Bat (*Saccolaimus saccolaimus nudicluniatus)* – note this species was not found during EIS surveys Cooktown Orchid (*Dendrobium bigibbum)* Chocolate Tea Tree Orchid (*Dendrobium johannis)* *Spathoglottis plicata* – note this species was not found during EIS surveys Avian migratory species that inhabit riparian areas	Water management design -reduction of number of water supply dams from two dams to one (Dam C) (refer Section 1.6.8 of EIS) Vegetation buffer protecting other suitable habitat (refer Section 7.9.2 of EIS) Fire management program (refer Section 7.10.2 of EIS) Progressive rehabilitation (refer Section 3.10 of EIS) and Mine Closure Plan	Reduction in water reliability (potential loss of production) Loss of production (resource) Operational cost Operational cost
Disturbance of suitable riparian habitat from construction of linear infrastructure (minor impact)	Cooktown Orchid (*Dendrobium bigibbum)* Chocolate Tea Tree Orchid (*Dendrobium johannis)* *Spathoglottis plicata* – note this species was not found during EIS surveys	Vegetation buffer protecting other suitable habitat (refer Section 7.9.2 of EIS) Fire management program (refer Section 7.10.2 of EIS) Progressive rehabilitation (refer Section 3.10 of EIS) and Mine Closure Plan	Loss of production (resource) Operational cost Operational cost
Disturbance of 400m^2 of mangrove habitat for Hey River ferry terminal (minor impact)	Cooktown Orchid (*Dendrobium bigibbum)* Ant Plant *Myrmecodia beccarii* Dwarf Sawfish (*Pristis clavata*) Green Sawfish (*Pristis zijsron)* Freshwater Sawfish (*Pristis microdon)* Dugong (*Dugong dugon)*	Implement any relevant conditions of approval under the *Fisheries Act 1994* (refer Section 6.9.3.2 of EIS)	Capital cost
Isolated localised minor effects in habitat areas adjacent to mining areas due to changes in hydrology associated with removal of bauxite (minor impact)	*Spathoglottis plicata* – note this species was not found during EIS surveys	Vegetation buffer protecting other suitable habitat (refer Section 7.9.2 of EIS) Progressive rehabilitation (refer Section 3.10 of EIS) and Mine Closure Plan	Loss of production (resource) Operational cost

Relevant impact	Potentially Affected MNES	Mitigation measure/Offset	Cost
Reduction of potential foraging habitat through clearing of Darwin Stringybark open forest for mining (minor impact)	Red Goshawk (*Erythrotriorchis radiates)* – note this species was not found during EIS surveys Bare-rumped Sheathtail Bat (*Saccolaimus saccolaimus nudicluniatus)* – note this species was not found during EIS surveys	Progressive rehabilitation (refer Section 3.10 of EIS) and Mine Closure Plan	Operational cost
Disturbance of nest tree (low probability)	Red Goshawk (*Erythrotriorchis radiates)* – note this species was not found during EIS surveys	To avoid disturbance of nests, undertake pre-clearance survey in likely habitat. For identified nests, establish buffer and maintain to end of breeding season. (refer Section 7.18.2 of EIS)	Loss of production
Disturbance of roosting tree in Dam C footprint (low probability)	Bare-rumped Sheathtail Bat (*Saccolaimus saccolaimus nudicluniatus)* – note this species was not found during EIS surveys	Targeted pre-clearing surveys would be undertaken to determine the presence of the species within the Dam C footprint. If present, disturbance of habitat trees would be avoided until after the breeding season (i.e. clearing to commence no earlier than May and be completed by end of November). If the species is present, all potential roost trees would also be identified within the Dam C disturbance area and pushed over in a manner that would allow any bats present to leave the roosts unharmed (refer Section 7.18.2 of EIS).	Operational cost
Hatchling disorientation due to lighting from the port and associated infrastructure (high risk of impact prior to mitigation. Proposed feral pig control offset program likely to offset this impact.)	Hawksbill Turtle (*Eretmochelys imbricate*) Flatback Turtle (*Natator depressus*) Olive Ridley Turtle (*Lepidochelys olivacea)*	Lighting plan (refer Table 6.49 of EIS) Feral pig control offset program (refer Section 7.10.2 of EIS) Removal of ghost nets (refer Section 6.9.4.3 of EIS) Monitoring program (refer Section 6.9.4.3 of EIS) Continuation of assistance with DERM research program to monitor sand temperature near Boyd Point	Capital cost Operational cost Operational cost Operational cost Operational cost Operational cost
Sediment deposition on sponge/soft coral habitat between Boyd Point and Pera Head which may locally affect feeding preferences in marine turtles (low risk of regional impact)	Hawksbill Turtle (*Eretmochelys imbricate*) Flatback Turtle (*Natator depressus*) Olive Ridley Turtle (*Lepidochelys olivacea)* Green Turtle (*Chelonia mydas*) Loggerhead Turtle (*Caretta caretta*) Leatherback Turtle (*Dermochelys coriacea*)	Lighting plan (refer Table 6.49 of EIS) Monitoring program (refer Section 6.9.4.3 of EIS) Feral pig control program (refer Section 7.10.2 of EIS) Removal of ghost nets (refer Section 6.9.4.3 of EIS) Continuation of assistance with DERM research program to monitor sand temperature near Boyd Point	Capital cost Operational cost Operational cost Operational cost Operational cost
Disturbance of minor areas of habitat as a result of dredging and the re-suspension of disturbed and deposited sediment and operation of barge/ferry terminal areas (minor impact on habitat)	Dwarf Sawfish (*Pristis clavata*) Green Sawfish (*Pristis zijsron)* Freshwater Sawfish (*Pristis microdon)*	Minor impact only on habitat, very low probability of impact on species. No mitigation required.	
Disturbance of minor areas of	Green Sawfish (*Pristis zijsron)*	Minor impact only on habitat, very low probability of impact on	

Relevant impact	Potentially Affected MNES	Mitigation measure/Offset	Cost
habitat as a result of dredging and operation of proposed port area (minor impact on habitat)		species. No mitigation required At the proposed port location, species richness and overall abundance of the fish assemblage is predicted to increase in response to the addition of piles.	
Minor increase (above background) in Total Suspended Solid concentrations and turbidity in Commonwealth marine area due to dredging and spoil disposal (minor impact)	Commonwealth marine area	To minimise potential turbidity impacts at the dredge spoil disposal sites, the following practical measures to reduce loss of bulk material into the marine environment during dredging operations would be considered as part of the Dredge Management Plan. (refer Section 6.10 of EIS) ○ Ensuring barge door seals are in good condition. ○ Taking loaded barges to spoil disposal area and discharging as soon as possible to minimise clays settling and adhering to the barge lining. Removing the settled clays within the barge lining generally requires sailing the barge at full speed across the spoil grounds when disposing, causing unwarranted turbidity. ○ Where possible, placing a sandy silt lining (from dredge material) on the bottom of the barge before loading clays to facilitate clay discharge. ○ Developing a spoil dumping plan to aid the even distribution of material over the spoil dumping grounds.	Capital costs
Macrobenthic infaunal assemblages at the new spoil ground are likely to be impacted through smothering during capital dredging spoil disposal, and the re-suspension of disturbed and deposited sediment (low risk of regional impacts)	Commonwealth marine area	Monitoring of infauna at the new spoil ground location following capital dredging to identify the extent of smothering impact, spoil migration and recovery over time. (refer Section 6.10 of EIS) Thereafter, monitoring would be undertaken every five years to monitor the effects of the maintenance dredging program. (refer Section 6.10 of EIS)	Operational costs Operational costs
Reduction in availability of potential freshwater nesting habitat as a result of construction of Dam C (minor impact)	Estuarine Crocodile	Feral pig control program (refer Section 7.10.2 of EIS) Water management design - reduction of number of water supply dams from two dams to one (Dam C) (refer Section 1.6.8 of EIS) Outlet pipe for environmental flows Monitoring	Operational cost Loss of reliability (potential loss of production) Capital cost Operational cost
Reduction in availability of potential freshwater nesting habitat downstream of Ward River pump due to altered hydrology (low probability of impact)	Estuarine Crocodile	Water management criteria: • Annual volume capped at 1% of mean annual flow • No pumping when Ward River flow <1000L/s • Rate of pumping <20% of river flow rate Environmental monitoring	Limited water supply (potential loss of production) Operational cost

Relevant impact	Potentially Affected MNES	Mitigation measure/Offset	Cost
Boat strike from operation of ferry from Hornibrook Terminal to Hey River Terminal in the Embley River (moderate risk of impact)	Dugong (*Dugong dugon)*	Transit lane for ferry Report any incidents to DSEWPaC and DERM	
Temporary avoidance of area/ habitat due to construction activities in the Embley River (minor impact)	Dugong (*Dugong dugon)* Indo-Pacific Humpback Dolphin (*Sousa chinensis*) Australian Snubfin Dolphin (*Orcaella heinsohni*)	"Soft-start" approach would be used to disperse animals in the vicinity prior to normal pile driving (refer Section 10.5 of EIS) An exclusion zone would be monitored prior to and during pile driving activities (Refer Section 10.5 of EIS)	Delay to Construction activities
Temporary avoidance of port area due to pile driving (short term/minor impact)	Dugong (*Dugong dugon)* Indo-Pacific Humpback Dolphin (*Sousa chinensis*) Australian Snubfin Dolphin (*Orcaella heinsohni*) Bryde's Whale (*Balaenoptera edeni*). Hawksbill Turtle (*Eretmochelys imbricate*) Flatback Turtle (*Natator depressus*) Olive Ridley Turtle (*Lepidochelys olivacea)* Green Turtle (*Chelonia mydas*) Loggerhead Turtle (*Caretta caretta*) Leatherback Turtle (*Dermochelys coriacea*)	"Soft-start" approach would be used to disperse animals in the vicinity prior to normal pile driving (refer Section 10.5 of EIS) An exclusion zone would be monitored prior to and during pile driving activities (refer Section 10.5 of EIS)	Delay to construction activities

Table 38 Commonwealth Tailored Guidelines Cross-Reference Table

EIS Guideline Requirement	EIS Section
1) General information	
Provide a description of the background of the action including:	
i) the title of the action;	EIS Section 1
ii) the full name and postal address of the designated proponent;	EIS Section 1.1
iii) a clear outline of the objective of the action;	EIS Section1.3
iv) the location of the action;	EIS Figure 1-1, Figure 1-3 and Figure 1-4, Section 1.2
v) the background to the development of the action;	EIS Section 1
vi) how the action relates to any other actions (of which the proponent should reasonably be aware) that have been, or are being, taken or that have been approved or proposed in the region affected by the action;	EIS Section 1.4
vii) the current status of the action;	EIS Section 1
viii) the consequences of not proceeding with the action.	EIS Section 1.6
ix) legislative background for the proposal, including the NES matters protected under Part 3 of the EPBC Act, and any other requirements and approvals needed under the EPBC Act, including s.160 of the Act;	EIS Section 1.9 (legislative background) 1.9.2 (EPBC Act requirements)
x) legislative background for the proposal of the Environment Protection (Sea Dumping) Act 1981.	EIS Section 1.9.3
2) Description of the action	
The Draft EIS must contain enough information about the action and its relevant impacts to allow the Minister to make an informed decision whether or not to approve under Part 9 of the EPBC Act (for the purposes of each controlling provision) the taking of the action.	
Provide a description of the action, including:	
i) all the components of the action;	EIS Section 2
ii) the precise location of any works to be undertaken, structures to be built or elements of the action that may have relevant impacts; including illustrations or maps;	EIS Figure 1-3 and Figure 1-4, and Section 2 The location of works is described and shown in the Section 2 of the draft EIS. The mine plan extends 40 years in the future and there may be changes to some precise locations of works. This is accounted for in the draft EIS.
iii) how the works are to be undertaken and design parameters for those aspects of the structures or elements of the action that may have relevant impacts;	EIS Section 2
iv) to the extent reasonably practicable, any feasible alternatives to the action, including:	EIS Section 1.6
a) if relevant, the alternative of taking no action;	EIS Section 1.6
b) a comparative description of the impacts of each alternative on the matters protected by the controlling provisions for the action; including alternatives to ocean disposal;	EIS Section 1.6. Alternatives to sea disposal are addressed in Section 1.6.11 of the EIS
c) sufficient detail to make clear why any alternative is preferred to another;	EIS Section 1.6
v) any consultation about the action, including:	EIS Section 15

EIS Guideline Requirement	EIS Section
a) any consultation that has already taken place;	EIS Section 15
b) proposed consultation about relevant impacts of the action;	EIS sections 1.8 and 15.4
c) if there has been consultation about the proposed action — any documented response to, or result of, the consultation;	EIS sections 15.2 and 16.3
vi) identification of potentially affected parties, including a discussion of any communities that may be affected and a description of their views.	EIS Section 15.1.1 and EPBC Report Section 2. The definition of "affected parties" under the Environmental Protection and Biodiversity Conservation Act 1999 encompasses those who have suffered loss or damage as a result of a contravention of the Act and therefore there no potentially "affected parties" with respect to the SoE Project.
3) Matters of National Environmental Significance (NES) Identify EPBC Act listed threatened species and ecological communities, listed migratory species and components of the Commonwealth marine environment potentially present on or off-site that are likely to be impacted, directly or indirectly, as a consequence of the proposal. For each of these matters of NES, the following information must be provided:	
i) information on the distribution, ecology, and habitat preferences of the species or community;	EPBC Assessment Report Section 4, and EIS sections 6.3, 6.6, 6.9.5, 7.6.2, 7.15.4, 7.15.5, 7.15.6 and 8.10 A updated search by Qld Herbarium did not identify any more records of EPBC threatened flora species within the Project site.
ii) a detailed discussion of known threats;	Threats addressed in EPBC Assessment Report Section 4 and also in EIS sections 6.6.2 (Whales and Dolphins), 6.6.3 (Dugong), 6.6.4 (Sharks and Sawfish), 6.6.5 (Turtles), 7.10.1 (impacts of weeds), 7.11.3 (significance assessment tables for threatened flora species describe threat of rubber vine to threatened plants), 7.15.3 (introduced fauna - impacts of pigs), 7.15.5 (threats to migratory birds), 8.10 (threats to Sawfish), 7.6.2 (threats to EPBC flora), 7.15.4 (threats to EPBC fauna), 7.15.5 (Crocodile).

EIS Guideline Requirement	EIS Section
iii) information on the conservation value of each habitat type on the site from a local and regional perspective, including the percentage representation of each habitat type on site in relation to its local and regional extent;	• EIS Section 6.3 describes marine habitats in the vicinity of Project infrastructure and Project activities, and their conservation values. • There are no reefs within footprint of Project infrastructure. EIS Section 6.3.2 describes the areas of reef habitat in the local region of the Project, and occurrence and areas of reef habitats in the wider region. • The area of reefs potentially impacted by dredge plume relative to areas of reef habitat in the local region are described in EIS Section 6.9.3.1. • The area of seagrass within the footprint of Project infrastructure relative to its extent in the Weipa region is described in EIS Section 6.9.3.3. • The value of different habitat types on site (in terms of REs) is described in EIS Section 7.7 . The REs that represent potential habitat for threatened flora and fauna species are provided in EIS Table 7-7 and Table 7-15 respectively. The REs that represent potential habitat for migratory bird species are provided in EIS Table 7-16. The REs that represent potential habitat for the Estuarine Crocodile are provided in EIS section 7.15.5. Refer to Figure 6, Figure 6a, Figure 6b, Figure 6c and Figure 6d for the location and distribution of these REs within the Project area. Refer to Table 7-10 for data on the area of each these REs within the Project area compared to the Weipa Plateau subregion and Cape York Bioregion. • The conservation value of different habitat types within the Project area and potential habitats for all MNES are summarised in Section 4 of the EPBC Assessment Report. • Areas of conservation significance with respect to aquatic habitats, within and adjacent to the Project area, are described in Section 8.2
iv) if a population is present on the site, its size and the importance of that population from a local and regional perspective;	• The importance of each population or potential population, of threatened marine fauna is described in EIS Section 6.9.5 and EPBC assessment Report Section 5. • EIS Figures 6-50, 6-51 and 6-52 show maps of known nesting locations and densities of marine turtle species in northern and eastern Australia, from literature. • EIS Section 7.15.5 describes crocodile population importance and size. • Scale of impacts on regional populations of threatened flora, and threatened and migratory fauna, are outlined in EIS Sections 7.11.3, 7.20 respectively, and also EPBC Assessment Report Section 5, including those species that are likely or possible to occur.

EIS Guideline Requirement	EIS Section
v) maps showing the location of known records (including those from databases and all surveys previously conducted for the proposal);	• EIS Figure 7-7, Figure 7-7a and Figure 7-7b detail the location of threatened flora recorded during surveys conducted for the Project - EIS Figure 7-7a, Figure 7-7b and Figure 7-11 detail the location of threatened terrestrial fauna and crocodiles recorded during surveys conducted for the Project. • EIS Figures 6-50, 6-51 and 6-52 show maps of known nesting locations of marine turtle species in northern and eastern Australia, from literature. • EIS Figure 6-53 shows location of turtle nesting activity from field surveys conducted for this Project and an earlier field survey. • Locations of Dolphins sightings during field work for this Project described in EIS Section 6.6.2. • Species known occurrence described in EIS sections 6.6, 7.6.2, 7.15.4, 7.15.5 and 8.10. • The Queensland Herbarium and Queensland Museum records (December 2010) do not have any specimens of EPBC-listed species recorded from the Project area (as at December 2010). • The Commonwealth Protected Matters search tool and the Queensland WildNet database do not provide point source data for species records.
vi) maps showing the potential habitat within the proposed site. These maps must highlight habitat components important for each relevant species, such as breeding habitat, wetlands, vine forests, rock outcrops, etc;	• EIS Section 6.6 describes potential habitat for marine threatened and migratory fauna. There is no reef habitat within footprint of Project infrastructure and very small amount of seagrass within footprint of Project infrastructure. • EIS Figure 6-53 shows location of turtle nesting activity in the port area, from May – July 2007 and April 2008 surveys • Potential habitat for threatened flora, terrestrial fauna and terrestrial migratory species and Crocodile, in terms of REs, is described in EIS sections 7.6.2, 7.15.4, 7.15.5 and 7.15.6 respectively. Refer to Figure 6, Figure 6a, Figure 6b, Figure 6c and Figure 6d for the location and distribution of these REs within the Project area.
vii) maps showing the potential habitat within the region;	• EIS Figure 6-20 shows seagrass distribution in the local region. • EIS Figures 6-50, 6-51 and 6-52 show maps of known nesting locations of marine turtle species in northern and eastern Australia, from literature. • EIS figures 6-18, 6-19 and 6-20 show reef habitat, hard and soft coral habitat and seagrass habitats respectively, in the local region. • Figure 10 shows reef habitats in the wider local region. • EIS Section 6.3.2 describes the areas of reef habitats in the wider region, which are poorly mapped. • Potential habitat for threatened flora, threatened terrestrial fauna and terrestrial migratory species and crocodile, in terms of REs, is discussed in EIS sections 7.6.2, 7.15.4, and 7.15.5 respectively, and also EPBC Assessment Report Section 4. Refer to Figure 6, Figure 6a, Figure 6b, Figure 6c and Figure 6d for the location and distribution of these REs within the Project area. EIS Table 7-5 describes the locations of each RE in reserves in the Cape York Bioregion and locations of reserves are shown in EIS Figure 7-1. • Potential habitat of estuarine species is described in EIS Section 8.10 and 8.7.4 and also EPBC Assessment Report Section 4.

EIS Guideline Requirement	EIS Section
viii) maps detailing regional migration pathways;	• EIS Section 7.15.5 discusses migration pathway of migratory birds and Crocodile • A conceptual representation of the migratory pathway for waders is provided in EIS Figure 7-12. • EIS Figure 7-13 illustrates the likely movement pattern of individuals of the Estuarine Crocodile between stream systems within the Project area and illustrates notional wet season movement paths within the Project area. • EIS sections 6.6.2, 6.6.3 and 6.9.4 discuss migration pathways of marine fauna in the vicinity of the port area.
ix) information on the survey methodology used, including any limitations of the methodology and data collected for each matter of NES, as well as a justification for the survey methodology and survey sites employed;	• EIS Sections 6.1, 6.3, 6.4, 6.5, 6.6.5, 7.4 and 7.13, Appendices 7A and 7E, Figure 7-3 and Figure 7-10, Section 8.3 and Figure 8-2
x) survey methodology must follow all relevant state and Commonwealth survey guidelines (e.g. the Survey Guidelines for Australia's Threatened Birds (DSEWPaC)) and demonstrate how this has been achieved;	• - There are no relevant survey guidelines for marine fauna. • Benthic habitat survey methods described in EIS section 6.3.1. • Survey and assessment of sediment characteristics is described in EIS Section 6.5.3 and 6.5.4. • Guidelines used for sediment characterisation are described in EIS Section 6.5.3 • The methodology for the turtle nesting activity survey is described in EIS section 6.6.5 • There were no other specific studies of the distribution and abundance of marine fauna in the study region, however, incidental observations were made while undertaking habitat mapping. • EIS Sections 7.4 and 7.13 discuss flora and fauna survey methodology respectively, including relevant survey guidelines used
xi) information on the scientific reliability of survey investigations and conclusions, including the degree of certainty or statistical confidence where appropriate;	• The assumptions and inputs for modelling the turbid plume generation, spoil resuspension, sediment deposition, and siltation depth are described in EIS section 6.9.2. Inputs to modelling include long term monitoring data and are described in EIS Sections 6.1 and 6.4. • Monitoring to validate the turbid plume modelling is described in EIS Section 6.9.3.1.
xii) for all listed threatened, migratory or marine species that are believed not likely to be impacted by the action, but for which suitable habitat is present and could be impacted by the action, detailed information must be included to demonstrate that a likely impact on the species will not occur. **4)Relevant impacts**	• Potential impacts on all species for which suitable habitat is present on site, regardless of whether presence was confirmed during surveys, have been assessed. • EIS Sections 6.6, 7.6.2, 7.15.4, 7.15.5 and 8.10 describe listed species, their likelihood of occurrence (confirmed, possible, likely or unlikely - based on habitat availability), and reasoning for likelihood of occurrence. EIS Sections 6.9.4, 6.9.5, 7.11.3, 7.18.1, 7.19.1 and 7.20 and EPBC Assessment Report Section 5 describe potential impacts on all listed species that are confirmed, possible or likely to occur.

EIS Guideline Requirement	EIS Section
Provide a description of the relevant impacts, including:	
i) a detailed assessment of the nature and extent of the likely long-term and short-term relevant impacts, including a summary table detailing the amount of habitat impacted for each matter of NES;	• EIS Sections 6.9, 7.11.3, 7.18.1, 7.19.1 and 7.20, and EPBC Assessment Report section 5, describe potential impacts on all listed species that are confirmed, possible or likely to occur, as well as the Commonwealth Marine Area. • Sections 20.6, 20.7 and 20.8 discuss relevant cumulative impacts. • EIS Section 20.14 describes facilitated impacts related to increased shipping rates. • Summary tables detailing amount of habitat to be impacted are presented in EPBC Assessment Report Tables 14, 18, 31, 34 and 35. • EIS Table 7-10 describes REs to be disturbed by Project.
ii) the assessment must detail direct, indirect, cumulative and facilitated impacts;	As above
iii) a statement whether any relevant impacts are likely to be unknown, unpredictable or irreversible;	• The EIS discusses impacts to threatened and migratory marine fauna that may be unknown or unpredictable (Section 6.9.1, 6.9.2, 6.9.3, 6.9.4 and 6.9.5). However, no relevant impacts to migratory and threatened marine fauna are likely to be unknown, unpredictable or irreversible (refer EPBC Assessment Report Section 5.5 and 5.7, or EIS Section 6.9.5). • The EIS discusses impacts to terrestrial flora and fauna that may be unknown or unpredictable (Sections 7.8, 7.9, 7.10, 7.11, 7.16, 7.17, 7.18, 7.19 and 7.20). However, no relevant impacts to threatened terrestrial flora and fauna are likely to be unknown, unpredictable or irreversible (refer EPBC Assessment Report Section 5.2 and 5.3). • The EIS discusses impacts to aquatic ecology that may be unknown or unpredictable (Sections 8.14 and 8.15). However, no relevant impacts to threatened aquatic fauna are likely to be unknown, unpredictable or irreversible (refer EPBC Assessment Report Section 5.5). • No relevant impacts on Commonwealth Marine Areas are likely to be unknown, unpredictable or irreversible (refer EPBC Assessment Report Section 5.8).
iv) analysis of the significance of the relevant impacts;	• EIS Sections 6.9, 7.11.3 and 7.20 include EPBC significance assessments- EPBC Assessment Report Section 5 includes EPBC significance assessments
v) any technical data and other information used or needed to make a detailed assessment of the relevant impacts;	All technical data and other information used to make impact assessment are included in the relevant sections of the EIS (EIS sections 6, 7 and 8).
vi) information on the scientific reliability of investigations and conclusions drawn, including the degree of certainty or statistical confidence where appropriate. This must include any assumptions or limitations of any models used to make predictions.	• The assumptions and inputs for modelling the turbid plume generation, spoil resuspension, sediment deposition, and siltation depth are described in EIS section 6.9.2. Inputs to modelling include long term monitoring data and are described in EIS Section 6.1 and 6.4. • Monitoring to validate the turbid plume modelling is described in EIS section 6.9.3.1. • EIS Section 8.14.1.2 discusses the resolution of the hydrological model. Monitoring to validate the model is described in EIS Section 5.5.

EIS Guideline Requirement	EIS Section
Indirect impacts refers to impacts which are not a direct result of the project, and may include off-site or downstream impacts, such as impacts on migratory species from changes to the hydrology of wetlands or estuarine areas located off-site.	Indirect impacts are addressed in each of the relevant sections referred to above.
Facilitated impacts refers to impacts resulting from the actions of third parties that are facilitated by proposed action, such as increased shipping or road traffic facilitated through the construction of a port or road.	EIS Section 20.14
Cumulative impacts refers to the incremental impacts of the action when combined with other past, present and reasonably foreseeable future actions (both related and unrelated).	EIS Section 20
5) Proposed safeguards and mitigation measures Provide a description of the proposed safeguards and mitigation measures to deal with relevant impacts of the action, including:	
i) a description, and an assessment of the expected or predicted effectiveness of, the mitigation measures;	Mitigation measures, and their expected or predicted effectiveness, are described in EIS sections 6.9.4 and 6.9.5 (marine fauna), 7.11 (threatened flora), 7.18.2 (threatened terrestrial fauna), 7.19.2 (migratory fauna) and 8.14 to 8.16 (aquatic fauna).
ii) any statutory or policy basis for the mitigation measures;	EIS Section 6.6.5 (describes TAP for turtles), 7.9.2 (describes vegetation management code - basis for vegetation buffer)
iii) the cost of the mitigation measures;	EPBC Assessment Report Section 7 provides the types of costs associated with the mitigation measures. Actual costs cannot be provided due to the significant variables involved (e.g. the extent to which the mitigation measure is required to be implemented, negotiations with stakeholders regarding how the proposed mitigation measures will be implemented, when the proposed mitigation measures will be required over the nominal 40 year Project, and so on).
iv) an outline of an environmental management plan (or plans) that set out the framework for continuing management, mitigation and monitoring programs for the relevant impacts of the action (both on and off-site), including any provisions for independent environmental auditing;	Draft Environmental Management Plan (sections 3.8 and 4), EPBC Assessment Report Section 5, EIS Sections 6.9, 7.11, 7.18.2 and 7.19.2, and 8.14 to 8.17.
v) the plan(s) must allow for the collection of baseline environmental data, and ongoing monitoring, management and mitigation for the duration of the action and subsequent mine rehabilitation, so impacts on matters of NES can be adequately measured;	Draft Environmental Management Plan (sections 3.8 and 4), EPBC Assessment Report Section 5, EIS Sections 6.9, 7.11, 7.18.2 and 7.19.2, and 8.14 to 8.17.
vi) the plan(s) must also detail how any management strategy or monitoring program would influence environmental practices on site, including trigger values and response measures where appropriate;	Draft Environmental Management Plan (sections 3.8 and 4), EPBC Assessment Report Section 5, EIS Sections 6.9, 7.11, 7.18.2 and 7.19.2, and 8.14 to 8.17.

EIS Guideline Requirement	EIS Section
vii) the name of the agency responsible for endorsing or approving each mitigation measure or monitoring program; viii) a consolidated summary list of mitigation measures proposed to be undertaken to prevent, minimise or compensate for the relevant impacts of the action, including mitigation measures proposed to be taken by State governments, local governments or the proponent.	• EIS Table 1-9 provides a summary of Project approvals, permits and licences with the responsible authority. • Draft EM Plan and Environmental Authority conditions to be approved by DERM which includes vegetation buffers, vegetation monitoring, environmental flow management, weed management, fire management, feral animal management and rehabilitation. • Long Term Management Plan for dredging and spoil disposal approved under the Environmental Protection (Sea Dumping) Act 1981 (Cwlth) or Environmental Protection Act 1994 (Qld) (refer EIS Section 6.9.2.8). • Reef monitoring would be designed in consultation with DSEWPC and DERM (refer EIS section 6.9.3.1).- DERM to be consulted about Lighting Plan and marine turtle threat reduction (refer EIS Section 6.9.4.3). • Waterway barrier permit would be required for the water supply dam under the Fisheries Act 1994 (DEEDI).- Removal of mangroves in the Hey River would require a permit under the Fisheries Act 1994 (DEEDI). • Management of any Red Goshawk nests found within 1km of water prior to vegetation clearing would be approved through the referral to DSEWPaC. • Summary of Commitments list provided in EIS Appendix 1F • EIS Sections 6.9 (marine fauna and Commonwealth marine areas), 7.11 (flora), 7.18.2 (threatened terrestrial fauna), 7.19.2 (migratory fauna) describe mitigation measures for relevant impacts. • EPBC Assessment Report Section 5 also describes mitigation measures for relevant impacts.
6) Proposed offset measures Where relevant impacts cannot be avoided or managed, provide a description of the proposed offset measures, including a proposed strategy to offset any impacts of the proposed action on matters of NES. The proposed strategy must: i) demonstrate how it will achieve long-term conservation outcomes; ii) have regard to the scale and intensity of impact from the development on the site; iii) contain long-term and certain conservation outcomes; iv) consider the approach of the relevant State or Territory. **7) Other approvals and conditions**	Proposed mitigation and offset measures are summarised in Section 7 of the EPBC Assessment Report. Details of mitigation and offset measures and expected conservation outcomes are described in the relevant sections of the EIS and in Section 5 of the EPBC Assessment Report. Section 5 of the EPBC Assessment Report Section 5 of the EPBC Assessment Report Section 5 of the EPBC Assessment Report Queensland government offset requirements are described in Section 7 of the EPBC Assessment Report.
Provide information on any other requirements for approval or conditions that apply, or that the proponent reasonably believes are likely to apply, to the proposed action. This must include:	

EIS Guideline Requirement	EIS Section
i) details of any local or State government planning scheme, or plan or policy under any local or State government planning system that deals with the proposed action, including:	State government planning policies are described in relevant sections of EIS, however, there are no planning schemes, plans or policies relevant to MNES.
a) what environmental assessment of the proposed action has been, or is being, carried out under the scheme, plan or policy;	NA
b) how the scheme provides for the prevention, minimisation and management of any relevant impacts;	NA
ii) a description of any approval that has been obtained from a State, Territory or Commonwealth agency or authority (other than an approval under the Act), including any conditions that apply to the action;	The *Commonwealth Aluminium Corporation Pty Limited Agreement Act 1957* authorises mining and associated activities on ML7024. ML6024 was also granted under this Act for the purposes of providing transport access to ML7024. EIS Section 1.9.4.
iii) a statement identifying any additional approval that is required;	EIS Section 1.9
iv) a description of the monitoring, enforcement and review procedures that apply, or are proposed to apply, to the action.	• Proposed monitoring is described in EIS sections 6.9.1, 6.9.2.5, 6.9.2.8, 6.9.3.1, 6.9.3.3, 6.9.4.3, 6.9.4.4, 6.9.4.6, Table 6-49, Table 6-50, 7.10.1, 7.10.2, 7.17.2, 7.18.2, 8.14.1, 8.14.2, 8.15.1, 8.16.2, Table 8-20. • Monitoring and review are described in the Draft EM Plan, sections 3 and 4. • Approvals, permits and licences, which would be enforceable, and relevant authorities for each, are described in EIS Table 1-2. • Proposed conditions for undertaking environmental activities on ML7024 and ML6024, such that DERM may issue the required amended environmental authority, are described in the Draft EM Plan Section 3.
8) Environmental record of person proposing to take the action	
Provide details of any proceedings under a Commonwealth, State or Territory law for the protection of the environment or the conservation and sustainable use of natural resources against:	
i) the person proposing to take the action;	EIS Section 1.1 - RTA has not been the subject to any proceedings under a Commonwealth or State law for the protection of the environment
ii) for an action for which a person has applied for a permit, the person making the application.	EIS Section 1.1 - RTA has not been the subject to any proceedings under a Commonwealth or State law for the protection of the environment
If the person proposing to take the action is a corporation, provide details of the corporation's environmental policy and planning framework.	RTA has a Health, Safety and Environment Policy that includes commitments to minimise environmental impact and continually monitor and improve the way the company works (refer EIS Appendix 1A).
9) Information sources	
For information given in a draft EIS, the draft must state:	

EIS Guideline Requirement	EIS Section
i) the source of the information;	References to source information are provided throughout the EIS and provided in the Reference list at the back of the document. Relevant references are also provided in the stand alone EPBC Assessment Report.
ii) how recent the information is;	As above
iii) how the reliability of the information was tested;	Details of survey methods and modelling are provided in the relevant sections and Appendices of the EIS
iv) what uncertainties (if any) are in the information;	As above
v) the qualifications and experience of the study team and any specialist consultants;	Appendix 1E of EIS
vi) the parts of the EIS each individual was responsible for, or had input into.	Appendix 1E of EIS
10) Guidelines that must be utilised in the EIS i) National Assessment Guidelines for Dredging 2009 ii) Annex 2 1996 Protocol to the Convention on the prevention of marine pollution by dumping of wastes and other matter 1972 (the London Protocol) iii) Waste Specific Guidelines for Assessment of Dredged Material. International Maritime Organisation	- Legislative background to Sea Dumping Act EIS Section 1.9.3 - Reference to Guidelines used in assessment EIS Section 6.5.3 - Monitoring undertaken and description of material to be dumped EIS Section 6.5 - Waste management EIS Section 13.3.3 - Minimisation of volume to be dredged EIS Section 1.6.10 - Alternatives to sea disposal EIS Section 1.6.11 - Dredging or loading procedures EIS Section 6.5.1 - Description of benthic habitat at proposed disposal site EIS Section 6.3.2.2 and 6.5.5 - Position fixing EIS Section 6.9.2.8 - Marine habitats EIS Section 6.3 - Water quality EIS Section 6.4 - Disposal sites sediment characteristics EIS Section 6.5.5 and 6.5.7 - Marine fauna EIS Section 6.6 - Projected impacts and mitigation measures EIS Section 6.9 - Monitoring EIS Section 6.9.3.1 (inshore reef habitat) and EIS Section 6.9.4.4 (spoil ground benthic infauna) - Consultation EIS Section 15

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Rio Tinto Alcan

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Environmental Impact Statement

for South of Embley Project

Section 1
Appendix

APPENDIX 1A

RTA HEALTH SAFETY AND ENVIRONMENT POLICY

Rio Tinto Alcan

Excellence in managing HSE responsibilities is essential to our long-term success and is the hallmark of Rio Tinto Alcan's activities.

Health, Safety and Environment Policy

Rio Tinto Alcan is committed to protecting the environment, preventing pollution and safeguarding the health, safety and welfare of those who work at or visit our sites in a manner that is respectful of local laws, customs and cultures.

Our vision is supported by our core values of fairness and honesty, integrity, respect, teamwork, trust and transparency, passion for excellence and tenacity in achieving results. As a business, we care about people and the world in which we live.

Health, Safety and Environment (HSE) guiding principles

- We collaborate to identify and eliminate, or otherwise control, HSE risks to our people, our communities and the environment in which we operate.
- We use the HSE risk framework and the application of the hierarchy of controls to develop and deliver measurable HSE objectives and targets.
- We deliver our HSE responsibilities and ensure our employees are equipped and trained to achieve our Goal of Zero incidents, injuries and illnesses.
- We encourage our employees to adopt a healthy, safe and environmentally conscious lifestyle both at work and home.
- We improve and support our suppliers' and customers' contribution to sustainable development by promoting the responsible use and multiple benefits of our products.
- We continuously seek to reduce the environmental footprint of our operations and related activities by:
  - Improving the energy efficiency and our natural resource consumption,
  - Reducing, reusing and recycling materials to minimise waste and pollution,
  - Endeavouring to protect and restore natural biodiversity,
  - Identifying and undertaking specific programmes to reduce the greenhouse gas emissions of our business.
- We generate sustainable HSE performance through long term, mutually beneficial relationships with our communities, governments, our business partners and other stakeholders.

To support the implementation of this policy, Rio Tinto Alcan commits to:

- Holding leaders accountable for the delivery of HSE improvements and for providing the necessary resources to do so.
- Requiring all in the business to understand their responsibilities and accountabilities in respect of HSE and to visibly demonstrate their commitment, through their actions, towards achieving our Goal of Zero incidents.
- Complying with all applicable laws, Rio Tinto HSE standards and other voluntary requirements.
- Developing, implementing and maintaining recognised management systems and programmes that ensure appropriate and consistent implementation of this HSE Policy, globally.
- Obtaining assurance of our HSE policy and management systems through regular audits and reviews of our performance.
- Promoting effective employee, contractor and stakeholder participation in and awareness of HSE issues and programmes related to our operations through training, communication and regular public reporting of performance.

As individuals, we personally commit to applying the principles of this policy to continuously improve *The way we work* every single day.

Jacynthe Côté, chief executive, Rio Tinto Alcan

February 2009

APPENDIX 1B

QUEENSLAND EIS TERMS OF REFERENCE

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Terms of reference for an environmental impact statement

South of the Embley project

Under Part 4 of the *State Development and Public Works Organisation Act 1971*

The Coordinator-General
April 2009

Queensland the Smart State

Queensland Government
Department of Infrastructure and Planning

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Synopsis

Rio Tinto Aluminium Limited (RTA), a wholly owned subsidiary of Rio Tinto, proposes to expand its bauxite mining operations in the Weipa area by opening a new mine south of the Embley River. The South of the Embley project involves a new open-cut bauxite mine, a beneficiation plant, new port and stockpile facilities near Boyd Point, south of Weipa, as well as ancillary infrastructure.

The project would ensure continuation of RTA's mining in the region for the next 40 years, as resources at the company's existing mining operations at East Weipa and Andoom/Ely north of the Embley River become depleted and are progressively phased out by 2023.

The Coordinator-General has declared the project to be a significant project requiring an environmental impact statement (EIS) under section 26(1)(a) of the *State Development and Public Works Organisation Act 1971*.

The Australian Government has determined that the project constitutes a controlled action pursuant to the *Environment Protection and Biodiversity Conservation Act 1999*. Controlling provisions are:

- sections 18 and 18A (listed threatened species and communities)
- sections 20 and 20A (listed migratory species).

The declaration of the South of the Embley project as a significant project does not indicate support for, or approval of, the project by the Coordinator-General or the Queensland Government. Rather it is a requirement for the project to undergo a rigorous EIS process.

The EIS process is being coordinated by the Department of Infrastructure and Planning on behalf of the Coordinator-General.

The terms of reference (TOR) set out the requirements, both general and specific, that the proponent should address in preparing an EIS for evaluation by the Coordinator-General. These TOR have been prepared by the Coordinator-General having regard to comments received from advisory agencies and the public on the draft TOR which were publicly advertised over the period 17 January 2009 to 16 February 2009.

The TOR are divided into two parts:

- Part A —general information and administrative procedures
- Part B—specific requirements and structure of the EIS

Abbreviations

The following abbreviations have been used in this document:

CG	Coordinator-General of the State of Queensland
CHMP	Cultural Heritage Management Plan
CLR	Contaminated Land Register
DERM	Qld Department of the Environment & Resource Development
DEWHA	Australian Government Department of Environment, Water, Heritage and the Arts
DIP	Qld Department of Infrastructure and Planning
DEEDI	Qld Department of Employment, Economic Development & Innovation
DME	Former Qld Department of Mines and Energy – now part of DEEDI
DMR	Former Qld Department of Main Roads – now part of DTM
DPIF	Former Qld Department of Primary Industries and Fisheries – now part of DEEDI
DTM	Qld Department of Transport & Main Roads
EIS	Environmental impact statement
EMP	Environmental management plan
EMR	Environmental management register
EP Act	*Environmental Protection Act 1994*
EPA	Former Qld Environmental Protection Agency – now part of DERM
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Cwlth)
EPP (Air)	Environmental Protection (Air) Policy 2008
EPP (Noise)	Environmental Protection (Noise) Policy 2008

EPP (Waste)	Environmental Protection (Waste) Policy 2000
EPP (Water)	Environmental Protection (Water) Policy 1997
ESD	Environmentally sustainable development
IAS	Initial advice statement as defined by Part 4 of the *State Development and Public Works Organisation Act 1971*
IPA	*Integrated Planning Act 1997*
Mdptpa	million dry product tones per annum
MNES	Matters of national environmental significance, as defined under the *Environment Protection and Biodiversity Conservation Act 1999* (Cwlth)
MRA	*Mineral Resources Act 1989*
NRW	Former Qld Department of Natural Resources and Water – now part of DERM
ROM	Run of mine
RTA	Rio Tinto Aluminium Limited
SDPWOA	*State Development and Public Works Organisation Act 1971*
The project	South of the Embley project
The proponent	Rio Tinto Aluminium
TOR	Terms of reference as defined by Part 4 of the *State Development and Public Works Organisation Act 1971*

Part A—general information and administrative procedures

1. Project summary

Rio Tinto Aluminium (RTA) has operated its Weipa bauxite mining operation since 1963. RTA propose to extend its existing bauxite mining operations located north of the Embley River at East Weipa and Andoom on western Cape York Peninsula to areas within existing mining lease 7024 located south of the Embley River. The northern existing bauxite reserves are gradually depleting while at the same time, international demand for bauxite remains strong.

Resource assessment from drilling programs has identified significant bauxite reserves that could sustain a mining operation south of the Embley River for about 40 years, depending on annual mine production. The South of the Embley project (the project) would provide for the long term continuation of mining in the Weipa region and enable continued bauxite supply to major alumina refineries in Queensland.

Initial production from the project would begin in about 2013 and reach 15 million dry product tonnes per annum (Mdptpa) within a year, replacing depleting East Weipa reserves. Production would later rise to 30 Mdptpa in about 2026 to replace depleted Andoom reserves. The project would be designed to enable expansion up to 50 Mdptpa, subject to market conditions.

Due to the presence of the Embley River estuary, development of the reserves south of the Embley River poses logistical challenges to the use of existing Weipa infrastructure. Studies have identified that new stand-alone infrastructure would be required to develop the reserves south of the Embley River. The proposed project consists of the construction and operation of a bauxite mine and associated beneficiation, infrastructure and port facilities. Water would be supplied from new artesian bores and new surface water dams.

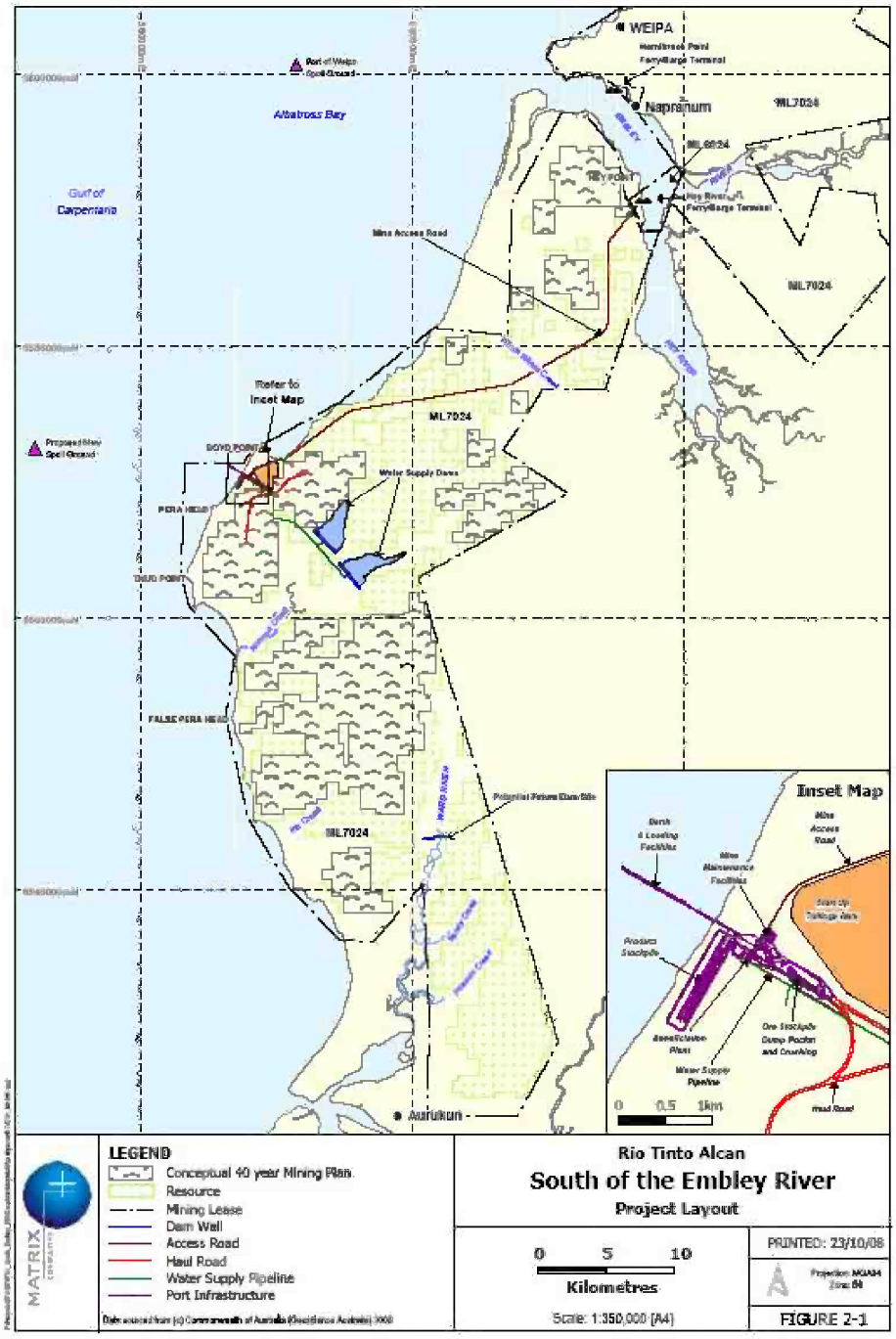
The project would employ about 350 people during the initial construction phase. At 15 Mdptpa, the overall number of direct employees working on the combined north and south of the Embley River operations would average about 870 people, slightly more than current operations. About 400 of these would be working on the project. The construction workforce would be housed in a fully serviced camp on site and the operational workforce would remain based in Weipa and commute on a daily basis.

The project would consist of the following components as shown in **Figure 1**:

- Bauxite mining—conventional bench mining of the bauxite with excavators, loaders and haul trucks would be undertaken initially in the Boyd Point and Pera Head areas and would then progress to the Norman Creek area with ore being transported from the mine via overland conveyor across Norman Creek. Mined areas would be progressively rehabilitated.
- Bauxite processing—the crude bauxite would be transported to a truck dump station located approximately 2 km south of Boyd Point and the bauxite would be processed in a beneficiation plant located adjacent to the ROM stockpiles. A second beneficiation plant would be constructed south of Norman Creek when the reserves in the Norman Creek area are mined. Beneficiation involves separation of the bauxite and waste materials through screening, crushing, grinding, washing and dewatering.

- Bauxite stockpiles—a stacker-reclaimer would be established adjacent to the port facilities to service product stockpiles capable of expansion up to a maximum capacity of 5.2 million dry product tonnes (Mdpt). Should ore from neighbouring mines operated by third parties be shipped through the proposed port, such ore would be conveyed by others across mining lease 7024 to a stockpile near the RTA stockpile.
- Ancillary infrastructure—diesel-fuelled power station, workshops, warehouse, administration facilities, vehicle wash-down facilities, tyre bay, package sewerage treatment plan, general waste disposal, diesel storage (generally located in the vicinity of the beneficiation plants).
- Water infrastructure—initially two freshwater dams on tributaries of Norman Creek are likely to be required, plus pipelines and several artesian bores. Combined surface area for the two dams when full will be approximately 900 ha. Increases in production above 15 Mdptpa are likely to require additional dams in the Norman Creek and Ward River catchments. Water infrastructure for the project will operate independently of the existing Weipa operations.
- Barge/ferry facilities—RTA would construct and operate a new roll-on roll-off barge/ferry terminal at Hornibrook Point and a new barge/ferry terminal on the western bank of the Hey River. These would be used to transport workforce and equipment between Weipa and the project.
- Mine access road—construction of approximately 40 km of new 'on-lease' access road from the Hey River terminal to the mine infrastructure area. The road would have an all-weather sealed pavement.
- Port and ship-loading facilities—construction and operation of new port and ship-loading facilities by RTA between Boyd Point and Pera Head. Works would include a jetty, berths, ship-loader and dredging of berth pockets and departure areas. In the initial phase, RTA propose to construct a port capable of shipping 30 Mdptpa, with provision to enable future expansion up to 63 Mdptpa. This would allow for the option to ship an additional 13 Mdptpa from third parties in addition to RTA's maximum production of 50 Mdptpa. RTA's initial phase of mining operations will be developed to reach 15 Mdptpa in 2014. If agreement is reached with third party producers, capacity could be provided within the initial development to allow commencement of third party shipments. As total port capacity demand increases, port facilities would be expanded up to 63 Mdptpa within which up to 13 Mdptpa would be available for third party shipments.
- Approximately 250 000m^3 of dredged spoil from the initial port development would require disposal offshore at a proposed new disposal ground approximately 15km west of the proposed port site. An extra berth would be added if ship loading capacity was increased to 63Mdptpa and approximately 90 000m^3 of additional dredged spoil would be generated for disposal in the same manner.

Figure 1— locality map



2. Project proponent

The project would be developed and operated by RTA (a company in the Rio Tinto Alcan group). RTA supplies bauxite, alumina and primary aluminium to Australia, New Zealand and export markets. The company provides about 26 per cent of Australia's total production of bauxite, 14 per cent of its alumina and 26 per cent of its primary aluminium. The business is a wholly owned subsidiary of Rio Tinto Limited.

RTA's head office for mining and refining is based in Brisbane, Australia, with mining and refining interests in Queensland including the existing Weipa mine and the Yarwun and Queensland Alumina Limited alumina refineries. RTA also operates the Boyne aluminium smelter in Gladstone.

Contact details for Rio Tinto Aluminium are as follows:

Manager—South of the Embley project
Rio Tinto Aluminium Limited
GPO Box 153
Brisbane Qld 4001
tel 1800 308 938 (freecall)
fax + 61 7 3867 1892
infoeis@riotintoalcan.com

3. Legislative framework

On 13 June 2008, RTA lodged an initial advice statement (IAS) and a request for 'significant project' declaration with the Queensland Coordinator-General (CG). The IAS provides an outline of the proposed project, including the project rationale and its potential impacts. The IAS was subsequently updated on 3 November 2008.

The project was declared a 'significant project for which an environmental impact statement (EIS) is required' pursuant to section 26(1)(a) of the *State Development and Public Works Organisation Act 1971* (SDPWOA) on 21 November 2008, by the CG. Matters considered by the CG in making this declaration included information contained in the IAS, relevant planning schemes and policy frameworks, infrastructure impacts, employment opportunities, environmental effects, complexity of local, state and Australian Government requirements, level of investment and the project's strategic significance.

The declaration initiates the statutory environmental impact assessment procedure under Part 4 of the SDPWOA which requires the proponent to prepare an EIS for the project.

RTA referred the project to the Australian Government Minister for the Environment, Heritage and the Arts for a decision as to whether the project constituted a controlled action under the provisions of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) (Referral No. 2008/4435). On 2 October 2008, the project was declared a 'controlled action' and the relevant controlling provisions were:

- listed threatened species and communities (section 18 and 18A)
- listed migratory species (sections 20 and 20A).

In accordance with the minister's decision on the assessment approach, the project will be assessed under the bilateral agreement with the Queensland Government. Under the bilateral agreement, the Australian Government has accredited the Queensland

SPDWOA EIS process to meet the impact assessment requirements under both federal and state legislation.

Consequently, the term 'EIS' used in these terms of reference (TOR) should be interpreted as satisfying the impact assessment requirements of all relevant Queensland and Australian Government legislation. The project will require approval from the Australian Government Minister for the Environment, Heritage and the Arts on MNES under Part 9 of the EPBC Act before it can proceed.

The Department of Infrastructure and Planning (DIP) is coordinating the EIS process on behalf of the CG. Relevant Australian, Queensland and local government authorities have been invited to participate in the EIS process as advisory agencies.

The first step in the impact assessment process under SDPWOA is the development of TOR for the EIS. The process involves the formulation of draft TOR that are made available for public and advisory agency comment. The CG will have regard to all properly made submissions received when finalising the TOR, which will be presented to the proponent. This document represents the draft TOR for public and advisory agency comment.

The proponent will prepare an EIS to address the TOR. Once the EIS has been prepared to the satisfaction of the CG, a public notice will be advertised in relevant newspapers. The notice will state where copies of the EIS can be viewed or purchased, the submission period and where the submissions should be sent. The proponent may be required to prepare a supplementary EIS to address specific comments submitted by advisory agencies and members of the public.

At the completion of the EIS phase, the CG will prepare a report (CG's report) evaluating the EIS and other relevant material, pursuant to section 35 of SDPWOA. The CG's report will include an assessment and conclusion about the environmental effects of the project and any associated mitigation measures. Material that will be assessed includes: the EIS, properly made submissions and other submissions accepted by the CG and any other material the CG thinks relevant to the project such as a supplementary report, comments and advice from advisory agencies and other entities, technical reports and legal advice.

The CG's report will be publicly notified by placing it on the Department of Infrastructure and Planning website at www.dip.qld.gov.au/projects. The CG's report will also be presented to the proponent, the assessment manager/s (under the *Integrated Planning Act 1971* (IPA)), the Australian Government Minister for Environment, Heritage and the Arts (under the EPBC Act), the Queensland Minister for Climate Change and Sustainability and the Queensland Minister for Natural Resources, Mines and Energy and Minister for Trade.

Under section 45 of SDPWOA, the CG's report may state conditions for the proposed mining lease(s) under the *Mineral Resources Act 1989* (MRA). If CG conditions are included in the report:

- the report must state reasons for their inclusion
- the CG must give the MRA Minister a copy of the report
- the conditions of the proposed mining lease are, subject to any inconsistency with native title conditions that have paramountcy under section 47 of SDPWOA, taken to include the CG conditions.

Similarly, the CG's report may, under section 49 of SDPWOA, state conditions for any draft environmental authority under the *Environmental Protection Act 1994* (EP Act) for

the proposed environmental authority (mining activities). If conditions are included in the report :

- the report must state reasons for their inclusion
- the CG must give the EPA Minister a copy of the report.

Finally, if the project involves development requiring an application for a development approval under IPA, the CG's report may, under section 39 of SDPWOA, state for the assessment manager one or more of the following:

- the conditions that must attach to the development approval
- that the development approval must be for part only of the development
- that the approval must be preliminary approval only.

Alternatively, the report must state for the assessment manager:

- that there are no conditions or requirements for the project
- that the application for development approval be refused.

4. EIS objectives

The objective of the EIS is to ensure that all potential environmental, social and economic impacts of the project are identified and assessed and, where possible, how any adverse impacts would be avoided or mitigated. Direct, indirect and cumulative impacts must be fully examined and addressed. The project should be based on sound environmental protection and management criteria.

The EIS should be a self-contained and comprehensive document that provides sufficient information for an informed decision on the potential impacts of the project and the management measures employed to mitigate adverse impacts. The EIS document should provide information for the following persons and groups, as the project stakeholders:

- **for interested bodies and persons** —a basis for understanding the project, prudent and feasible alternatives, affected environmental values, impacts that may occur, and the measures to be taken to mitigate all adverse impacts
- **for groups or persons with rights or interests in land**—an outline of the effects of the proposed project on that land including access arrangements
- **for government agencies and referral bodies** —a framework for decision-makers to assess the environmental aspects of the proposed project with respect to legislative and policy provisions, and based on that information, to make an informed decision on whether the project should proceed or not, and if so, subject to what conditions, if any
- **the proponent** —a mechanism by which the potential environmental impacts of the project are identified and understood, including information to support the development of management measures, such as an environmental management plan, to mitigate the effects of adverse environmental impacts of the development.

The proponent is required to address the TOR to the satisfaction of the CG before the EIS is made publicly available. It should be noted that the CG does not evaluate the EIS until public notification is completed and the CG has obtained any other

material the CG considers relevant to the project, including additional information or comment about the EIS and the project from the proponent.

5. General EIS guidelines

The EIS is to provide stakeholders with sufficient information to understand the type and nature of the project, the potential environmental, social and economic impacts, and the measures proposed by the proponent to mitigate all adverse impacts on the natural, social and economic environment. It should be recognised that Australian, Queensland and local governments, special interest groups and the general public will have an interest in the EIS.

All phases of the project should be described in the EIS including pre-construction, construction, operation and decommissioning, including final rehabilitation of the mine site and any redundant infrastructure. Direct, indirect and cumulative impacts should be identified and assessed with respect to environmental values and potential extent of impacts. Cumulative impacts include impacts accumulating over time and impacts exacerbated by intensity or scale or frequency or duration of impacts both at project sites and areas remote from these.

Specifically, the EIS should provide:

- an executive summary of the potential environmental impacts of the project
- an overview of the proponent and its existing operations
- a description of the project's objectives and rationale, as well as its relationships to strategic policies and plans
- a description of the entire project, including associated infrastructure requirements
- a description of feasible alternatives capable of substantially meeting the proposal's objectives
- an outline of the various approvals required for the project to proceed
- descriptions of the existing environment, particularly where this is relevant to the assessment of impacts
- measures for avoiding, minimising, managing and monitoring adverse impacts, including a statement of commitment to implement the measures
- rigorous assessment of the risks of adverse and beneficial environmental impacts arising from the project and relevant alternatives on environmental, social and economic values, relative to the 'no project' scenario
- any information derived from baseline and predictive studies, the required extent of which will be commensurate to risks
- a description of stakeholder consultation undertaken
- responses to issues raised during public and stakeholder consultation.

The main EIS report needs to be supported by appendices containing relevant data, technical reports and other sources of the EIS analysis. In preparing the EIS, the approach to be adopted requires that:

- predictions of environmental impacts are based on scientifically supported studies

- the EIS is to present all technical data, sources or authority and other information used to assess impacts
- the methods used to undertake any specialist studies are outlined, together with any relevant assumptions and professional or scientific judgements
- the scientific reliability of investigations and predictions is indicated, including the estimated degree of certainty or, if possible, statistical confidence wherever appropriate
- proposed measures to mitigate and manage identified issues are described and evaluated
- residual impacts that are not quantifiable are described qualitatively, in as much detail as reasonably practicable.

The assessment of all environmental impacts needs to encompass both potential impacts on and uncertain risks to the environment. The level of investigation of potential impacts or particular risks needs to be proportionate to both the severity of the potential consequences of possible events and the likelihood of those events occurring.

Specific types of relevant impacts requiring investigation are set out in Part B. However, the EIS will need to address other issues or aspects that may emerge during the investigations and preparation of the EIS. Ultimately, it is the proponent's responsibility to ensure that adequate studies are undertaken and reported.

The EIS should state the criteria adopted in assessing the proposed project and its impacts, such as compliance with relevant legislation, policies, standards, community acceptance and maximisation of environmental benefits and minimisation of risks.

Any prudent and feasible alternatives should be discussed and treated in sufficient detail, and reasons for selection of the preferred option should be clearly identified.

Where possible, information provided in the EIS should be clear, logical, objective and concise, so that non-technical persons may easily understand it. Where appropriate, text should be supported by maps and diagrams. Factual information contained in the document should be referenced wherever possible. Where applicable, aerial photography and/or digital information (e.g. of project site, etc) should be presented.

The term 'detail' and 'discuss' should be taken to include both quantitative and qualitative matters as practicable and meaningful. Similarly, adverse and beneficial effects should be presented in quantitative and/or qualitative terms as appropriate. Should the proponent require any information in the EIS to remain confidential, this should be clearly indicated, and separate information should be prepared on these matters.

6. Stakeholder consultation

The proponent should undertake a comprehensive and inclusive program of consultation with the stakeholders identified in section 4 Part A. The consultation program should provide stakeholders with the opportunity to obtain information about the project, to raise issues and express their concerns and to receive feedback on how the proponent intends to address the issues and mitigate all adverse impacts of the project.

Consultation with advisory agencies should be the principal forum for identifying legislation, regulations, policies and guidelines relevant to the project and EIS process.

Where appropriate, information bulletins can be used to disseminate information to a wider audience. These bulletins can also be used to inform stakeholders of the proponent's progress in the EIS process and on specific investigations.

The proponent is encouraged to provide opportunities for the general public to obtain information about, and comment on, the project through public information sessions.

As part of this EIS process, consultation should also be undertaken to better understand the social impacts of the proposed project and opportunities for mitigation of those impacts.

Specific requirements for stakeholder consultation are covered in section 1.9 Part B.

7. EIS format and copy numbers

The EIS should generally be presented in a format consistent with that outlined in Part B.

Maps, diagrams and other illustrative material should be included in the EIS to assist in the interpretation of the information.

The EIS should be produced on A4 size paper capable of being photocopied, with maps and diagrams on A4 or A3 size. The EIS document should not contain watermarks across the body of the text. The EIS should also be produced on CD-ROM/DVD.

Two separate CD-ROM/DVD copies should be provided:

1. CD-ROM/DVD—resolution equivalent to the printed document for distribution to the stakeholders.
2. CD-ROM/DVD—for placement on the internet. Copies should be in Adobe® PDF format. All compression must be down-sampled to 72 dpi. PDF documents should be no larger than 1 MB in file size. The executive summary should be supplied in HTML 3.2 format with *.jpg graphics files. Text size and graphics files included in the PDF document should be of sufficient resolution to facilitate reading and enable legible printing, but should be such as to keep within the 1 MB file size.

The final nature and number of EIS copies required to be submitted and made available, should be discussed and agreed with the CG in the early stages of the EIS process.

8. Further information

For further inquiries about the EIS process for this project, please contact:

EIS Project Manager—South of the Embley project
Significant Projects Coordination
Department of **Infrastructure and Planning**
PO Box 15009
Brisbane City East Qld 4002
tel + 61 7 3224 8351
fax + 61 7 3225 8282

SOE@dip.qld.gov.au
www.dip.qld.gov.au

Part B—specific requirements and structure of the EIS

It is preferred that the EIS generally follows the format and content outlined in this part of the TOR. If this is not possible, guidelines describing how the EIS responds to the TOR should be included in the appendices.

Executive summary

The function of the executive summary is to convey the most important aspects and options relating to the project to the reader in a concise and readable form. It should use plain English and avoid the use of jargon and esoteric terms. The executive summary should be written as a standalone document, able to be reproduced on request and distributed to interested parties who may not wish to read or purchase the EIS as a whole.

The structure of the executive summary should follow that of the EIS, and focus strongly on the key issues to enable the reader to obtain a clear understanding of the project and its potential adverse and beneficial environmental, social and economic impacts and the management measures to be implemented by the proponent to mitigate all residual impacts.

The executive summary should include:

- the title of the project
- name and contact details of the proponent, and a discussion of previous projects undertaken by the proponent and their commitment to effective environmental management
- a concise statement of the aims and objectives of the project
- the legal framework, decision-making authorities and advisory agencies
- an outline of the background and need for the project, including the consequences of not proceeding with the project
- a description of alternative options considered and reasons for the selection of the proposed development option
- a brief description of the project (pre-construction, construction and operational activities) and the existing environment, utilising visual aids where appropriate
- an outline of the principal environmental impacts predicted and the proposed environmental management strategies (including waste minimisation and management, mitigation measures and environmental offsets) and commitments to minimise the significance of these impacts
- detailed maps of the proposed project location.

Glossary of terms

A glossary of technical terms, acronyms and abbreviations, that appear in the EIS, should be provided.

1. Introduction

The introduction should clearly explain the function of the EIS, why it has been prepared and what it sets out to achieve. It should also define the audience to whom it is directed, and contain an overview of the structure of the document.

1.1 Project proponent

This section should describe the experience of the project proponent, including the nature and extent of business activities, experience and qualifications, role and responsibilities and environmental record, including the proponent's environmental policy.

1.2 Project description

This section should provide a brief description of the key elements of the project particularly the mining, beneficiation and port facilities and associated processes. The location of the project and its infrastructure requirements should be described and mapped. Detailed descriptions of the project should follow in section 2.

1.3 Project rationale

This section should provide a statement of the objectives of the project and a brief outline of the events leading up to the project's formulation, envisaged time scale for implementation and project life, anticipated establishment costs and actions already undertaken within the project area.

The justification for the project should be described, with particular reference made to the economic and social benefits, including employment and flow-on business development, which the project may generate. The status of the project should be discussed on a regional, state and national context. This discussion should examine, the infrastructure needs of the state and far north Queensland economies and the project's role in supporting state development and environmental policies and strategies.

1.4 Relationship to other projects

This section should also describe how the project relates to any other projects, of which the proponent should reasonably be aware, that have been, or are being taken or that have been approved in the area affected by the project.

Consequential impacts as defined under the EPBC Act, and projects which will be considered as part of cumulative impact assessment (section 7) should be identified and their relevance discussed.

1.5 Socio-economic cost and benefits of the project

Section 4 deals with social values, impacts and their management and section 5 deals with economic impacts and their management. This section should summarise the short and long-term:

- economic costs and benefits of the project to businesses and the wider community, including direct and indirect employment and local business involvement
- any increased demands on local and regional community services and facilities
- direct social costs and benefits, including community disruption, related land use changes, employment, skills development and any workforce accommodation issues
- any increased demand for natural resources as a result of the project.

1.6 Alternatives to the project

This section should describe feasible alternatives, including conceptual, technological and locality alternatives to the project, and discussion of the consequences of not proceeding with the project. Alternative beneficiation technologies, such as in-pit dry screening of bauxite should be discussed.

Alternatives should be discussed in sufficient detail to enable an understanding of the reasons for preferring certain options and courses of action and rejecting others. Where relevant, comparative environmental impacts of each alternative should be summarised.

The interdependencies of the various project components should be explained, together with any infrastructure requirements that may affect the viability of the project. Should water supply, power, transport and/or storage infrastructure be included as an element of the project, this section should include a description of and rationale for such additional infrastructure.

The reasons for selecting the preferred options should be outlined and include technical, commercial, social and environmental aspects where relevant. In particular, compliance with government policy and with the principles and objectives of ecologically sustainable development should be included in this discussion.

1.7 Co-location opportunities

Opportunities may exist for efficiency gains and the mitigation of environmental and property impacts through the co-location of any proposed linear infrastructure project elements within existing or other proposed linear infrastructure (such as rail corridors, gas pipelines and electricity transmission and distribution easements). There may also be opportunities to co-locate proposed linear infrastructure from third parties in, near or parallel to the proposed linear infrastructure project elements.

The project proponent should identify any third party proposals to develop infrastructure within the vicinity of project investigation corridors. Such proposals

would be limited to those projects which are in the public arena during the period of preparation of this EIS and for which a proponent can be readily identified.

It would be the responsibility of any such third parties to provide the required information to the proponent. The Department of Infrastructure and Planning can, at the proponent's request, assist with the facilitation of meetings with known proponents of other linear infrastructure and common user infrastructure in the project area.

It would be inappropriate for this EIS to evaluate the environmental impacts of other infrastructure not directly required for this project. However, the EIS should describe the implications of locating other forms of linear infrastructure within or near proposed project corridors. Where co-location may be likely, the EIS should consider opportunities to coordinate or enhance any of the impact mitigation strategies proposed for the project through cooperation with other proponents in the locality. In particular, the potential implications of any infrastructure co-location on corridor widths and alignment should be described.

1.8 The environmental impact assessment process

1.8.1 Methodology of the EIS

This section should outline the stages of the EIS process under the SDPWOA, including information on the relevant stages of the approvals process, Commonwealth referrals, statutory and public consultation requirements, any associated licence or permit application processes and any interdependencies that exist between approvals (details of specific approvals should be presented under section 1.10). The information in this section is required to ensure:

- stakeholders are informed of the EIS process to be followed
- stakeholders understand the relationships between the EIS and other associated approvals
- stakeholders are aware of any opportunities for input and participation
- relevant legislation is addressed.

1.8.2 Objectives of the EIS

This section should provide a statement of the objectives of the environmental impact assessment process. The structure of the EIS can then be outlined as an explanation of how the EIS will meet its objectives. The purpose of the EIS is to:

- provide public information on the need for and likely effects of the project on the natural, social and economic environment
- identify relevant environmental values, impacts (both beneficial and adverse) on environmental values and propose mitigation measures, based on acceptable standards
- demonstrate how unavoidable environmental impacts can be managed through the protection and enhancement of the environmental values.

The role of the EIS in providing information for the formulation of the environmental management plan (EMP) for the project should be discussed. Discussion of options and alternatives is a key aspect of the EIS.

1.8.3 Submissions

The reader should be informed as to how and when public submissions on the EIS will be addressed and taken into account in the decision-making process. The EIS should inform the reader on how to make submissions and what form the submissions should take.

1.9 Public consultation process

An appropriate public consultation program is an important component of the EIS process. The public consultation program should provide opportunities for community involvement and education. It may include interviews with individuals, public communication activities, interest group meetings, production of regular summary information and updates, and other consultation mechanisms to encourage and facilitate active public consultation.

The public consultation process should identify broad issues of concern to local and regional communities and interest groups and address issues from project planning through commissioning and project operations.

A consultation plan should be prepared during the initial phase of the EIS process. This should identify:

- the types of activities to be undertaken
- timing
- target the Stakeholder/community representatives
- integration with other EIS activities and the project development process
- consultation responsibilities
- communication protocols
- reporting and feedback arrangements.

This section should outline the methodology adopted to:

- identify stakeholders and how their involvement was facilitated
- identify the process conducted to date and future consultation strategies and programs, including during the operational phase of the project
- indicate how consultation involvement and outcomes were integrated into the EIS process and future site activities, including opportunities for engagement and provision for feedback and action if necessary.

Detailed results of the consultation process should be provided as a Consultation Report and presented as an Appendix to the EIS. A summary of the key processes and outcomes should be provided in this section.

1.10 Project approvals

1.10.1 Relevant legislation and policy requirements

This section should identify and explain the legislation and policies controlling the approvals process and should identify all the approvals, permits and licences that will need to be obtained for the development of the proposed project including those on strategic port land.

Key pieces of legislation that will need to be addressed in terms of implications for project approval include:

Australian Government

Environment Protection and Biodiversity Conservation Act 1999

Environment Protection (Sea Dumping) Act 1981

Native Title Act 1993

Aboriginal and Torres Strait Islander Heritage Protection Act 1984

Civil Aviation Regulations 1988 and Civil Aviation Safety Regulations 1988

Queensland Government

State Development and Public Works Organisation Act 1971

Integrated Planning Act 1997

Environmental Protection Act 1994

Coastal Protection and Management Act 1995

Vegetation Management Act 1999

Nature Conservation Act 1992

Fisheries Act 1994

Aboriginal Cultural Heritage Act 2003

Water Act 2000

Land Act 1994

Mineral Resources Act 1989

Queensland Heritage Act 1992

Transport Infrastructure Act 1994

Transport Operations (Marine Pollution) Act 1995

Transport Operations (Marine Safety) Act 1994

Land Protection (Pest and Stock Route Management) Act 2002

Commonwealth Aluminium Corporation Limited Agreement Act 1957

Alcan Queensland Pty Limited Agreement Act 1965

Wild Rivers Act 2005

The approvals interrelationship between the *Commonwealth Aluminium Corporation Limited Agreement Act 1957* and the *Alcan Queensland Pty Limited Agreement Act 1965* with other relevant approvals legislation should be addressed.

1.10.2 Planning processes and standards

This section should discuss the project's consistency with existing land uses or long-term policy framework for the area (e.g. as reflected in local and regional plans) and with legislation, standards, codes or guidelines available to monitor and control operations on site. This section should refer to all relevant Queensland and regional planning policies. This information is required to demonstrate how the proposal conforms to state, regional and local plans for the area.

1.10.3 Accredited process for controlled actions under Commonwealth legislation

The project is a controlled action under the Australian Government's EPBC Act and a significant project under the SDPWOA. The EIS will be developed pursuant to the bilateral agreement between the Australian and Queensland Governments for the purposes of the Australian Government's assessment under Part 8 of the EPBC Act.

The EIS should address potential impacts on the MNES that were identified in the controlling provisions when the project was determined to be a controlled action.

A stand-alone report should be provided as an appendix to the EIS that exclusively and fully addresses the issues relevant to the controlling provisions. It should comply with the following outline:

1 Introduction

2 Description of proposed action (as it would impact on MNES)

3 Description of the affected environment relevant to the controlling provisions (i.e. describe the features of the environment that are MNES protected under the EPBC Act)

4 Assessment of impacts on MNES and mitigation measures (in accordance with available guidelines and species recovery plans), including consideration of any potential offsets to ameliorate residual impacts

5 Conclusions

6 References.

2 Description of the project

The objective of this section is to describe the project (mine, port, processing plant etc) through its lifetime of construction and operation and decommissioning (including rehabilitation). This information is required to allow assessment of all aspects of the project, including which approvals may be required and how they may be managed through the life of the project.

2.1 Overview of project

The EIS should provide an overview of the project to put it into context. This section should include:

- a description of the key components of the project through the use of text and design plans where applicable
- the expected cost and overall duration and timing of the project
- the employment benefits from the construction and operational phases of the project
- a summary of any environmental design features of the project.

2.1.1 Mine

This section should provide a description of bauxite mining and the layout of key components:

- the mine life and mineral resources
- the mining methods and ore handling methods to be used, including the major equipment to be used in the various components of the operation
- the location and boundaries of proposed mining areas, illustrated on maps
- mine development sequence and timeframes
- any proposed stream diversions or public road diversions
- the final landform and any final voids to be left at the cessation of mining.

2.1.2 Beneficiation

This section should provide a description of the bauxite beneficiation process and the layout of key components of the plant including:

- description of key plant and equipment, processes, capacities and raw materials to be used
- indicative material balances for the processing plant, and the anticipated rates of inputs along with similar data on products and tailings streams
- data on any chemicals be used
- location of propose tailings disposal areas
- description of the types, quantities and characteristics of the products produced
- product handling.

2.1.3 Port facilities

This section should provide a description of the port and the layout of key components including:

- port boundaries
- details of the port authority, existing port limits, facilities and Strategic Port Land in the area
- details of area to be dredged and dredged spoil disposal areas
- details of capital and maintenance dredging equipment and methods
- jetty and wharf alignment
- ship loading equipment
- berths for tugs and other non-bulk carrier vessels
- offshore ship mooring locations
- any other associated facilities including maritime safety.

2.1.4 Associated infrastructure

This section should provide a description of associated infrastructure. The location and a description should be provided of the following:

- power plant, power lines, workshops, offices and warehouses
- fuel and chemical storage facilities
- access roads and telecommunications
- fuel and chemical storage facilities
- water supply dams and bores and water pipelines
- barge landings and ferry terminals
- permanent and temporary accommodation facilities.

2.2 Location

The regional and local context of the project should be described and illustrated on maps at suitable scales and reference points. Real property descriptions of the project site should be provided. Maps should show the precise location of the project area, and in particular:

- the location of the resource to be explored, developed or mined
- the location and boundaries of land tenures, in place or proposed, to which the project area is or will be subject to (including tenures for facilities in marine waters)
- the location and boundaries of mining tenures, granted or proposed, to which the project area is or will be subject to
- the location and boundaries of the project footprint showing all key aspects, including mine, beneficiation plant, port, power station, stockpiles, areas of fill, watercourses, plant locations, water storages, buildings, roads, bridges hardstands, car parks and any final void to be left at the cessation of mining etc

- any part of the resource not intended to be mined and any part of the resource that may be sterilised by the proposed mining operations
- the location of all proposed project transport infrastructure for inputs and outputs for each elements of the project
- the location of any proposed buffers surrounding the working areas
- the identification of all site access points to, from and within the project on maps, to assist in the assessment of emergency planning.

Consideration should be given to providing a rectified air photo enlargement to illustrate components of the project in relation to the land and mining tenures and natural and built features of the area.

2.3 Construction

The extent and nature of the project's construction phase should be described (as well as any works required off-site enabling construction to commence) including a map at reasonable scale that shows the footprint of the mine and construction works. The description should include the type and methods of construction, the construction equipment to be used and the items to be transported onto the construction site.

Any staging of the project should be described and illustrated showing site boundaries, development sequencing and timeframes.

2.3.1 Mine

This section should provide a description of construction activities relating to the project including:

- site access:
  - vegetation clearing
  - provision of site access, power, telecommunications, water supply and other infrastructure
  - establishment requirements for construction facilities
- construction requirements, including source and extraction of construction inputs and materials, including construction water:
  - details of the method of construction of the mine and volumes of material required
  - any staging of construction activities
- type, source, quantity and method of transport of construction materials
- general construction standards and site management, including environmental and safety management
- an assessment of expected physical and chemical properties and quantities of soil/rock to be excavated
- details of any potential disruption to flows of waterways during construction and any diversion works required
- details of any potential disruption to groundwater flow and groundwater/surface water interaction during construction and any aquifer dewatering works required

- relocation of existing infrastructure
- timetable for construction, particularly noting seasonal rainfall or flows
- the hours of operation
- emergency aid/medical facilities to be provided on site
- the construction methods and containment/disposal of construction spoil
- solid and liquid waste handling.

2.3.2 Port, beneficiation plant and other infrastructure

This section should provide a description of construction activities relating to the project's associated infrastructure including:

- a map showing location of any works
- on-site plans, layouts, boundaries and elevations
- detailed concept and staging (if any proposed) for additional transport facilities and locations
- plant and machinery likely to be involved
- supply and storage of materials—volume, composition, handling and storage during construction
- where dredging is involved:
  - expected frequency and duration
  - volume of material to be disposed of and disposal area
  - geotechnical properties of dredged material
  - type of dredge
- extent that service corridors will be used during construction and maintenance
- width of vegetation clearing required. This information must indicate where vegetation to be cleared has significant conservation value (such as sensitive environmental areas and creek crossings), and must also reference where in the EIS the impacts on such vegetation have been addressed
- typical crossing techniques including restoration works that would be used at creek crossings, provisions for fish passage, road, rail, and other service corridor crossings
- disposal of plant-matter left after clearing vegetation
- cleanup and restoration (rehabilitation) of areas used during construction including any accommodation facilities and storage areas
- disposal/reuse of surplus excavated material and if this material can be coordinated with concurrent construction activities in the vicinity.

2.4 Operations

This section should describe the activities involved in operating all aspects of the project, in particular:

2.4.1 Mine

2.4.1.1 Mine life and mineral resource base

Specific details should be provided of the following:

- the proposed mine life and an outline of the mineral resource base (further detail should be provided in section 3.2.2, Geology)
- the quantity of mineral to be mined annually including any proposed ramping up of production or staging of development.

2.4.1.2 Mining methods and equipment

Specific details should be provided of the following:

- the mining type and methods to be used, including the major equipment to be used in the various components of the operation
- the use of different techniques in areas of different topographic or geo-technical character
- chemicals to be used.

The description should refer to, and be complemented by, the figures previously presented in section 2.2, showing the locations of key aspects of the project. Additional figures should be provided if required.

2.4.1.3 Mine sequencing

Specific details should be provided of the following:

- the proposed sequence and timing of mining of each seam/ore body within the mining lease
- the physical extent of excavations, location of stockpiles of overburden and/or mineral reject to be handled during the project's operation or left after mining ceases—the description should include the rate of throughput of stockpiles of product, reject and overburden
- the proposed progressive backfilling of excavations
- the area disturbed at each major stage of the project
- the progressive rehabilitation of disturbed areas.

2.4.1.4 Ongoing evaluation and exploration activities

This section should describe the extent and nature of any proposed ongoing exploration or geological/geo-technical evaluation within the project area that may be required over the life of the project.

2.4.2 Bauxite beneficiation plant

This section should describe the quantities and characteristics of the products produced on an annual basis. Indicative process flow-sheets should be provided showing material balances for the processing plant, and the anticipated rates of inputs, along with similar data on products, wastes and recycle streams. The proposed mineral handling methods and facilities to be used for mineral product storage and transfer to the port facility, should be described.

The proposed methods and facilities to be used for bauxite storage and for transferring product to ship should be described and shown on plans at an appropriate scale. A summary of any environmental design features of the new facilities should be provided.

2.4.3 Port

The location and nature of the processes and operations associated with the long-term operation of the port should be described including:

- a general description of the operations of the terminal
- the capacity of stockpiling, in loading and out loading operations for each stage of the port's development
- the expected shipping frequency and intensity
- tug operations
- refuelling arrangements
- hours of operation
- expected access, navigational and anchorage arrangements
- capital and maintenance dredging operations
- potential threats from aquatic pests originating from ballast water or other discharges in the Gulf as shipping tonnages increase
- environmental management measures incorporated in the operation of the port.

Concept and layout plans should be provided highlighting the port boundary, proposed structures, plant and equipment associated with port operations. The proposed methods and facilities to be used for loading product to ship should be described and shown on plans at an appropriate scale.

2.5 Decommissioning and rehabilitation

This section should describe the options, strategies and methods for progressive and final rehabilitation of the environment disturbed by the project. The strategic approach to progressive and final rehabilitation should be described. A preferred rehabilitation strategy should be developed with a view to minimising the amount of land disturbed at any one time. The final topography of any excavations, waste areas and dam sites should be shown on maps at a suitable scale.

The strategies and methods presented for progressive and final rehabilitation of disturbed areas should demonstrate compliance with the objectives of the Environmental Management Policy for Mining in Queensland (1991), and the EPA's A Policy Framework to Encourage Progressive Rehabilitation of Large Mines (2004), or with updated versions of that policy available at the time of drafting the EIS. Land suitability assessment should follow the technical guidelines for the Environmental Management of Exploration and Mining in Queensland (1995). In particular, the strategies and methods should have the following objectives:

- Mining and rehabilitation should aim to create a landform with land use capability and/or suitability similar to that prior to disturbance unless other beneficial land uses are pre-determined and agreed.

- Mine wastes and disturbed land should be rehabilitated to a condition that is self-sustaining, or to a condition where the maintenance requirements are consistent with an agreed post-mining land use.
- Surface and ground waters that leave the lease should not be degraded to a significant extent. Current and future water quality should be maintained at levels that are acceptable for users downstream of the site.

The means of decommissioning the project, in terms of the removal of plant, equipment, structures and buildings should be described, and the methods proposed for the stabilisation of the affected areas should be given. Information should be provided regarding decommissioning and rehabilitation of the plant site, removal of processing plant, rehabilitation of concrete footings and foundations, hardstand areas, storage tanks and wharfage (including any potential for reuse of these facilities). Options and methods for the disposal of wastes from the demolition of plant and buildings should be discussed in sufficient detail for their feasibility and suitability to be established.

Proposals to divert creeks during operations, and, if applicable, for the reinstatement of the creeks after operations have ceased, should be provided. In this case, hydrological processes should be restored as far as possible to resemble those which occurred prior to mining. Where dams are to be constructed, proposals for the management of these structures after the completion of the project should be given. Also, the final drainage and seepage control systems and long-term monitoring plans should be described.

A description of topsoil management should consider transport, storage and replacement of topsoil to disturbed areas. The minimisation of topsoil storage times (to reduce fertility degradation) should also be addressed.

Detail of the impacts of the preferred rehabilitation strategy should be discussed in the appropriate subsections of section 3—Environmental values and management of impacts, particularly with regard to such issues as final landform stability, rehabilitation of flora and the long-term quality of water in any final voids. Implications for the long-term use and fate of the site should also be addressed, particularly with regard to the on-site disposal of waste and the site's inclusion on the environmental management register or contaminated land register.

Future land tenure arrangements post decommissioning of the project should be discussed.

2.6 Associated infrastructure

This section should detail requirements for new infrastructure or the upgrading/ relocating of existing infrastructure to service the project. Matters to be considered include workforce accommodation, transportation, water supply, energy supply, telecommunications, stormwater and sewerage.

2.6.1 Workforce and accommodation

This section should describe the number of personnel to be employed, the skills' base of the required workforce and the likely sources (i.e. local, regional or overseas) for the workforce during the construction and operational phases for each component of the project. The estimated number of people to be employed during construction and operations and arrangements for their transport to and from the project areas, including the proposed use of regional or charter air services should be provided.

Reference should be made to the expected cumulative impacts on local workforce and accommodation needs the project would have in relation to other major projects, which are currently occurring or planned for the region. This information should also include the timing of employees travelling from larger urban centres, detailing likely routes on the state-controlled and local government road networks.

Estimates should be provided according to occupational groupings and variations in the workforce numbers for the duration of the project. The information should show anticipated peaks in worker numbers during the construction period.

The EIS should provide an outline of recruitment schedules and policies for recruitment of local indigenous and non-indigenous workers, and non-local workers.

This section should also discuss an accommodation strategy for the construction workforce that addresses the estimated housing needs of both single and accompanied construction workers. This should include details of the size, location and management of any temporary worker accommodation that will be required either on-site or off-site. Maps should be included as necessary to illustrate the site and should include the location of any proposed construction workers' accommodation on-site or in the vicinity of the project. The strategy should also include details of the operational workforce and how such accommodation is proposed to be supplied.

If camp sites are to be used to accommodate the workforce, details on the number, location (shown on a map), proximity to the construction site and typical facilities for these sites should be provided. Information should include data relating to facilities for:

- food preparation and storage
- licensed premises or alcohol storage facilities
- ablution facilities
- vector and vermin control
- fire safety
- dust and noise control in relation to proximity of camp site to the construction area
- the service personnel required to maintain the camp and the supply of services to each construction camp including visiting police and emergency services to deal with major incidents or investigations
- any local government approvals required for establishment and operation of such camps should be outlined.

2.6.2 Transport

This sub-section should describe arrangements for the transport of plant, equipment, products, wastes and personnel during both the construction phase and operational phases of the project. The description should address the use of existing local and regional facilities and all requirements for the construction, upgrading or relocation of any transport related infrastructure (e.g. road, ports, airstrips, barge and ferry facilities etc.).

Full details of transport volumes, modes and routes available in both the wet and dry seasonsalong with the assessment of transport impacts on existing infrastructure and impact mitigation measures should be provided in accordance with section 3.9.

2.6.3 Water supply and storage

The EIS should provide information on water usage by the project, including the quality and quantity of all water supplied to project sites. In particular, the proposed and optional sources of water supply should be described (e.g. artesian and non-artesian bores, any surface storages, municipal water supply pipelines). If infrastructure is required for the purpose of supplying water to the project, for example, pipelines from water supplies to the project, then the impacts of such infrastructure are to be assessed as part of the project and discussed at each of the relevant sub-sections in section 3.

Estimated rates of supply from each source (average and maximum rates) should be given along with estimates of demand from each source and an overall water balance presented. Any proposed water conservation and management measures should be described. Any proposed recycling measures should be fully described, including necessary storage and other infrastructure and estimated concentrations of potential contaminants in operational storages to enable hazard and risk assessments of those structures.

Determination of potable water demand should be made for the project, including the temporary demands during the construction period. Details should be provided of any existing town water supply to meet such requirements. If water storage and treatment is proposed on site, for use by the site workforce, then this should be described.

2.6.4 Stormwater drainage

A description should be provided of the proposed stormwater drainage system and the proposed disposal and/or re-use arrangements, including any off-site services and downstream impacts. Each element of the project needs to be addressed (e.g. mine, beneficiation and product handling) Further details should be provided in section 3.4.

2.6.5 Sewerage

This section should describe, in general terms, the sewerage infrastructure required to service each project component. Volume estimates of existing and likely industrial and domestic effluent that will be produced should be provided and the proposed method of disposal identified. This should include the expected physical and chemical characteristics of such effluent. Further details should be provided in section 3.8.

2.6.6 Energy

The EIS should describe all energy requirements, including electricity, natural gas, and/or solid and liquid fuel requirements for the construction and operation of the project. The locations of any easements should be shown on an appropriate plan.

Energy conservation should be briefly described in the context of any Commonwealth, state and local government policies.

Any proposed power station should be described, including type of equipment, fuel use and expected emissions to air.

2.6.7 Telecommunications

The EIS should describe the telecommunications proposed for the project and any impacts on existing telecommunications infrastructure (such as optical cables, microwave towers, etc). Infrastructure owners need to be identified.

3 Environmental values and management of impacts

The functions of this section of the EIS are to:

- Describe the existing environmental values of the area which may be affected by the project. Environmental values should be described by reference to background information and studies, which should be included as appendices to the EIS.
- Describe the potential adverse and beneficial impacts of the project on the identified environmental values. Any likely environmental harm to the environmental values should be described.
- Describe any cumulative impacts on environmental values caused by the project, either in isolation or by combination with other known existing or planned sources of impact.
- Present environmental protection objectives and the standards and measurable indicators to be achieved.
- Describe the control strategies, proposed actions and technologies to be implemented for managing impacts to achieve the stated objectives and standards. Where relevant, alternative techniques to control and manage impacts to the nominated objectives should be discussed.
- Describe any likely residual environmental harm on environmental values, why it cannot be avoided and discuss potential offsets in accordance with Queensland Government specific-issue offsets policies.

This section should detail the environmental protection measures incorporated in the planning, construction, operations, decommissioning, rehabilitation and associated works for each component of the project. Measures should prevent, or where prevention is not possible, minimise environmental harm and maximise socio-economic and environmental benefits of the project. Preferred measures should be identified and described in more detail than other alternatives.

The EIS should describe any computational models used to make predictions of impacts and/or outcomes of mitigation measures. The description should address the inputs, assumptions, limitations, sensitivities, accuracy and precision of the models.

This section should address all elements of the environment such as land, freshwater, marine waters, coast, air, noise, nature conservation, cultural heritage, social and community, economy, waste, health and safety, hazards and risk, in a way that is comprehensive and clear.

It is recommended that the EIS follow the heading structure shown below. The mitigation measures, monitoring programs, etc., identified in this section of the EIS should be used to develop the environmental management plan (EMP) for the project (see section 8).

3.1 Climate and climate change adaptation

3.1.1 Climate

This section should describe the rainfall patterns (including magnitude and seasonal variability of rainfall), air temperatures, humidity, wind (direction and speed) and any other special factors (e.g. temperature inversions) that may affect management of the project. Historic weather patterns in the project area and seasonal conditions (e.g. cyclones, thunderstorms, floods and storms) that may influence timing and/or construction methods should be discussed, including how this would be managed. Extremes of climate (e.g. droughts, floods, etc) should be discussed with particular reference to water management at the project site.

The potential impacts due to climatic factors should be addressed in the relevant sections of the EIS. The impacts of rainfall on soil erosion should be addressed in section 3.2. The impacts of storm events on the capacity of waste containment systems (e.g. site bunding / stormwater management and tailings dams) should be addressed in section 3.4 with regard to contamination of waterways and in section 3.8 with regard to the design of the waste containment systems. The impacts of winds, rain, humidity and temperature inversions on air quality should be addressed in section 3.6.

3.1.2 Climate change adaptation

The implications of climate change on the project's environmental and commercial feasibility should be assessed in detail.

Impacts of climate change risks and adaptation measures should include the following:

- analyse risks to the project from climate change impacts (e.g. increased risk and severity of flood; increased vulnerability to more intense bushfires, sea level rise etc
- identify adaptation measures to minimise risk to the project from climate change impacts, particularly where there may be a significant impact to human safety or property.

3.2 Land

This section should describe the existing environmental values of the land area that may be affected by the project. It should also define and describe the objectives and practical measures for protecting or enhancing land-based environmental values, describe how nominated quantitative standards and indicators may be achieved, and how the achievement of the objectives will be monitored, audited and managed.

3.2.1 Topography and geomorphology

3.2.1.1 Description of environmental values

Maps based on latitudes and longitudes using the Geocentric Datum of Australia (GDA94) should be provided locating the project in both regional and local contexts. The topography of the project site should be detailed with contours at suitable

increments, shown with respect to Australian Height Datum. Commentary on the maps should be provided highlighting the significant topographical features.

The environmental values of the cultural landscapes of the affected area, in terms of the physical and cultural integrity of the area, should be described.

3.2.1.2 Potential impacts and mitigation measures

The potential impacts of the landscape character of the project site and the surrounding area should be described. Particular mention should be made of any changes to the broad-scale topography and vegetation character of the area, such as due to spoil dumps, excavated voids and broad-scale clearing.

Details should be provided of measures to be undertaken to mitigate or avoid the identified impacts.

3.2.2 Geology

3.2.2.1 Description of environmental values

The EIS should provide a description, map and a series of cross-sections of the geology of the project area, with particular reference to the physical and chemical properties of surface and sub-surface materials and geological structures within the proposed areas of disturbance. The general suitability of the mine site overburden material for road building (or other productive use) should be discussed briefly.

Geological properties of all project sites which may influence stability, occupational health and safety, rehabilitation programs, or the quality of waste water leaving any area disturbed by the project should be described.

Investigations into the physical, geo-mechanical and chemical properties of waste rock in both fresh and weathered forms needs to be determined for slope stability, rehabilitation and possible acid generation for waste rock dump design.

This section should also consider the geology underlying the proposed infrastructure corridors for bauxite transport, electricity easements, pipeline easements and any off-mine infrastructure. Of particular interest are any other mineral resources that may be impacted or sterilised by the infrastructure.

The EIS should provide a summary of the results of studies and surveys undertaken to identify and delineate the bauxite mineral resources within the project area (including any areas underlying related infrastructure).

The location, tonnage and quality of the bauxite resources within the project area should be described in detail and include the modifying factors and assumptions made in arriving at the estimates The resources should be estimated and reported in accordance with the Australasian code for reporting of mineral resources and ore reserves (the JORC Code available at www.jorc.org/main.php) and the principles outlined in the Australia guidelines for the estimating and reporting of inventory bauxite reserves as appropriate.

3.2.2.2 Potential impacts and mitigation measures

The EIS should analyse the effectiveness of the mining proposal in achieving the optimum utilisation of the bauxite resources within the project area and consider its impacts on other resources. It should demonstrate that the mining proposal will 'best develop' the bauxite resources, minimise resource wastage and avoid any unnecessary sterilisation or loss of these or any other of the state's coal, mineral, and

petroleum (including gas and coal seam methane) resources that may be impacted upon or sterilised by the mining activities or related infrastructure.

3.2.3 Soils

3.2.3.1 Description of environmental values

A soil survey of the sites affected by the project should be conducted at a suitable scale, with particular reference to the physical and chemical properties of the materials that will influence erosion potential, storm water run-off quality, rehabilitation and agricultural productivity of the land. Information should also be provided on soil stability, suitability for construction of proposed facilities and any approved soil conservation plans.

Soil profiles should be mapped at a suitable scale and described according to the Australian Soil and Land Survey Field Handbook (McDonald et al, 1990) and Australian Soil Classification (Isbell, 1996). An appraisal of the depth and quality of useable soil should be undertaken. Information should be presented according to the standards required in the Planning Guidelines: The Identification of Good Quality Agricultural Land (DPI & DHLGP, 1993), and the State Planning Policy 1/92: Development and the Conservation of Agricultural Land (DME, 1995).

The requirement for soils mapping in terms of area and mapping scale should follow the Queensland Department of Mines and Energy: Technical Guidelines for Environmental Management of Exploration and Mining in Queensland (1995). These guidelines recommend that disturbed areas be mapped more intensively than non-disturbed areas and provide guidance on acceptable mapping scale and site intensity.

Acid sulphate soil (ASS) investigations are required to meet State Planning Policy 2/02, Planning and Managing Development involving ASS where the proposed development would trigger one of the criterion listed in section 2.3 of that policy. All investigations should be conducted in accordance with the SPP2/02 guideline and the Guidelines for Sampling and Analysis of Lowland Acid Sulfate Soils in Queensland 1998. Where disturbance to ASS is unavoidable, an ASS Management Plan should be prepared in accordance with the Queensland Acid Sulfate Soil Technical Manual – Soil Management Guidelines.

3.2.3.2 Potential impacts and mitigation measures

Possible erosion rates and management techniques should be described for all permanent and temporary landforms. The erosion potential (wind and water) and erosion management techniques should be outlined for each soil type identified. An erosion-monitoring program, including rehabilitation measures for erosion problems identified during monitoring, should also be outlined. Mitigation strategies should be developed to achieve acceptable soil loss rates, levels of sediment in rainfall runoff and wind-generated dust concentrations.

The EIS should include an assessment of likely erosion effects for all disturbed areas such as:

- areas cleared of vegetation
- waste dumps
- stockpiles
- dams, banks and creek crossings

- the port area and surrounding buildings
- the mine site, including buildings
- access roads or other transport corridors
- areas under rehabilitation.

Methods proposed to prevent or control erosion should be specified and should be developed with regard to preventing soil loss in order to maintain land capability / suitability, and preventing significant degradation of local waterways by suspended solids.

Consideration should be given to the amendment or revocation of any approved soil conservation plans as a result of project activities.

3.2.4 Land use and tenure

3.2.4.1 Description of environmental values

The EIS should provide a description of current land tenures, current land uses and identify the areas covered by Native Title claims in all project and relevant adjacent areas, with particular mention of land with special purposes. Additional land tenures required for the project should also be listed.

The location and owner/custodians of all tenures, reserves, roads and road reserves, railways and rail reserves, stock routes and the like, covering the affected land should be shown on maps of a suitable scale. Locations of gas and water pipelines, power lines and any other easements should be indicated. The environmental values affected by this infrastructure should be described.

Maps at suitable scales showing existing land uses, tenures and infrastructure such as roads, railways, stock routes, pipelines, electricity and the like, should be provided at the project component locations, as well as the surrounding land that could be affected by the development. The maps should identify areas of conservation value and marine areas in any locality that may be impacted by the project. The location of existing dwellings and the zoning of all affected lands according to any existing town or strategic plan, or port land use plan should be included.

The land use suitability of the affected area in terms of the physical and economic attributes should be described. The assessment should set out soil and landform subclasses assigned to soil mapping units in order to derive land suitability classes. The limitations and land suitability classification system to use is that in Attachment 2 of Land Suitability Assessment Techniques in the Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland (1995).

A land suitability map of the proposed and adjacent area should be provided, setting out land suitability and current land uses, e.g. for grazing of native and improved pastures and horticulture. Land classified as 'good quality agricultural land' in the Department of Natural Resources' land classification system should be shown in accordance with the planning guideline, The Identification of Good Quality Agricultural Land, which supports State Planning Policy 1/92.

3.2.4.2 Potential impacts and mitigation measures

The potential for the construction and operation of the project to change existing and potential land uses of the project site and adjacent areas should be detailed. Consideration should be given to impacts arising from property disruption and severance, construction and maintenance. Post operations land use options should be

detailed including suitability of the area to be used for agriculture, forestry, industry, or nature conservation. The factors favouring or limiting the establishment of those options should be given in the context of land use suitability prior to the project and minimising potential liabilities for long-term management.

The potential environmental harm caused by the project on the adjacent areas currently used for agriculture, urban development, recreation, tourism or other business and the implications of the project for future developments in the impact area including constraints on surrounding land uses should be described. If the development adjoins or potentially impacts on good quality agricultural land, then an assessment of the potential for land use conflict is required. Investigations should follow the procedures set out in the planning guideline, The Identification of Good Quality Agricultural Land, which supports State Planning Policy 1/92.

Incompatible land uses, whether existing or potential, adjacent to all aspects of the project, including essential and proposed ancillary developments or activities and areas directly or indirectly affected by the construction and operation of these activities should be identified and measures to avoid unacceptable impacts defined.

3.2.5 Landscape character and visual amenity

3.2.5.1 Description of environmental values

This section should describe in general terms the existing character of the landscape that will be affected by the project. It should comment on any changes that have already been made to the natural landscape since European settlement. It should describe the general impression of the landscape that would be obtained while travelling through and around it.

This section should also describe existing landscape features, panoramas and views that have, or could be expected to have, value to the community whether of local, regional, state-wide, national or international significance. Information in the form of maps, sections, elevations and photographs should be used, particularly where addressing the following issues:

- identification of elements within the proposal and surrounding area that contribute to their image of the town/city as discussed in the any local government strategic plan—city image and townscape objectives and associated maps
- major views, existing viewing outlooks, ridgelines and other features contributing to the amenity of the area
- focal points, landmarks (built form or topography), gateways associated with project site and immediate surrounding areas, waterways, and other features contributing to the visual quality of the area and the project site
- character of the local and surrounding areas including character of built form (scale, form, materials and colours) and vegetation (natural and cultural vegetation) directional signage and land use
- identification of the areas of the proposal that have the capacity to absorb land use changes without detriment to the existing visual quality and landscape character
- the value of existing vegetation as a visual screen.

3.2.5.2 Potential impacts and mitigation measures

The potential impacts of the project landscape character of the site and the surrounding area should be described. Particular mention should be made of any changes to the broad-scale topography and vegetation character of the area, such as due to spoil dumps, excavated voids and broad-scale clearing. Details should be provided of measures to be undertaken to mitigate or avoid the identified impacts.

This section should analyse and discuss the visual impact of the project on particular panoramas and outlooks. It should be written in terms of the extent and significance of the changed skyline as viewed from places of residence, work, and recreation, from road, cycle and walkways and other known vantage points day and night, during all stages of the project as it relates to the surrounding landscape. The assessment is to address the visual impacts of the project structures and associated infrastructure, using appropriate simulation. Sketches, diagrams, computer imaging and photos are to be used where possible to portray the near views and far views of the completed structures and their surroundings from visually sensitive locations.

Special consideration is to be given to public roads, public thoroughfares, and places of residence or work, which are within the line-of-sight of the project.

Details of the design and colour of any major structures, buildings or fixed plant and all proposed screenings either vegetative or material should be described and discussed where relevant to the minimisation of the visual impacts of the project. Where plantings for screening or landscaping are proposed, details should be provided of the species that will be used, and their likely provenance. Preference should be given to species native to the area.

The obstruction of sunlight due to the construction of buildings or alteration of landforms should be considered, as well as major illumination or reflection impacts on adjacent properties or roads.

Detail should be provided of all management options to be implemented and how these will mitigate or avoid the identified impacts.

Management of the lighting of the project, during all stages, is to be provided, with particular reference to objectives to be achieved and management methods to be implemented to mitigate or avoid:

- the visual impact at night
- night operations/maintenance and effects of lighting on fauna and residents
- the potential impact of increased vehicular traffic
- changed habitat conditions for nocturnal fauna and associated impacts.

3.2.6 Land contamination

3.2.6.1 Description of environmental values

This section should discuss the potential for land contamination within the project area from existing and past uses, based on known land use history and the nature and concentrations of any contaminants. The review should identify land within the proposed mine, associated infrastructure corridors and any other areas affected by the proposed works, which has been used, or is being used, for a Notifiable Activity as listed in Schedule 2 of the EP Act, or is potentially contaminated, or is on the environmental management register or contaminated land register.

The EIS should include a preliminary site investigation for all properties that have been impacted by existing and past land uses that could have resulted in land contamination.

3.2.6.2 Potential impacts and mitigation measures

The EIS should discuss the management of any contaminated land and potential for contamination from construction, commissioning and operation, in accordance with EPA's Draft Guidelines for the Assessment and Management of Contaminated Land in Queensland (1998) and the National Environment Protection (Assessment of Site Contamination) Measure 1999.

The EIS should also describe the possible contamination of land from aspects of the project, including waste, saline water from coal seam gas extraction used for dust suppression, reject bauxite, overburden, bauxite washing plant and spills at chemical and fuel storage and handling areas.

This section should describe strategies and methods to be used to prevent and manage any land contamination resulting from the project, including the management of any acid generation or saline impacts from the mining activities and the management of chemicals and fuels to prevent spills or leaks.

3.2.7 Land disturbance

3.2.7.1 Potential impacts and mitigation measures

The EIS should contain strategies aimed at minimising the amount of land disturbed at any one time. The strategic approach to progressive rehabilitation and final decommissioning should be described. The consistency of the approach with relevant guidelines and the results of recent research should be described.

Management of all dams, roads, rail, port, electricity and other infrastructure during construction, operation and decommissioning phases should be described in detail.

The methods to be used for the project, including backfilling, covering, re-contouring, topsoil handling and revegetation, should be described. Consideration should be given to the use of threatened plant species during any landscaping and revegetation.

Where creeks and waterways are proposed to be diverted, the impact on land use due to hydrology changes, both upstream and downstream, should be described.

Where dams and roads and other infrastructure are to be constructed, proposals for the management of these structures after the completion of the project should be given. A contour map of the area should be provided. Also, the final drainage and seepage control systems and any long-term monitoring plans should be described.

Proposed decommissioning of project operations should be described in detail, including consolidation, revegetation, fencing, and monitoring. Discussion of any decommissioning works should address rehabilitation of concrete footings and foundations, hard stand areas and storage tanks (including any potential for reuse of these facilities). Reference should also be made to section 2.5.

A description of topsoil management should consider transport, storage and replacement of topsoil to disturbed areas. The topsoil management should also outline how soil from Good Quality Agricultural Land will be best utilised. The minimisation of topsoil storage times (to reduce fertility degradation) should also be addressed. Erosion and sediment control measures should be described, particularly in relation to the management of sodic and saline overburden material.

3.3 Nature conservation

This section should describe the existing environmental values for nature conservation that may be affected by the project in terms of:

- integrity of ecological processes, including habitats of rare and threatened species and ecological communities
- conservation of resources
- biological diversity, including habitats of rare and threatened species
- integrity of landscapes and places including wilderness and similar natural places
- aquatic and terrestrial ecosystems.

In assessing environmental values and impacts, regard should be given to the regional, national and international environmental significance of the Cape York Peninsula.

3.3.1 Sensitive environmental areas

3.3.1.1 Description of environmental values

The EIS should identify areas that are environmentally sensitive in proximity to the project. Environmentally sensitive areas should also include areas classified as having national, state, regional or local biodiversity significance, or flagged as important for their integrated biodiversity values. Consideration should be given to nature refuges, national parks, conservation parks, declared fish habitat areas, wilderness areas, aquatic reserves, declared wild rivers or rivers subject to a declaration proposal, heritage/historic areas or items relating to biodiversity, national estates, world heritage listings and sites covered by international treaties or agreements (e.g. Ramsar, Japan-Australia Migratory Bird Agreement, China-Australia Migratory Bird Agreement, Republic of Korea-Australia Migratory Bird Agreement), areas of cultural significance relating to biodiversity and scientific reserves.

The proximity of the project to any environmentally sensitive areas should be shown on a map of suitable scale. Areas that would be regarded as sensitive with regard to flora and fauna have one or more of the following features:

- important habitats of species listed under the *Nature Conservation Act 1992* and/or the EPBC Act as 'presumed extinct', 'critically endangered', 'endangered', 'vulnerable' or 'rare'
- regional ecosystems recognised by the EPA as 'endangered' or 'of concern' or 'not of concern' but where permits are no longer granted due to being at threshold levels, and/or ecosystems listed as 'presumed extinct', 'critically endangered', 'endangered' or 'vulnerable' under the EPBC Act
- ecosystems that provide important ecological functions, such as riparian vegetation, important buffer to a protected area, refugia or important habitat corridor between areas and wetlands
- protected areas which have been proclaimed under the *Nature Conservation Act 1992* or are under consideration for proclamation.

3.3.1.2 Potential impacts and mitigation measures

This section should discuss the following:

- the impact of the project on species, communities and habitats of local, regional or national significance
- proposals to mitigate impacts (e.g. timing of works, minimise width of disturbance, proposed rehabilitation of in-stream and floodplain disturbances)
- planned rehabilitation of vegetation communities and any relevant previous experience/experiments rehabilitating these communities
- offsets relating to residual impacts with regard to the Queensland Government specific-issues Environmental Offsets Policies, the Policy for Vegetation Management Offsets (NRW 2007)—refer to the Regional Vegetation Management Code for Western Bioregions, as well as the draft policy statement on the use of environmental offsets under the EPBC Act.

Potential impacts and associated mitigation measures should be discussed further under section 3.3.2 Terrestrial flora, and section 3.4 Water resources.

3.3.2 Terrestrial flora

3.3.2.1 Description of environmental values

The terrestrial vegetation communities within the affected areas should be described at an appropriate scale with mapping produced from aerial photographs and ground truthing, showing the following:

- location and extent of vegetation types including recognised regional ecosystem type descriptions and any areas of national, state or regional significance
- location of vegetation types of conservation significance
- vegetation map unit descriptions, including their relationship to regional ecosystems. Sensitive or important vegetation types should be highlighted and their value as habitat for fauna and conservation of specific rare floral and faunal assemblages or community types discussed
- the current extent (bioregional and catchment) of protected vegetation types of conservation significance within the protected areas (e.g. national parks, conservation parks, resource reserves, nature refuges)
- any plant communities of cultural, commercial or recreational significance
- the distribution and abundance of significant exotic and weed species.

The description should contain a review of published information regarding the assessment of the significance of the vegetation to conservation, recreation, scientific, educational and historical interests. The assessment should also include a description of vegetation (including re-growth and restored areas in addition to remnant vegetation) to indicate any areas of state, regional or local significance.The description should also include, where relevant, MNES identified within the EPBC Act.

For each defined vegetation community likely to be impacted by the project, vegetation surveys should be undertaken at an appropriate number of sites, allowing for seasonal factors, as follows:

- all data requirements of the Queensland Herbarium CORVEG database should be collected

- appropriate minimum site sizes should be selected, observing recognised sampling approaches and to provide an adequate sample of surveyed communities
- a list of species present at each site should be recorded
- the relative abundance and community structure of plant species present should be recorded
- any plant species of conservation, cultural, commercial or recreational significance should be identified
- vegetation mapping and data should be submitted to the Queensland Herbarium to assist the updating of the CORVEG database
- specimens of species listed as 'protected plants' under the Nature Conservation (Wildlife) Regulation 1994, other than common species, are to be submitted to the Queensland Herbarium for identification and entry into the HERBRECS database.

The existence of rare or threatened species should be specifically addressed under sensitive areas. Any special landscape values of natural vegetation communities should be described.

Existing information on plant species may be used instead of new survey work provided that the data are derived from surveys consistent with the above methodology and describe existing conditions. Methodology used for flora surveys should be specified in the appendices to the report. Any existing information should be revised and comments provided on whether the areas are degraded, cleared or affected in ways that would affect their environmental value.

The occurrence of pest plants (weeds), particularly declared plants under the *Land Protection (Pest and Stock Route Management) Act 2002* and weeds of national significance (WONS) should be shown on a map at an appropriate scale. A weed management strategy should be provided.

The location of any horticultural crops in the vicinity of the project area should be shown.

3.3.2.2 Potential impacts and mitigation measures

This section should discuss all foreseen direct and indirect effects on terrestrial flora and the potential level of environmental impact identified. Action plans for protecting rare or threatened species and vegetation types identified as having high conservation value should be described and any obligations imposed by state or federal government biodiversity protection legislation or policy should be discussed.

Construction and operation of the project involving clearing, salvaging or removal of vegetation should be described, and indirect impacts on vegetation not cleared should be discussed.

Impacts during construction and operation of the project should be assessed. The number of hectares of remnant vegetation proposed to be cleared (by conservation status and regional ecosystem type) for the mine and each proposed infrastructure component should be identified. These figures should be discussed in terms of the long-term sustainability of these ecosystems to remain in the landscape at a regional level. Short- and long-term durations should be considered.

Measures to mitigate the impacts of the project on vegetation types identified as having high conservation values, listed species and sensitive habitat or the inhibition of propagation should be described. This should also include the identification of

potential offset areas, in an 'offset strategy', consistent with Queensland Government specific-issues offsets policies, to compensate for any loss of vegetation.

With regard to the project area, this section should include:

- the significance of impacts at a local, catchment, bioregional, state or national levels
- impact on any plants of potential or recognised environmental or economic significance
- a discussion of the ability of identified stands of vegetation to withstand any increased pressure resulting from the project and measures proposed to mitigate impacts
- a description of the methods to ensure rapid rehabilitation of disturbed areas following construction, including the species chosen for revegetation which should be consistent with the surrounding associations. Details of any post construction monitoring programs and what benchmarks would be used for review of monitoring should be included. Consideration should be given to the establishment of reference sites (at least two for each ecosystem type being rehabilitated) that could be established and monitored to provide benchmarking for rehabilitation activities
- a plan to systematically check areas to be cleared over the projected 40 years of the mine life. A commitment to undertake ongoing flora surveys should be a component of the EMP
- a draft weed management plan in an EMP, to be developed and finalised in consultation with land protection officers from the Department of Primary Industries and Fisheries (DPIF) and local government environmental officers, to cover construction, rehabilitation and operation periods
- a description of the potential for the introduction and/or spread of weeds or plant disease, including:
  - identification of the origin of construction materials, machinery and equipment
  - vehicle inspection regime, which addresses the need for vehicle and machinery wash-down and any other hygiene protocols, including the requirement that all vehicles and equipment must be cleaned before starting the job and that these wash down areas contain water/soil away from creeks and gullies
  - staff/operator education programs
  - determination of the potential for the introduction of, or facilitation of, exotic, non-indigenous and noxious plants.

The above assessment should also include, where relevant, MNES identified within the EPBC Act.

3.3.3 Terrestrial fauna

3.3.3.1 Description of environmental values

The terrestrial, and riparian fauna occurring in the areas affected by the project should be described, noting the broad distribution patterns in relation to vegetation, topography and substrate. Wildlife corridors and refugia should be identified and mapped.

The description of the fauna present or likely to be present in the area should include:

- species diversity (i.e. a species list) and indicative abundance of animals, including amphibians, birds, reptiles, mammals (including bats)
- any species that are poorly known but suspected of being rare or potentially threatened
- habitat requirements and sensitivity to changes; including movement corridors and barriers to movement
- the existence of feral or exotic animals, including maps of major pest infestations
- existence of any rare, threatened or otherwise noteworthy species/communities in the study area, including discussion of range, habitat, breeding, recruitment, feeding and movement requirements, and current level of protection (e.g. any requirements of protected area management plans)
- use of the area by migratory and nomadic birds in particular areas for breeding or significant congregations.

The EIS should contain results from surveys for species listed as threatened or migratory under the EPBC Act. Surveys should be conducted at the appropriate time of the year when the species is known to be present on the site, so that identification and location of these species is optimal.

Methodology used for fauna surveys should be specified in the appendices to the report. The EIS should indicate how well any affected significant communities and species are represented and protected elsewhere in the region where the site of the project occurs. Relevant site data should be provided to the EPA in a format compatible with EPA WildNet database for listed threatened species.

3.3.3.2 Potential impacts and mitigation measures

This section should discuss all foreseen direct and indirect effects on terrestrial fauna. Strategies for protecting rare or threatened species should be described, and any obligations imposed by state or federal government threatened species legislation or policy should be discussed.

Any recovery plans for potentially affected threatened species should be outlined, and strategies for complying with the objectives and management practices of relevant recovery plans should be described. Measures to mitigate the impact on habitat or the inhibition of normal movement, breeding or feeding patterns, and change to food chains should be described. Any provision for buffer zones and movement corridors, or special provisions for migratory or nomadic animals should be discussed.

With regard to terrestrial and riparian fauna, the assessment of potential impact should consider:

- impacts the project may have on terrestrial fauna, relevant wildlife habitat and other fauna conservation values, including:
  - direct and indirect impacts due to loss of range/habitat, food supply, nest sites, breeding/recruiting potential or movement corridors
  - cumulative effects of direct and indirect impacts
  - impacts on rare and threatened or otherwise noteworthy animal species
  - identification of the conservation importance of identified populations at the regional, state and national levels

- measures to minimise wildlife capture and mortality during construction and operation
- details of the methodologies that would be used to avoid injuries to livestock and native fauna as a result of the project's construction and operational works, and if accidental injuries should occur the methodologies to assess and handle injuries
- methods for minimising the introduction of feral animals, and other exotic fauna such as declared pest ant species (fire ants and yellow crazy ants)
- review of control measures to prevent increases in local populations and spread of biting insect species of pest and health significance associated with construction activities and disposal of construction wastes.

These would also include, where relevant, MNES identified within the EPBC Act.

3.3.4 Freshwater aquatic flora and fauna

3.3.4.1 Description of environmental values

The aquatic flora and fauna occurring in the areas affected by the project should be described, noting the patterns and distribution in the waterways. A description of the habitat requirements and the sensitivity of aquatic flora and fauna species to changes in flow regime, water levels and water quality in the project areas should be provided. The discussion of the fauna and flora present or likely to be present in the area should include:

- fish species, mammals, reptiles, amphibians and aquatic invertebrates occurring in the waterways within the project area, including any feral and exotic fauna species
- aquatic (waterway) macrophytes including native and exotic/weed species
- wetlands listed by the EPA as areas of national, state or regional significance, and their values and importance
- a description of terrestrial species that are ecologically associated with wetlands or waterways and are likely to be affected by the project
- aquatic substrate and stream type.

These would also include, where relevant, MNES identified within the EPBC Act.

Wetlands should be mapped , described and analysed in a similar manner to that of regional ecosystems.

3.3.4.2 Potential impacts and mitigation measures

This section should discuss all foreseen direct and indirect effects on aquatic flora and fauna, including strategies for protecting rare or threatened species and any obligations, legislation or policies imposed by the state and federal governments. The discussion should include:

- measures to minimise wildlife injury and mortality during construction and operation
- details of the methodologies that would be used to avoid injuries to native fauna as a result of the project's construction and operational works, and if accidental injuries should occur the methodologies to assess and handle injuries
- details of measures to be used to maintain fish passage in creeks that will be affected

- methods for minimising the introduction of feral species, and other exotic fauna
- review of control measures to prevent increases in local populations and spread of biting insect species of pest and health significance associated with construction activities and disposal of construction wastes
- identification of necessary permits/authorities required by the project
- description of mitigation measures to prevent the creation of new mosquito and biting midge breeding sites during construction
- description of the potential for and mitigation measures to prevent the introduction, transfer or facilitation of exotic, non-indigenous and noxious plants and water borne insect pests.

3.3.5 Marine flora and fauna

3.3.5.1 Description of environmental values

Marine flora and fauna occurring in the areas affected by the proposal should be described noting the patterns and distribution in coastal waters and estuaries. The description of the fauna and flora present in the areas should include:

- fish species, mammals, reptiles and crustaceans occurring in marine waters, including pest species
- marine plants, including seagrass and mangroves
- benthic, rocky shore and reefal habitats
- habitat for commercial and recreational fisheries
- particular reference habitat of any rare or threatened species
- proximity to declared Fish Habitat Areas
- presence of marine mammals and marine turtle foraging areas and nesting areas in vicinity of the proposed port
- sea floor habitat and benthic macroinvertebrate communities in the vicinity of the spoil ground
- where relevant, MNES identified within the EPBC Act.

3.3.5.2 Potential impacts and mitigation measures

The potential impacts of the project on benthic habitat and marine fauna and flora, including sea grass beds, marine plants, other fish habitats and other rare or threatened species should be assessed. The EIS should also discuss the potential for damage to these ecosystems (including dependent faunal species). Mitigation methods to reduce impacts on identified environmental values should be outlined. Restoration of the disturbed area (especially where marine plants have been removed) should also be outlined.

The proponent should also identify and describe potential offsets, if required, for marine fish habitats and ecosystems in accordance with the Queensland Government Environmental Offsets Policy (QGEOP) and its specific issue policy, Fish Habitat Management Operational Policy (FHMOP005).

Vectors for an introduction of a marine pest, possible impacts of a marine pest incursion and proposed mitigation measures, should be discussed together with on-going monitoring for marine pests in the port and proposed response arrangements if a marine pest incursion occurs.

Assessments should include, where relevant, MNES identified within the EPBC Act.

3.4 Water resources

This section should describe the existing environment for water resources that may be affected by the project in the context of environmental values as defined in the Queensland water quality guidelines for region-specific parameter values, and such documents as the EP Act, Environmental Protection (Water) Policy 1997 (EPP (Water)) and the Australian and New Zealand Environment and Conservation Council, State of the Environment Reporting Taskforce 2000 (ANZECC 2000). The definition of waters in the EPP(Water) includes the bed and banks of waters, so this section should address impacts on benthic sediments as well as the water column.

Where a licence or permit will be required under *the Water Act 2000* to take or interfere with the flow of water, this section of the EIS should describe the amount of water to be taken and the details of the works to be constructed, and impacts of the works. Works that may require a dam failure impact assessment under the Water Act should be described. Similarly, waterway barrier works may need approval under the *Fisheries Act 1994*, and if so should be addressed in the EIS.

3.4.1 Surface water and watercourses

3.4.1.1 Description of environmental values

A description should be given of the surface watercourses and their quality and quantity in the area affected by the project with an outline of the significance of these waters to the river catchment system in which they occur. Details provided should include a description of existing surface drainage patterns and existing and historical flow regimes in major streams and wetlands. Details should also be provided of the likelihood of flooding, history of flooding including extent, levels and frequency, and a description of present and potential water uses downstream of the areas affected by the project. Flood studies should include a range of annual exceedance probabilities for affected waterways, based on observed data if available or use appropriate modelling techniques and conservative assumptions if there are no suitable observations. The flood modelling should include local flooding due to short duration events from contributing catchments on site, as well as larger scale regional flooding including waterways downstream.

The EIS should provide a description, with photographic evidence of the geomorphic condition of any watercourses likely to be affected by disturbance or stream diversion. The results of this description should form the basis for the planning and subsequent monitoring of rehabilitation of the watercourses during or after the operation of the proposal.

An assessment is required of existing water quality in surface waters and wetlands likely to be affected by the proposal. The basis for this assessment should be a monitoring program, with sampling stations located upstream and downstream of the proposal. Complementary stream-flow data should also be obtained from historical records (if available) to aid in interpretation.

The water quality should be described, including seasonal variations or variations with flow where applicable. A relevant range of physical, chemical and biological parameters should be measured to gauge the environmental harm on any affected creek or wetland system.

The EIS should describe the environmental values of the surface waterways of the affected area in terms of:

- values identified in the EPP(Water)
- sustainability, including both quality and quantity
- physical integrity, fluvial processes and morphology of watercourses, including riparian zone vegetation and form
- any water resource plans, land and water management plans, declared or nominated wild river areas relevant to the affected catchment.

3.4.1.2 Potential impacts and mitigation measures

The water management systems for all project elements should be described, addressing surface water quality, quantity, drainage patterns and sediment movements. The beneficial (environmental, production and recreational) use of nearby surface water should be discussed, along with any proposal for the diversion of affected creeks during mining, and the stabilisation of those works.

Where it is proposed to divert creeks during construction or operations, provision should be made for either the reinstatement of the creeks or decommissioning and rehabilitation, such that the long-term risk of environmental harm, due to regional and local flooding, is no greater than that prior to mining. Fish passage and access to fish habitats needs to be addressed where creeks and waterways are to be diverted.

Analysis of potential impacts of the diversion of affected creeks on existing and proposed relocated roads should also be carried out. This analysis should identify any likely inundation and duration, as this may affect emergency vehicle access.

Monitoring programs should be described which will assess the effectiveness of management strategies for protecting water quality during the construction, operation and decommissioning of the project. Monitoring programs should also be designed to evaluate changes in the physical integrity and geomorphic processes associated with stream diversions.

If on-site storage of water sourced from waste water treatment plants is proposed, the EIS should detail how this water would be managed to ensure environmental harm is avoided. The EIS should also describe the design features of any such storages to effectively contain saline water and other harmful constituents.

Key water management strategy objectives include:

- maintenance of sufficient quantity and quality of surface waters to protect existing beneficial downstream uses and environmental values of those waters (including maintenance of aquatic ecosystems) in accordance with EPP (Water)
- protection of the integrity of the marine environment
- maintenance or replication of the existing geomorphic conditions of local watercourses
- minimisation of impacts on flooding levels and frequencies both upstream and downstream of the project.

The EIS should include a risk assessment for uncontrolled emissions to water due to system or catastrophic failure, implications of such emissions for human health and natural ecosystems, and strategies to prevent, minimise and contain impacts.

The potential environmental harm to the flow and the quality of surface waters from all phases of the proposal should be discussed, with particular reference to their suitability

for the current and potential downstream uses, including the requirements of any affected riparian area, wetland, estuary, littoral zone, and any marine and in-stream biological uses. The impacts of surface water flow on existing infrastructure should be considered with reference to the EPP (Water) and *Water Act 2000*

The EIS should describe the proposed mine stormwater drainage system and the proposed disposal arrangements, including any off-site services and downstream impacts. Options for storage and/or disposal of surplus groundwater (if applicable) should be discussed, including the beneficial and adverse impacts of each option. Licensing requirements for each option should be identified.

Where dams, weirs, voids or ponds are proposed, the EIS should investigate the effects of predictable climatic extremes (droughts, floods) upon the structural integrity of the containing walls, and the quality of water contained, and flows and quality of water discharged.

A dam failure impact assessment should be carried out for any proposed dams that, due to their size, trigger the need for such an assessment under the *Water Act 2000*. Any dams that are likely to be referrable under the *Water Act 2000* should be noted and emergency response procedures incorporated into the project's environmental management plan (EMP).

The need, or otherwise, for licensing of any dams (including referable dams) or creek diversions, under the *Water Act 2000*, should be discussed. The process for water allocation and water discharge should be established in consultation with the EPA and NRW. Consideration should also be given to any water allocation and management plans.

Hydrologic/hydraulic studies should be undertaken to estimate the impacts on operational water storages, drainage and containment systems from local and regional storm events of relevant annual exceedance probability (AEP), in accordance with EPA guidelines, commensurate with hazards associated with failure scenarios.

Consideration should be given to the potential impacts of the project on floodplain hydrology (including changes to flooding characteristics), existing land use and infrastructure and the integrity of any watercourses. Minimising risk to life and property and the protection of water (flood harvesting) entitlements are also issues that should be addressed. Potential impacts to the natural environment from stream diversions should also be discussed.

The environmental values of the surface waters potentially affected by the project should be identified in accordance with the EPP (Water). Surface water quality objectives should be determined after consideration of the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (NWQMS 4, 2000).

Risks to farmland from potentially contaminated surface water flow, particularly during flood events and/or failure of levee banks, should be assessed.

Options for flood mitigation and the effectiveness of mitigation measures should be discussed with particular reference to sediment, salinity and other emissions of a hazardous or toxic nature to human health, flora or fauna. Proposals for maintenance of flood levees post-mining should be discussed.

3.4.2 Groundwater

3.4.2.1 Description of environmental values

The EIS should review the quality, quantity and significance of artesian and non-artesian groundwater resources within the project area. The review should include a

survey of existing groundwater supply facilities (bores, wells, or excavations). The information to be gathered for analysis should include:

- location and type of facilities
- pumping parameters
- draw down and recharge at normal pumping rates
- seasonal variations (if records exist) of groundwater levels.

A network of observation points which would satisfactorily monitor groundwater resources both before and after commencement of operations should be developed.

This section should include reference to:

- Nature of the aquifer(s):
  - geology/stratigraphy—such as alluvium, volcanic, metamorphic
  - aquifer type—such as confined, unconfined
  - depth to and thickness of the aquifers
- Hydrology of the aquifer(s):
  - depth to water level and seasonal changes in levels
  - groundwater flow directions (defined from water level contours)
  - interaction with surface water
  - interaction with sea/salt water
  - possible sources of recharge
  - vulnerability to pollution.

The data obtained from the groundwater survey should be sufficient to enable specification of the major ionic species present in the groundwater, pH, electrical conductivity and total dissolved solids.

The environmental values of the underground waters of the affected area should be described in terms of:

- values identified in the EPP(Water)
- sustainability, including both quality and quantity
- physical integrity, fluvial processes and morphology of groundwater resources.

3.4.2.2 Potential impacts and mitigation measures

The EIS should include an assessment of the potential environmental impact caused by the project (and its associated project components) to local groundwater resources, including the potential for groundwater induced salinity.

The impact assessment should define the extent of the area within which groundwater resources are likely to be affected by the proposed operations and the significance of the project to groundwater depletion or recharge, and propose management options available to monitor and mitigate these effects. The response of the groundwater resource to the progression and finally cessation of the proposal should be described.

An assessment should be undertaken of the impact of the project on the local ground water regime caused by the altered porosity and permeability of any land disturbance.

Any potential for the project to impact on groundwater dependent ecosystems should be assessed and described. Avoidance and mitigation measures should be described.

The proponent should address potential impacts of surface water storage volumes on groundwater pressure and levels in relation to the sea/freshwater interface and associated ecology of wetlands.

An assessment of the potential to contaminate groundwater resources and measures to prevent, mitigate and remediate such contamination should be discussed.

3.5 Coastal environment

This section should describe the existing coastal environment, which may be affected by the project in the context of coastal values identified in State of the Coastal Zone Reports and environmental values as defined by the EP Act and environmental protection policies.

This section should also identify actions associated with the project that are assessable development within the coastal zone and will require assessment under the provisions of the *Coastal Protection and Management Act 1995.*

3.5.1 Marine water and sediment

3.5.1.1 Description of environmental values

Information should be provided on water quality in the sea and in estuaries below the limit of tidal influence, including salinity, heavy metals, acidity, turbidity and oil in water. Interaction of freshwater flows with marine waters, its significance in relation to marine flora and fauna in and adjacent to the port area, should be discussed.

Environmental values of the coastal seas of the affected area should be described, as relevant, in terms of:

- values identified in the EPP (Water)
- the state coastal management plan and any regional coastal plan

An assessment of physical and chemical characteristics of sediments should be provided for:

- the area to be dredged
- if offshore disposal is proposed, the disposal location for dredged material.

Any contaminants and implications for management of the dredged material should be described. The description of sediment characteristics should be based on the results of sediment sampling and analysis conducted as per a sampling and analysis plan (SAP) approved under the *Environment Protection (Sea Dumping) Act 1981*.

The chemical and physical characteristics of the material to be dredged, the spoil ground and control sites should be summarised. If the material is to be disposed in an offshore area, a statement as to the suitability of the sediment for unconfined ocean disposal should be made using the framework within the National Ocean Disposal Guidelines for Dredged Material (DEWHA 2002).

3.5.1.2 Potential impacts and mitigation measures

This section defines and describes the water quality objectives and practical measures for protecting or enhancing coastal environmental values, to describe how nominated

quantitative standards and indicators may be achieved, and how the achievement of the water quality objectives will be monitored, audited and managed.

Describe the water quality objectives used (including how they were developed), and how predicted activities will meet these objectives (refer to the EPA's Queensland water quality guidelines and the Australian and New Zealand guidelines for fresh and marine water quality, ANZECC, 2000).

The potential environmental harm caused by the project on coastal resources and processes should be described in the context of controlling such effects. The State Planning Policy—Planning and Managing Development involving Acid Sulfate Soils 2002 should be addressed as should the State Coastal Management Plan 2001 and DPIF Guidelines for Marine Areas.

The role of buffer zones in sustaining fisheries resources through maintaining connectivity between coastal and riparian vegetation and estuarine and freshwater reaches of catchments should be discussed.

Impacts on water quality due to increased water turbidity and other contaminants from the sediment due to dredging and sea disposal of material, if required, should be addressed and strategies developed to address potential impacts.

In addition to the above considerations, the following guidelines and standards should be considered:

- the EPP (Water), and any recent or proposed amendments that incorporate recommendations of the National Environment Protection Measures
- ANZECC Australian Water Quality Guidelines for Fresh and Marine Waters (2000)
- amelioration or mitigation measures to address each activity identified to impact on local and regional water quality
- any monitoring of water quality recommended during the dredging activities to ensure environmental values are protected.

The potential impacts of sediment quality on the marine environment should be discussed. This assessment should be guided by the suitability of the sediment for ocean disposal as determined by the framework outlined in the National Ocean Disposal Guidelines for Dredged Material (DEWHA 2002).

3.5.2 Coastal processes

3.5.2.1 Description of environmental values

Describe the physical processes of the adjacent marine environment, including but not limited to currents, tides, storm surges, freshwater flows and their interaction in relation to the assimilation and transport of potential pollutants entering marine waters from the project area .

Describe the environmental values of the coastal resources of the affected area in terms of the physical integrity and morphology of landforms created or modified by coastal processes. Assessment should be based on hydrodynamic investigations and include a description of:

- the physical properties of the sediments likely to be dredged
- sediment dynamics at the off-shore disposal ground based on the influence of tides, waves, currents and turbidity.

The relationship of these processes to marine flora and fauna and biological processes within the study area should also be discussed. The relationship between currents, wave actions and extreme events (such as cyclones) and how they influence coastal processes should be discussed.

3.5.2.2 Potential impacts and mitigation measures

The impacts of development of the berth area on hydrodynamic processes within the port study area should be described. In particular, impacts on siltation and any implications for marine flora and fauna and/or biological processes should be discussed, including generation and migration of turbid plumes. Information on currents in the region should be used to predict impacts and these impacts on marine environmental values should be assessed.

3.6 Air quality

3.6.1 Description of environmental values

This section of the EIS should describe the existing air quality that may be affected by the project in the context of environmental values as defined by the EP Act and EPP (Air).

Ambient air quality conditions in terms of particulate matter and any other major constituent of the air environment that may be affected by the proposal should be described for any sensitive localities such as residences. These descriptions should include any baseline monitoring results.

3.6.2 Potential impacts and mitigation measures

The following air quality issues and their mitigation should be considered:

- quality and quantity of air emissions within the project area expected during construction and operational activities
- impacts of dust generation from construction activities (including blasting, excavation and extraction), especially in areas where construction activities are adjacent existing road networks or are in close proximity to sensitive receivers
- identification of climatic patterns that could affect dust generation and movement
- impact on terrestrial flora and fauna
- predicted changes to existing air quality from operational activities including mining, processing, stockpiling and loading of bauxite, dust generation along haulage roads, vehicle emissions, electricity generation and shipping
- impacts on air quality from gaseous emissions including greenhouse gas emissions and ozone depleting substances
- the human health risk associated with emissions from the project of all hazardous or toxic pollutants, whether they are or are not covered by the National Environmental Protection Council (Ambient Air Quality) Measure or the EPP (Air) that may reasonably be expected to impact human health.

3.6.3 Greenhouse gas emissions and abatement

This sub-section of the EIS should:

- provide an inventory of projected annual emissions for each relevant greenhouse gas, with total emissions expressed in 'CO_2 equivalent' terms
- estimate emissions from upstream activities associated with the proposed project, including fossil fuel based electricity consumed
- briefly describe the method(s) by which estimates were made.

Greenhouse gas abatement measures should be proposed, assessed and include:

- a description of the proposed measures (alternatives and preferred) to avoid and/or minimise greenhouse gas emissions directly resulting from activities of the project, including such activities as transportation of products and consumables, and energy use by the project
- an assessment of how the preferred measures minimise emissions and achieve energy efficiency
- a comparison between preferred measures for emission controls and energy consumption with best practice environmental management in the relevant sector of industry
- a description of any opportunities for further offsetting greenhouse gas emissions through indirect means.

The environmental management plan in the EIS should include a specific module to address greenhouse abatement. That module should include consideration of the following:

- commitments to the abatement of greenhouse gas emissions from the project with details of the intended objectives, measures and performance standards to avoid, minimise and control emissions
- commitments to energy management, including undertaking periodic energy audits with a view to progressively improving energy efficiency
- a process for regular review of new technologies to identify opportunities to reduce emissions and use energy efficiently, consistent with best practice environmental management
- any voluntary initiatives such as projects undertaken as a component of the national Greenhouse Challenge Plus program, or research into reducing the lifecycle and embodied energy carbon intensity of the project's processes or products
- opportunities for offsetting greenhouse emissions, including, if appropriate, carbon sequestration and renewable energy uses
- commitments to monitor, audit and report on greenhouse emissions from all relevant activities and the success of offset measures.

3.7 Noise and vibration

3.7.1 Description of environmental values

This section should describe the existing environmental values that may be affected by noise and vibration from project activities.

If the proposed activity could adversely impact on the noise environment, baseline monitoring should be undertaken at a selection of sensitive receptors affected by the proposal. Sensitive receptors are defined in the Environmental Protection (Noise) Policy 2008 (EPP(Noise)). Long-term measured background noise levels should take into account seasonal variations. The locations of sensitive sites should be identified on a map at a suitable scale. The results of any baseline monitoring of noise and vibration in the proposed vicinity of the proposal should be described.

Sufficient data should be gathered to provide a baseline for later studies. The daily variation of background noise levels at nearby sensitive receptors should be monitored and reported in the EIS, with particular regard given to detailing variations at different periods of the night. Monitoring methods should adhere to accepted best practice methodologies, relevant EPA guidelines and Australian standards, and any relevant requirements of the EPP (Noise).

Comment should be provided on any current activities near the project area that may cause a background level of ground vibration (for example: major roads, quarrying activities, etc.).

3.7.2 Potential impacts and mitigation measures

The need or otherwise for noise modelling should take into account the distance of relevant project sources of noise from neighbouring sensitive receptors such as residential and commercial developments believed to be sensitive to the effects of noise. Noise from mining, beneficiation and power generation components of the project should be modelled, where appropriate, using a suitable acoustic model covering the construction and operational phases.

The assessment of noise impacts, neighbouring sensitive receptors, should include matters raised in the document The health effects of environmental noise – other than hearing loss published by the enHealth Council, 2004 (or later editions), ISNB 0 642 82304 9.

The potential environmental harm of noise and vibration at all potentially sensitive places, in particular, any place of work or residence should be quantified in terms of objectives, standards and indicators to be achieved and measurable indicators. Particular consideration should be given to emissions of low-frequency noise that is, noise with components below 200Hz.

The assessment should also include environmental impacts on terrestrial animals and avifauna, particularly migratory species. Proposed measures for the minimisation or elimination of impacts should be provided, including details and illustrations of any screening, lining, enclosing or bunding. A discussion should be provided of timing schedules for construction and operations with respect to minimising environmental nuisance and harm from noise. This description should also include temporary sensitive places, if applicable.

Information should be supplied on blasting which might cause ground vibration or fly rock on, or adjacent to, the site with particular attention given to places of work, residence, recreation, worship and general amenity. The magnitude, duration and frequency of any vibration should be discussed. A discussion should be provided of measures to prevent or minimise environmental nuisance and harm. Blasting noise and vibration limits are provided in the EP Act, section 440ZB Blasting. Reference should also be made to the EPA Guideline: Noise and vibration from blasting.

The assessment should also address off-site noise and vibration impacts that could arise due to increased road or other transportation directly resulting from the project.

Any potential for ground vibration effects on underground pipelines and telecommunication lines should be examined.

3.8 Waste

3.8.1 Waste generation

This section should provide technical details of waste generation, treatment, minimisation and management. All sources of waste to be generated during the construction, operational and decommissioning stages of the project should be identified and described in this section. Refer to each of the waste streams previously described and provide references to more detailed descriptions of the relevant environmental values in other sections of the EIS.

3.8.2 Waste management

The EIS should provide details of waste management strategies (including reduction, reuse, recycling, storage, transport and disposal of waste) which demonstrate that waste minimisation and cleaner production techniques and designs have been implemented through the selection of processes, equipment and facilities to prevent or minimise environmental impacts.

This section should assess the potential impact of all wastes to be generated during the construction, operational and decommissioning stages of the project, and provide details of each waste in terms of:

- operational handling and fate of all wastes including storage
- on-site treatment methods proposed for the wastes
- methods of disposal (including the need to transport wastes off-site for disposal) proposed to be used for any trade wastes, liquid wastes and solid wastes
- the potential level of impact on environmental values
- proposed discharge/disposal criteria for liquid and solid wastes
- measures to ensure stability of any dumps and impoundments should be described
- methods to prevent, seepage and contamination of groundwater from stockpiles and/or dumps should be given
- market demand for recyclable waste (where appropriate) should be addressed
- waste minimisation techniques processes proposed
- decommissioning of the site.

Having regard for best practice waste management strategies and the Environmental Protection (Waste) Policy 2000, the proposals for waste avoidance, reuse, recycling, treatment and disposal should be described in the appropriate sub-section below. Information should also be provided on the variability, composition and generation rates of all waste produced at the site and processing plant.

Cleaner production waste management planning should be detailed especially as to how these concepts have been applied to preventing or minimising environmental impacts at each stage of the proposal. Measures to improve natural resource use efficiency (e.g. energy and water), integrated processing design, any co-generation

of power and by-product reuse as shown in a material/energy flow analysis should be presented.

This information is required to enable the resource management agencies and other stakeholders to assess the efficiency of resource use, and allocation issues.

- **Air emissions**—this section should provide information on air emissions, including particulates, fumes and odours, during the construction and operation stages of the project. Particulate emissions include those that would be produced by any industrial process, or disturbed by wind action on stockpiles and conveyors, or by transportation equipment (e.g. trucks, either by entrainment from the load or by passage on unsealed roads). The methods to be employed in the mitigation of impacts from air emissions should be described in the section 3.6 Air.
- **Excavated waste**—this section should describe and show the location, design and methods for constructing dumps for waste rock and subsoil. The location of the dumps should be shown on a map relative to topography and other natural features of the area.
- **Tailings**—this section should describe the tailings waste produced by preparation and/or processing plants and the proposed methods for its disposal. Describe alternative options for tailings disposal including the proposed location, site suitability and volume of any tailings storage and/or disposal site(s), including the method of construction.

  Describe the approximate quantity of tailings to be produced by the project and its processing plant annually for the life of the mine. Tailings characterisation information should also be presented in this section.

  The construction of the tailings storage facility should be described with regards to construction material and design. The EIS should address how the tailings storage facility complies with relevant codes for the construction of such containment systems.

  Describe the strategies to monitor and manage seepage into ground and surface waters. The location of the storage and/or disposal site with regard to adjacent creeks and rivers should be described.
- **Solid waste disposal**—describe the quantity and quality of solid wastes (other than waste rock, subsoil and tailings addressed in other sections) and the proposed methods of their disposal. The proposed location, site suitability, dimensions and volume of any landfill, including its method of construction, should be shown.
- **Liquid waste**—a description should be presented of the origin, quality and quantity of wastewater, sewerage, contaminated runoff and any immiscible liquid waste originating from the project other than that addressed in other sections. Particular attention should be given to the capacity of wastes to generate acid, and saline or sodic wastewater and the potential for this water to contain metals and metalloids.
- **Ship waste**—details should be provided on the management of ship waste, including:
  - handling, treatment and disposal of solid quarantine waste
  - ship's sewage
  - ship's washings and slops

Details of expected volumes of ballast water to be discharged in port, the source of the ballast, location of ship discharges, risk of introducing marine pests and proposed controls, including ballast water inspections, should all be specified. The management of ballast water and risk of introduced marine pests should be discussed in the context of Commonwealth requirements and systems.

3.9 Transport

3.9.1 Transport methods and routes

The assessment of transport impacts should be presented as separate sub-sections of the EIS, for each project-affected mode, as relevant (road, rail, air and sea). The assessment should provide sufficient information to allow an independent assessment to be made of how existing transport infrastructure will be affected by project transport at the local and regional level.

The EIS should detail:

- any proposed new or alterations to transport-related infrastructure required by the project (as distinct from impact mitigation works). This includes modifications to roads for access works and realignments, rail lines (including level crossings and services) and air and sea port facilities. The EIS should also include the construction of any project-related plant and utilities, within or impacting on the jurisdiction of any transport authority
- expected volumes/tonnage of project inputs and outputs of transported raw materials, wastes, hazardous goods, finished products and so on for all phases of the project
- how identified project inputs and outputs will be moved through the transport network (volume/tonnage, composition, trip timing and routes)
- traffic generated by workforce personnel including visitors (mode,volume, composition, timing and routes)
- likely heavy and oversize/indivisible loads (volume, composition, timing and routes) highlighting any vulnerable bridges and structures along proposed routes.

3.9.2 Potential impacts and mitigation measures

The impact assessment should include:

- details of assessment methodology adopted with a summary of consultation undertaken with transport authorities (for example, DMR, local government and Queensland Transport) regarding the scope of the impact assessment and methodology to be used
- details of all base data assumptions, including current condition of the affected network and its performance
- details on possible interruptions to transport operations
- details of any impacts on the natural environment within the jurisdiction of an affected transport authority (for example road and rail corridors)
- details on the nature and likelihood of product-spill during transport if relevant

- **road impacts**—in assessing road impacts, reporting should be in general accordance with DMR, Guidelines for Assessment of Road Impacts of Development (2006), available on the DMR website: lwww.mainroads.qld.gov.au and include:
  - an assessment of project impacts (from either transport or project operations) on the safety, efficiency and condition of road operations and assets
  - an assessment of project impacts on overland water-flows and their interaction with the road network
  - an assessment of driver fatigue for workers travelling to and from regional centres and key destinations
  - an assessment of project impacts on any existing or proposed pedestrian/ cycle networks
  - an assessment of project impacts on any existing public transport networks (assets and services).
- **rail Impacts**—in assessing rail impacts, the proponent should consider:
  - project impacts on the amenity and health of adjacent land users as a result of dust, noise and vibration
  - impacts on passenger transport and services, should the project generate large public transport trip movements.
- **air and sea ports**—in assessing air and sea impacts, the proponent should consider project impacts on the ongoing operation of existing air and sea port facilities, including capacity of throughput and any land-use impacts as a result of the project's operations. The impact of the project on the Port of Weipa, particularly, how the operation of a new port at Boyd Point will affect the existing Port of Weipa, should be addressed.

Mitigation strategies to address project impacts should be included for each project-affected transport mode. The proponent should discuss and recommend how identified impacts will be mitigated so as to maintain safety, efficiency and condition of each mode. These mitigation strategies should be prepared by the proponent in close consultation with relevant transport authorities and include:

- consideration of any transport authority's works program and forward planning
- proposed construction plans of all required transport infrastructure works in accordance with relevant and accepted authority standards and practices
- timing and responsibilities of these works (when and by whom)
- a summary of relevant approvals and legislative requirements needed to implement mitigation strategies including transport infrastructure works required by the project.

3.10 Indigenous cultural heritage

3.10.1 Description of indigenous cultural heritage values

The EIS should describe the known indigenous cultural heritage values that may be affected by the project. An indigenous cultural heritage survey (as part of the Cultural Heritage Management Plan (CHMP) process or otherwise) should be undertaken for

significant indigenous objects and significant indigenous areas. The indigenous cultural heritage survey should:

- refer to the NRW Indigenous Site Database and any existing literature relating to the affected areas
- refer to:
  - the consultation and negotiation with traditional owners and the outcomes about:
    - significant indigenous objects and significant indigenous areas
    - confidentiality of culturally sensitive information
  - the involvement of traditional owners in field surveys.
- include locations of significant indigenous objects and significant indigenous areas identified during the survey and which are likely to be impacted by the project
- provide a report of work done which includes background research, relevant environmental data and methodology, as well as results of field surveys, significance assessment and conclusions and management recommendations (having due for any confidentiality requirements specified by community representatives).

3.10.2 Potential impacts and mitigation measures

The management of indigenous cultural heritage impacts should be detailed in either a native title agreement with traditional owners or in a CHMP, with the native title agreement or plan to be developed in a form that complies with the provisions of Part 7 of the *Aboriginal Cultural Heritage Act 2003,* thereby meeting the cultural heritage duty of care. The agreement or plan must provide a process for the conduct of comprehensive cultural heritage investigations and the identification of significant indigenous objects and significant indigenous areas in the proposed project area. It is also to provide a process for the management of those objects, areas and values identified in the proposed project area.

The agreement or plan should include the following:

- a process for including indigenous communities or indigenous parties in the identification, management and protection of indigenous cultural heritage in the project area
- a process for undertaking a comprehensive and systematic cultural heritage assessment
- processes for the mitigation, management and protection of identified cultural heritage objects and areas in the project area, and in any areas to be affected by development of any associated infrastructure, both during construction and operational phases of the project
- provision for the management of the accidental discovery of cultural material, including burials, in the project area
- processes for determining any requirements for monitoring of the project during construction, and measures by which any monitoring program is to be implemented

- Indigenous cultural heritage induction and awareness programs for project staff, subcontractors and staff, consultants and agents of the project
- a conflict resolution process.

The development of the agreement or plan should be negotiated with all relevant stakeholder representatives, subject to any confidentiality specified by the indigenous community, registered native title applicants, and/or indigenous parties as appropriate.

As a minimum, impact assessment, management and protection strategies should satisfy statutory responsibilities and duties of care under the *Aboriginal Cultural Heritage Act 2003* and the *Aboriginal and Torres Strait Islander Heritage Protection Act 1984 (Cwlth)*.

If a CHMP has not been approved by the submission of the EIS to the CG then the following should be provided:

- a outline of the draft CHMP, subject to any confidentiality provisions, with the position of the endorsed cultural heritage parties
- details of the proposed steps and timeframes for seeking the ratification of the CHMP.

3.11 Non-Indigenous cultural heritage

3.11.1 Description of non-indigenous cultural heritage values

The EIS should describe the existing environmental values for non-indigenous cultural heritage that may be affected by the project activities. The non-indigenous cultural heritage survey should:

- refer to:
  - the Australian Heritage Places Inventory
  - the EPA Queensland Heritage Register and other information regarding places of potential non-indigenous cultural heritage significance
  - local government heritage register
  - any existing literature relating to the affected areas
- refer to consultations and negotiations with the local community and historical societies about:
  - places of non-indigenous cultural heritage significance
  - the significance of any non-indigenous cultural heritage places located or identified
- include locations of culturally significant sites likely to be impacted by the project
- provide a constraints' analysis of the proposed development area to identify and record non-indigenous cultural heritage places
- provide the location of mining areas with historical significance should be shown on maps

- provide a report of work done which includes background research, relevant environmental data and methodology, as well as results of field surveys, significance assessment and conclusions and management recommendations (having due regard for any confidentiality requirements specified by community representatives).

As a minimum, investigations and consultation should be undertaken in such manner and detail to satisfy statutory responsibilities and duties of care, under the EPBC Act and *Queensland Heritage Act 1992*.

3.11.2 Potential impacts and mitigation measures

The proponent should provide an assessment of any likely effects on sites of non-indigenous cultural heritage values, including but not limited to the following:

- description of the significance of artefacts, items or places of conservation or non-indigenous cultural heritage value likely to be affected by the project and their values at a local, regional and national level
- recommended means of mitigating any negative impacts on non-indigenous cultural heritage values and enhancing any positive impacts
- where relevant, negotiations with Queensland Heritage Council and the EPA regarding management of places of historic heritage significance, taking account also of community interests and concerns
- documented management strategies in accordance with the outcomes of negotiations with Queensland Heritage Council, EPA and the community.

As a minimum, impact assessment, management and protection strategies should satisfy statutory responsibilities and duties of care, including those under the EPBC Act and *Queensland Heritage Act 1992*.

4 Social values and management of impacts

4.1 Social

4.1.1 Description of social values

This section should describe the existing social values that may be affected by the project including effects at both footprint and benefited area locations. The social amenity and use of the project area and adjacent areas for rural, agricultural, forestry, fishing, recreation, industrial, educational, cultural or residential purposes, should be described. In the development of this community profile, consideration should be given to:

- Indigenous communities
- rural properties, farms, croplands and grazing areas
- community infrastructure and services, access and mobility
- population, demographics and family structure of the affected community
- local community characteristics, identity, values, vitality and lifestyles
- recreational, cultural, leisure and sporting facilities and activities in relation to the affected area
- recreational, commercial and Indigenous fishing areas and livelihoods
- health and educational facilities
- local government and public facilities
- number of properties directly affected by the project
- number of families directly affected by the project (including Indigenous Traditional Owners and their families), this should include not only property owners but also families of workers either living on the property or workers where the property is their primary employment.

Social, economic and cultural values are not as easily separated and therefore it may be necessary for some material in this section to be cross-referenced to other sections of the EIS.

The EIS should give an overview of the project's near neighbours and local communities at the level of Indigenous communities, townships, district, region and state and be comprised of:

- a definition of the local community area, developed in consultation with the DIP Social Impact Unit
- the location of other relevant proposals or projects within the local community area
- other features in the local community area, including social infrastructure and human services.

The EIS should include a social baseline study which describes the profile and demographics of the local community, including:

- the identity, characteristics and aspirations of each community within the project area, including Indigenous communities
- the name and location of the community, size, history, and spatial distribution
- land use and land ownership patterns
- key social and political organisations including local government, non-government organisations and other civil society organisations
- major trends/changes in the population make-up that may be occurring irrespective of the project
- total population (the total enumerated population for the local community area and the full time equivalent (FTE) transient population)
- population growth and population forecasts with and without the project
- age and gender distributions (including Indigenous communities)
- education including schooling levels
- occupation and ethnic characteristics
- median individual and household incomes
- employment, unemployment and not in the labour force
- housing costs (monthly housing repayments) (per cent of dwellings in each category), and weekly rent (per cent dwellings in each category), housing tenure type and landlord type, household and family type
- social and economic index for areas and index of disadvantage—score and relative ranking
- disability prevalence
- crimes, including domestic violence and crimes against the person
- a description of social issues currently faced by local communities should be outlined. Regard should be given to any other recent social impact work done in the Western Cape area
- other such indicators that may be determined by the community as relevant.

The EIS should provide a profile of the local business community including:

- a description of the key industries
- the number of properties and families directly affected by the project including Indigenous families and families of workers either living on the property or workers where the property is their primary employment
- use of the project area for forestry, fishing and recreation tourism, if applicable
- Indigenous and non-Indigenous traditional and significant sites.

4.1.2 Potential impacts and mitigation measures

The social impact assessment of the project should be carried out in consultation with affected local authorities/communities and relevant state authorities including the

DIP Social Impact Unit. The assessment of impacts should describe the likely response of affected communities and identify possible beneficial and adverse impacts (both immediate and cumulative). These impacts should be considered both at the local and regional level.

The social impact assessment of the project should consider the information gathered through a community engagement program (public consultation program – section 1.9) and the analysis of the existing socio-economic environment, and describe the project's impact, both beneficial and adverse, on the Indigenous, local and regional community. The impacts of the project on Indigenous, local and regional residents' community services and recreational activities should be analysed and discussed for all stages of the development. The nature and extent of the community engagement program should be described and a summary of the results incorporated in the EIS.

The social impact assessment should include sufficient data to enable affected local authorities and state authorities, to make informed decisions about how the project may affect their business and plan for the continuing provision of public services in the region of the project.

Cumulative impacts—direct, indirect and secondary impacts resulting from existing projects, the proposed project and anticipated future projects, should be identified including the important cause and effect of relationships between human activities and resources, ecosystems, traditional Indigenous lands, and human communities. The magnitude and significance of these cumulative effects should be determined.

The EIS should provide an assessment of the following, taking into account relevant demographic, social, cultural, Indigenous, and economic profiles:

- impacts on Indigenous, local and regional residents, current land uses, cultural land use and existing lifestyles and enterprises
- impacts on local, regional and state labour markets, with regard to the source of the workforce. This information should be presented according to occupational groupings and whether the proponent, and/or contractors, are likely to employ local and Indigenous residents or through other means and whether there are initiatives for local Indigenous business opportunities.
- impacts on both construction and operational workforces and associated contractors on housing demand, housing affordability, community services and community cohesion. The capability of the existing housing stock, including rental accommodation, to meet any additional demands created by the project should be discussed at a local, regional and state scale, including direct impacts on Indigenous people.
- proposed new skills and training related to the project, including the occupational skill groups required and potential skill shortages anticipated
- the degree of service revenue and project work (e.g. provisioning, catering and site maintenance) likely to flow to existing communities in the area of the project, particularly if a fly-in, fly-out workforce is proposed
- the ability of both affected Indigenous and non-Indigenous communities to live in accordance with their own values and priorities
- use of, and access to, culturally important areas and landscapes
- access to existing human and commercial services and housing
- ability to participate in local and regional employment and training opportunities

- any influx of a new project workforce and their families
- impacts on the various educational sectors.

The proponents initiatives to promote environmental and cultural awareness for the general public should be described.

Mitigation and enhancement strategies for identified impacts to social values should be outlined. Practical monitoring regimes for project-related impacts should be recommended and a procedure to establish a complaints register and a conflict resolution mechanism should be incorporated.

The social impact mitigation strategies should address:

- strategies to address all project-related Indigenous issues including effective ongoing consultation
- the sourcing of the construction and operational workforce and the social and cultural implications this may have for the host community, particularly if any part of the workforce is sourced from overseas
- an accommodation strategy, where necessary, in consultation with relevant state government agencies, with proposals that avoid, mitigate or offset any short and medium term adverse effects on the local and regional housing market
- the demographic changes in the profile of the region and the associated sufficiency of current infrastructure and services
- the development of a community engagement plan that promotes an active and on-going role for impacted communities including Indigenous communities and is inclusive of relevant demographic groups such as young people, men, women, elders etc.

The social impact assessment should contain an evaluation of the net social impacts of the proposed project including a summary table of net social impacts identified by the study, and an estimation of the overall significance of those impacts.

The EIS should discuss any social responsibility initiatives proposed by the proponent, including:

- modifications or alternatives to avoid, minimise, or mitigate significant cumulative effects
- key policies and procedures to be adopted or used by the proponent that would mitigate or enhance impacts
- key government documents outlining proposed local, state or Australian Government initiatives or plans that would mitigate or enhance impacts. Uncertainty should be addressed through the design of an effective monitoring system.

A Social Impact Management Plan should be prepared to address social impacts arising from the project. In particular, the plan should identify potential impacts and outline mitigation strategies, commitments and management measures to ameliorate the impacts identified.

4.2 Health and safety

4.2.1 Description of environmental values

This section should describe the existing community values for public health and safety that may be affected by the proposal. For projects proposing air emissions, and/or those with the potential to emit odours, nearby and other potentially affected populations should be identified and described. Particular attention should be paid to those sections of the population, such as children and the elderly, that are especially sensitive to environmental health factors.

4.2.2 Potential impacts and mitigation measures

This section should define and describe the objectives and practical measures for protecting or enhancing health and safety community values, describe how nominated quantitative standards and indicators may be achieved for social impacts management, and how the achievement of the objectives will be monitored, audited and managed.

The EIS should assess the effects on the project workforce of occupational health and safety risks and the impacts on the community in terms of health, safety, and quality of life from project operations and emissions. Any impacts on the health and safety of the community, workforce, suppliers and other stakeholders should be detailed in terms of health, safety, quality of life from factors such as lighting, air emissions, odour, dust, noise and vibration.

Map(s) should be provided showing the locations of sensitive receptors, such as, but not necessarily limited to, kindergartens, schools, hospitals, aged care facilities, residential areas, and centres of work (e.g. office buildings, factories and workshops). The EIS, illustrated by the maps, should discuss how planned discharges from the project could impact on public health in the short and long term, and should include an assessment of the cumulative impacts on public health values caused by the proposal, either in isolation or by combination with other known existing or planned sources of contamination.

The EIS should address the project's potential for providing disease vectors. Measures to control mosquito and biting midge breeding should be described.

Potential public health risks to drinking water supplies should be assessed and mitigation measures outlined to ensure compliance with the Australian Drinking Water Guideline 2004. If the proponent must register as a water service provider, provision of potable water and recycled water must comply with the *Water Supply (Safety and Reliability) Act 2008* administered by NRW.

Any use of recycled water should be assessed for its potential to cause infection by the transmission of bacteria and/or viruses by contact, dispersion of aerosols, and ingestion (e.g. via use on food crops). Similarly, the use of recycled water should be assessed for its potential to cause harm to health via the food chain due to contaminants such as heavy metals and persistent organic chemicals. Practical monitoring regimes should also be recommended in this section.

5 Impacts on the state and local economies and management of impacts

5.1 Economy

5.1.1 Description of affected local and regional economies

This section should describe the existing economy in which the project is located and the economies materially impacted by the project. In particular, the following should be addressed:

- define the economy in which the project is to be located
- describe the economy including:
  - gross regional product or other appropriate measure of annual economic production
  - population
  - labour force statistics
  - infrastructure
- describe the regional economy's key industries and their contribution to regional economic income
- discuss regional resource endowment, competitive advantage and expected future growth
- describe the key regional markets relevant to the project:
  - labour market
  - housing and land markets
  - construction services and building inputs market
- with regard to the region's key industries:
  - provide information on current input costs (wage rates, building costs, housing rent etc)
  - provide information on land values in the region by type of use.

5.1.2 Potential Impacts and mitigation measures

The potential impacts should consider regional, state and national perspective as appropriate to the scale of the project.

The analysis should include the direct economic impacts on industry and the community including:

- property values
- industry output
- employment

- factor incomes.

The analysis should also:

- assess any forgone industry output from the project
- assess any forgone opportunities and impacts to households (eg recreation, increased travel times)
- assess the indirect impacts likely to flow to other industries and economies from the development of the project. This should also consider the implications of the project for future development

5.1.2.1 Strategies for local participation

The assessment of economic impacts should outline:

- strategies for assessing the cost effectiveness of sourcing local inputs from the regional economy during the construction, rehabilitation and operation of the project
- employment strategies for local residents including members of Indigenous communities including a skills assessment and recruitment and training programs to be offered
- strategies to meet obligations under any existing Indigenous Land Use Agreement
- strategies responding to government policy, where relevant, relating to:
  - employment opportunities for Indigenous people arising from the Western Cape Regional Partnership Agreement
  - the level of training provided for construction contracts on Queensland Government building and construction contracts, with regard to the *Queensland Government Building and Construction Contracts Structured Training Policy* (the 10 per cent policy)
  - Indigenous employment opportunities, with regard to the *Indigenous Employment Policy for Queensland Government Building and Civil Construction projects* (the 20 per cent policy)
  - the use of locally sourced goods and services, with regard to the *Local Industry Policy* (Department of State Development, 1999).

5.1.2.2 Strategies to mitigate disruption to the local economy during construction and operation

The economic assessment should:

- identify all potential changes to industry practices likely to occur during construction and operation of the project
- identify all potential impacts on households (travel time, noise etc) likely to occur during construction and operation of the project
- estimate the cost of these changes if material
- describe the measures to be taken to minimise disruption or alleviate cost impacts of the project.

5.1.2.3 Impact upon property management

This section should address the current and future management processes for adjacent properties which are likely to be impacted by the project during construction and/or operation. Mention should be made of:

- the impact of the project on existing agricultural land uses and management practices, e.g. disruption to stockyards, fences, water points, sowing or harvesting of crops, movement of livestock, agricultural machinery and any loss of agricultural land
- the range of measures required to mitigate real and potential disruptions to rural practices and management of properties.

5.2 Sustainable development

The EIS should provide a comparative analysis of how the project conforms to the objectives for 'sustainable development' (see the National Strategy for Ecologically Sustainable Development (1992), available from the Australian Government Publishing Service).

This analysis should consider the cumulative impacts (both beneficial and adverse) of the project from a life-of-project perspective, taking into consideration the scale, intensity, duration and frequency of the impacts to demonstrate a balance between environmental integrity, social development and economic development.

This information is required to demonstrate that sustainable development aspects have been considered and incorporated during the scoping and planning of the project.

6 Hazard and risk

6.1 Hazard and risk assessment

This section of the EIS should describe the potential hazards and risks that may be associated with the project and should incorporate all known hazards, which may include:

- identification of potential hazards, accidents, spillages and abnormal events occurring during all stages of the project, including possible frequency of occurrence
- indication of cumulative risk levels to surrounding land uses
- identification of all hazardous substance to be used, stored, processed or produced and the rate of usage
- potential wildlife hazards such as snakes and disease vectors.

The EIS should deal with on-site risks. External risks to the project should also be considered. External risks from natural hazards could be determined on the basis of Australia/New Zealand Standard on Risk Management AS/NZS 4360:2004. The study should assess risks during the construction, operational and decommissioning phases associated with the project. These risks should be assessed in quantitative terms where possible. Possible hazards, accidents, and abnormal events that may arise for the project, both during construction and in operation should be described, including:

- accidental release of hazardous goods or other materials
- fires associated with incidents arising from the project activities
- vulnerability of the project area to bushfire, flooding and cyclones and other natural disasters.

Analysis of the consequences of each of these events on safety and environmental damage in the project area should be conducted, including direct harm to the environment as a result of project hazards. The analysis should examine the likelihood of these consequences being experienced, both individually and collectively. In regard to the on-site handling and storage of explosive raw material, consultation is encouraged with the Department of Emergency Services Chemical Hazards and Emergency Management Services Unit.

Details should be provided on the safeguards that would be employed or installed to reduce the likelihood and severity of hazards, consequences and risks to persons, fauna and environmentally sensitive sites within and adjacent to the project area.

6.2 Emergency management plan

An outline of the proposed emergency management procedures should be provided for the range of situations identified in the above risk assessment where there are measurable risks. This should include an overview of the objectives and management principles to be adopted for the preparation of a detailed emergency plan (including emergency response and recovery/cleanup procedures) in consultation with the relevant emergency services. Planning should include reference

to State Planning Policy 1/03, Mitigating the Adverse Impacts of Flood, Bushfire and Landslide.

In particular, the following should be presented:

- contingency plans to deal with hydrocarbon (e.g. diesel, lubricating oils) oil spills during construction, operation and maintenance of the project
- contingency plans to account for natural disasters such as storms, flooding and fires during the construction, operation and maintenance phases
- emergency planning and response procedures that have been determined in consultation with state and regional emergency service providers
- plans for involvement of the relevant state agencies (such as the Department of Emergency Services, which includes the Queensland Ambulance Service, Queensland Fire and Rescue Service, Queensland Police Service and Emergency Management Queensland) in relation to emergency medical response and transport and first aid matters.

7 Cumulative impacts

The purpose of this section is to provide clear and concise information on the overall impacts of the project, and to discuss the interrelationship of these impacts. This is in addition to the discussion of cumulative impacts which feature in the relevant sections. The cumulative impacts as they relate to particular issues (e.g. water management, cultural heritage, social and economic costs and benefits, community disruption and accommodation etc.) may also be discussed in this section. These impacts should be considered over time or in combination with other impacts because of the scale, intensity, duration or frequency of the impacts.

The cumulative impacts of the project, in combination with other proposed mining projects , on the biodiversity and ecological function of the Western Peninsula bauxite plateau, should be assessed within the EIS. Specific issues that should be covered include impacts on:

- regional ecosystems associated with the western Cape York Peninsula bauxite plateau
- the natural integrity of Cape York Peninsula as a whole
- key habitats (e.g. riparian, wetland, threatened species habitat) which retain connections with adjacent remnant vegetation and habitat
- hydrologically connected surface water and groundwater systems that support wetlands and base flows in rivers and creeks.

The requirements of any relevant state planning policies, environmental protection policies, national environmental protection measures, water resource planning and any other relevant plans should also be addressed.

The methodology to be used to determine the cumulative impacts of the project should be discussed. The methodology should detail the range of variables to be considered including, where applicable, relevant baseline or other criteria upon which the incremental aspects of the project should be assessed.

8 Environmental management plan

This section of the EIS should detail the EMP developed for the project. The EMP should be developed from, and be consistent with, the preceding information in the EIS and be consistent with the EPA Guideline 'Preparing an Environmental Management Overview Strategy for non-standard mining projects'.

An EMP should provide control actions in accordance with agreed performance criteria for specified acceptable levels of environmental harm.

In addition, the EMP should identify:

- potential impacts on environmental values
- mitigation strategies
- relevant monitoring
- appropriate indicators and performance criteria
- reporting requirements
- appropriate corrective actions, should an undesirable impact or unforeseen level of impact occur
- the recording of and response to complaints.

The aim of the EMP is to provide:

- commitments by the proponent to practical and achievable strategies and design standards (performance specifications) for the management of the project to ensure that environmental requirements are specified and complied with an integrated plan for comprehensive monitoring and control of impacts
- local, state and federal government authorities, stakeholders and the proponent with a common focus for approvals conditions and compliance with policies and conditions
- the community with evidence that the environmental management of the project is acceptable.

The recommended structure of the EMP is:

Element/issue	Aspect of construction or operation to be managed (as it affects environmental values)
Operational policy	The operational policy or management objective that applies to the element
Performance criteria	Measurable performance criteria (outcomes) for each element of the operation
Implementation strategy	The strategies, tasks or action program (to nominated operational design standards) that would be implemented to achieve the performance criteria
Monitoring	The monitoring requirements to measure actual performance (i.e. specified limits to pre-selected indicators of change)
Auditing	The auditing requirements to demonstrate implementation of agreed construction and operation environmental management strategies and compliance with agreed performance criteria
Reporting	Format, timing and responsibility for reporting and auditing of monitoring results
Corrective action	The action (options) to be implemented in case a performance requirement is not reached and the person(s) responsible for action (including staff authority and responsibility management structure)

An EMP should commit to manage, enhance or protect identified environmental values. The commitments should contain the following components for performance criteria and implementation strategies:

- environmental protection objectives for enhancing or protecting each relevant value
- indicators to be measured to demonstrate the extent to which the environmental protection objective is achieved
- environmental protection standards (a numerical target or value for the indicator), which defines the achievement of the objective
- an action program to ensure the environmental protection commitments are achieved and implemented. This will include strategies in relation to:
  - communication
  - continuous improvement
  - environmental auditing
  - monitoring

- reporting
- staff training
- a decommissioning program for land proposed to be disturbed under each relevant aspect of the project.

9 Conclusions and recommendations

The EIS should make conclusions and recommendations with respect to the project based on the studies presented, the EMP and conformity of the project with legislative and policy requirements.

10 References

All references consulted should be presented in the EIS in a recognised format.

11 Recommended appendices

11.1. Final TOR for this EIS

A copy of the final TOR should be included in the EIS.

11.2. TOR cross-reference table

A cross reference table should be provided which links the requirements of each section/subsection of the TOR with the corresponding section/subsection of the EIS where those requirements have been addressed.

11.3. Development approvals

A list of the development approvals required by the project should be presented.

11.4. EPBC report

A report addressing MNES and potential impacts of the project should be provided.

11.5. Consultation report

A list of advisory agencies should be provided in a summary consultation report, which should also list the federal, state and local government agencies consulted, and the individuals and groups of stakeholders consulted. A summary of the issues raised by these groups, and the means by which the issues have been addressed, should be provided in the text of the EIS.

The EIS should summarise the results of the community consultation program, providing a summary of the groups and individuals consulted, the issues raised, and the means by which the issues were addressed. The discussion should include the methodology used in the community consultation program including criteria for identifying stakeholders and the communication methods used.

Information about identifying affected parties (as defined by the EPBC Act) and interested and/or affected persons (as defined by the EP Act) should be included.

11.6. Study team

The qualifications and experience of the study team and specialist sub-consultants should be provided.

11.7. Glossary of terms

A glossary of technical terms and acronyms should be provided.

11.8. Specialist studies

All reports generated on specialist studies undertaken as part of the EIS are to be included as appendices. These may include:

- flora and fauna studies including the subregional analysis of representativeness and adequacy of protection for the terrestrial/riparian vegetation communities and their component flora and fauna taxa within the affected areas
- an integrated assessment of relative biodiversity/conservation values, based on the methodology outlined in EP Act
- air pollution, noise and vibration
- waterway hydrology
- groundwater
- geology
- economic studies and/or cost-benefit analyses
- hazard and risk studies
- land use and land capability studies.

11.9. Corporate environmental policy

The proponent should attach a copy of its corporate environmental policy and planning framework document.

11.10. List of proponent commitments

A list of all commitments made by the proponent in the EIS should be provided together with a reference to the relevant section in the report.

APPENDIX 1C

COMMONWEALTH EIS TAILORED GUIDELINES

Tailored Guidelines for the preparation of Draft Environmental Impact Statement (EIS)

South of the Embley Bauxite Mine and Port Facilities (EPBC ref 2010/5642)

These tailored guidelines are based on the standard guidelines at Schedule 4 of the *Environment Protection and Biodiversity Conservation Regulations 2000.*

The information required under these guidelines may be provided in an EIS that addresses state specific requirements, however it must be included in a stand-alone report or chapter that exclusively and fully addresses the issues relevant to the controlling provisions. To reduce overlap, cross referencing to other parts of the EIS may be used where required. The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) controlling provisions for this project are:

- listed threatened species and communities (section 18 and 18A)
- listed migratory species (sections 20 and 20A)
- Commonwealth marine areas (sections 23 and 24A).

1) General information

Provide a description of the background of the action including:

i) the title of the action;

ii) the full name and postal address of the designated proponent;

iii) a clear outline of the objective of the action;

iv) the location of the action;

v) the background to the development of the action;

vi) how the action relates to any other actions (of which the proponent should reasonably be aware) that have been, or are being, taken or that have been approved or proposed in the region affected by the action;

vii) the current status of the action;

viii) the consequences of not proceeding with the action;

ix) legislative background for the proposal, including the NES matters protected under Part 3 of the EPBC Act, and any other requirements and approvals needed under the EPBC Act, including s.160 of the Act;

x) legislative background for the proposal of the *Environment Protection (Sea Dumping) Act 1981.*

2) Description of the action

The Draft EIS must contain enough information about the action and its relevant impacts to allow the Minister to make an informed decision whether or not to approve under Part 9 of the EPBC Act (for the purposes of each controlling provision) the taking of the action.

Provide a description of the action, including:

i) all the components of the action;

ii) the precise location of any works to be undertaken, structures to be built or elements of the action that may have relevant impacts, including illustrations or maps;

iii) how the works are to be undertaken and design parameters for those aspects of the structures or elements of the action that may have relevant impacts;

iv) to the extent reasonably practicable, any feasible alternatives to the action, including:

   a) if relevant, the alternative of taking no action;

   b) a comparative description of the impacts of each alternative on the matters protected by the controlling provisions for the action, including alternatives to ocean disposal;

   c) sufficient detail to make clear why any alternative is preferred to another;

v) any consultation about the action, including:

   a) any consultation that has already taken place;

   b) proposed consultation about relevant impacts of the action;

   c) if there has been consultation about the proposed action — any documented response to, or result of, the consultation;

vi) identification of potentially affected parties, including a discussion of any communities that may be affected and a description of their views.

3) Matters of National Environmental Significance (NES)

Identify EPBC Act listed threatened species and ecological communities, listed migratory species and components of the Commonwealth marine environment potentially present on or off-site that are likely to be impacted, directly or indirectly, as a consequence of the proposal. For each of these matters of NES, the following information must be provided:

i) information on the distribution, ecology, and habitat preferences of the species or community;

ii) a detailed discussion of known threats;

iii) information on the conservation value of each habitat type on the site from a local and regional perspective, including the percentage representation of each habitat type on site in relation to its local and regional extent;

iv) if a population is present on the site, its size and the importance of that population from a local and regional perspective;

v) maps showing the location of known records (including those from databases and all surveys previously conducted for the proposal);

vi) maps showing the potential habitat within the proposed site. These maps must highlight habitat components important for each relevant species, such as breeding habitat, wetlands, vine forests, rock outcrops, etc;

vii) maps showing the potential habitat within the region;

viii) maps detailing regional migration pathways;

ix) information on the survey methodology used, including any limitations of the methodology and data collected for each matter of NES, as well as a justification for the survey methodology and survey sites employed;

x) survey methodology must follow all relevant state and Commonwealth survey guidelines (e.g. the Survey Guidelines for Australia's Threatened Birds (DSEWPaC)) and demonstrate how this has been acheived;

xi) information on the scientific reliability of survey investigations and conclusions, including the degree of certainty or statistical confidence where appropriate;

xii) for all listed threatened, migratory or marine species that are believed not likely to be impacted by the action, but for which suitable habitat is present and could be impacted by the action, detailed information must be included to demonstrate that a likely impact on the species will not occur.

4) Relevant impacts

Provide a description of the relevant impacts, including:

i) a detailed assessment of the nature and extent of the likely long-term and short-term relevant impacts, including a summary table detailing the amount of habitat impacted for each matter of NES;

ii) the assessment must detail direct, indirect, cumulative and facilitated impacts;

iii) a statement whether any relevant impacts are likely to be unknown, unpredictable or irreversible;

iv) analysis of the significance of the relevant impacts;

v) any technical data and other information used or needed to make a detailed assessment of the relevant impacts;

vi) information on the scientific reliability of investigations and conclusions drawn, including the degree of certainty or statistical confidence where appropriate. This must include any assumptions or limitations of any models used to make predictions;

Indirect impacts refers to impacts which are not a direct result of the project, and may include off-site or downstream impacts, such as impacts on migratory

species from changes to the hydrology of wetlands or estuarine areas located off-site.

Facilitated impacts refers to impacts resulting from the actions of third parties that are facilitated by proposed action, such as increased shipping or road traffic facilitated through the construction of a port or road.

Cumulative impacts refers to the incremental impacts of the action when combined with other past, present and reasonably foreseeable future actions (both related and unrelated).

5) Proposed safeguards and mitigation measures

Provide a description of the proposed safeguards and mitigation measures to deal with relevant impacts of the action, including:

i) a description, and an assessment of the expected or predicted effectiveness of, the mitigation measures;

ii) any statutory or policy basis for the mitigation measures;

iii) the cost of the mitigation measures;

iv) an outline of an environmental management plan (or plans) that set out the framework for continuing management, mitigation and monitoring programs for the relevant impacts of the action (both on and off-site), including any provisions for independent environmental auditing;

v) the plan(s) must allow for the collection of baseline environmental data, and ongoing monitoring, management and mitigation for the duration of the action and subsequent mine rehabilitation, so impacts on matters of NES can be adequately measured;

vi) the plan(s) must also detail how any management strategy or monitoring program would influence environmental practices on site, including trigger values and response measures where appropriate;

vii) the name of the agency responsible for endorsing or approving each mitigation measure or monitoring program;

viii) a consolidated summary list of mitigation measures proposed to be undertaken to prevent, minimise or compensate for the relevant impacts of the action, including mitigation measures proposed to be taken by State governments, local governments or the proponent.

6) Proposed offset measures

Where relevant impacts cannot be avoided or managed, provide a description of the proposed offset measures, including a proposed strategy to offset any impacts of the proposed action on matters of NES. The proposed strategy must:

i) demonstrate how it will achieve long-term conservation outcomes;

ii) have regard to the scale and intensity of impact from the development on the site;

iii) contain long-term and certain conservation outcomes;

iv) consider the approach of the relevant State or Territory.

7) Other approvals and conditions

Provide information on any other requirements for approval or conditions that apply, or that the proponent reasonably believes are likely to apply, to the proposed action. This must include:

i) details of any local or State government planning scheme, or plan or policy under any local or State government planning system that deals with the proposed action, including:

   a) what environmental assessment of the proposed action has been, or is being, carried out under the scheme, plan or policy;

   b) how the scheme provides for the prevention, minimisation and management of any relevant impacts;

ii) a description of any approval that has been obtained from a State, Territory or Commonwealth agency or authority (other than an approval under the Act), including any conditions that apply to the action;

iii) a statement identifying any additional approval that is required;

iv) a description of the monitoring, enforcement and review procedures that apply, or are proposed to apply, to the action.

8) Environmental record of person proposing to take the action

Provide details of any proceedings under a Commonwealth, State or Territory law for the protection of the environment or the conservation and sustainable use of natural resources against:

i) the person proposing to take the action;

ii) for an action for which a person has applied for a permit, the person making the application.

If the person proposing to take the action is a corporation, provide details of the corporation's environmental policy and planning framework.

9) Information sources

For information given in a draft EIS, the draft must state:

i) the source of the information;

ii) how recent the information is;

iii) how the reliability of the information was tested;

iv) what uncertainties (if any) are in the information;

v) the qualifications and experience of the study team and any specialist consultants;

vi) the parts of the EIS each individual was responsible for, or had input into.

10) Guidelines that must be utilised in the EIS

i) National Assessment Guidelines for Dredging 2009

ii) Annex 2 1996 Protocol to the Convention on the prevention of marine pollution by dumping of wastes and other matter 1972 (the London Protocol)

iii) Waste Specific Guidelines for Assessment of Dredged Material. International Maritime Organisation

APPENDIX 1D

TOR CROSS REFERENCE TABLE

ToR Section and Requirement		EIS Section
Executive Summary		Executive summary
1	**Introduction**	
	The section should explain:	
	• the function of the EIS;	1.7.1
	• why it has been prepared;	1, 1.7.1
	• what it sets out to achieve;	1.7.2
	• the audience to whom it is directed; and	1.7.1
	• contain an overview of the structure of the document.	1.7.4
1.1	**Project Proponent**	
	This section should describe the experience of Rio Tinto Alcan (RTA), including the nature and extent of business activities, experience and qualifications, role and responsibilities and environmental record, including the proponent's environmental policy.	1.1, Appendix 1A
1.2	**Project Description**	
	This section should provide:	
	• a brief description of the key elements of the Project;	1.2
	• the location of the Project and its infrastructure requirements.	Figures 1-1, 1-3 and 1-4, section 1.2
1.3	**Project Rationale**	
	This section should provide:	
	• a statement of the objectives of the Project and a brief outline of the events leading up to the Project's formulation, envisaged time scale for implementation and Project life, anticipated establishment costs and actions already undertaken within the Project area.	1.3, Table 1-1
	• justification for the Project, with reference to the economic and social benefits, including employment and flow-on business development, which the Project may generate;	1.5
	• the status of the Project on a regional, state and national context, examining the infrastructure needs of the state and far north Queensland economies; and	1.5
	• project's role in supporting state development and environmental policies and strategies.	1.5
1.4	**Relationship to other Projects**	
	This section should describe:	
	• how the Project relates to any other Projects, of which RTA are aware, that have been, or are being taken or that have been approved in the area affected by the Project; and	1.4
	• consequential impacts as defined under the EPBC Act, and Projects which will be considered as part of cumulative impact assessment identified and their relevance discussed.	1.4

ToR Section and Requirement		EIS Section
1.5	**Socio-Economic Cost and Benefits of the Project**	
	This section should summarise the short and long-term	
	• economic costs and benefits of the Project to businesses and the wider community, including direct and indirect employment and local business involvement;	1.5
	• any increased demands on local and regional community services and facilities;	1.5
	• direct social costs and benefits, including community disruption, related land use changes, employment, skills development and any workforce accommodation issues; and	1.5
	• any increased demand for natural resources as a result of the Project.	1.5
1.6	**Alternatives to the Project**	
	This section should describe:	
	• feasible alternatives, including conceptual, technological and locality alternatives to the Project, and the consequences of not proceeding with the Project;	1.6
	• alternative beneficiation technologies, such as in-pit dry screening of bauxite;	1.6.6
	• the interdependencies of the various Project components together with any infrastructure requirements that may affect the viability of the Project;	1.4
	• should water supply, power, transport and/or storage infrastructure be included as an element of the Project, this section should include a description of and rationale for such additional infrastructure;	1.2, 1.6.2, 1.6.4, 1.6.5, 1.6.8
	• the reasons for selecting the preferred options including technical, commercial, social and environmental aspects where relevant. In particular, compliance with government policy and with the principles and objectives of ecologically sustainable development.	1.6
1.7	**Co-location opportunities**	
	The EIS should:	
	• identify any third party proposals to develop infrastructure within the vicinity of Project investigation corridors;	1.4
	• describe the implications of locating other forms of linear infrastructure within or near proposed Project corridors;	1.4
	• where co-location may be likely, describe the potential implications of any infrastructure co-location on corridor widths and alignment.	Not Relevant - see 1.4

ToR Section and Requirement		EIS Section
1.8	**The Environmental Impact Assessment Process**	
1.8.1	**Methodology of the EIS**	
	This section should outline:	
	• the stages of the EIS process under the SDPWOA;	1.7.3
	• information on the relevant stages of the approvals process;	1.7.3
	• Commonwealth referrals, statutory and public consultation requirements;	1.7.3, 1.8
	• associated licence or permit application processes; and	1.9, Table 1-2
	• interdependencies that exist between approvals.	1.7.3, 1.9
1.8.2	**Objectives of the EIS**	
	This section should provide:	
	• a statement of the objectives of the environmental impact assessment process;	1.7.2
	• the structure of the EIS; and	1.7.4
	• discussion of role of the EIS in providing information for the formulation of the environmental management plan (EMP).	1.7.2
1.8.3	**Submissions**	
	• The reader should be informed as to how and when public submissions on the EIS will be addressed and taken into account in the decision-making process.	1.8
	• The EIS should inform the reader on how to make submissions and what form the submissions should take.	1.8
1.9	**Public Consultation Process**	
	This section should outline the methodology adopted to:	
	• identify stakeholders and how their involvement was facilitated;	1.8
	• identify the process conducted to date and future consultation strategies and programs, including during the operational phase of the Project; and	1.8
	• indicate how consultation involvement and outcomes were integrated into the EIS process and future site activities, including opportunities for engagement and provision for feedback and action if necessary.	1.8
	Detailed results of the consultation process should be provided as a Consultation Report and presented as an Appendix to the EIS.	Section 15
	A summary of the key processes and outcomes should be provided in this section	1.8

ToR Section and Requirement		EIS Section
1.10	**Project Approvals**	
1.10.1	**Relevant Legislation and Policy Requirements**	
	This section should identify and explain:	
	• the legislation and policies controlling the approvals process;	1.9
	• all the approvals, permits and licences that will need to be obtained for the development of the proposed Project including those on strategic port land; and	1.9
	• the approvals interrelationship between the Commonwealth Aluminium Corporation Limited Agreement Act 1957 and the Alcan Queensland Pty Limited Agreement Act 1965 with other relevant approvals legislation should be addressed.	1.9.4
1.10.2	**Planning Processes and Standards**	
	This section should discuss:	
	• the Project's consistency with existing land uses or long term policy framework for the area (e.g. as reflected in local and regional plans) and with legislation, standards, codes or guidelines available to monitor and control operations on site; and	1.9
	• refer to all relevant Queensland and regional planning policies.	1.9
1.10.3	**Accredited Process for Controlled Actions under Commonwealth Legislation**	
	The EIS should:	
	• address potential impacts on the MNES that were identified in the controlling provisions when the Project was determined to be a controlled action;	EPBC Assessment Report (section 22) - Section 5
	• a stand-alone report should be provided as an appendix to the EIS that exclusively and fully addresses the issues relevant to the controlling provisions. It should comply with the following outline:	EPBC Assessment Report (section 22)
	1. Introduction 2. Description of proposed action (as it would impact on MNES) 3. Description of the affected environment relevant to the controlling provisions (i.e. describe the features of the environment that are MNES protected under the EPBC Act) 4. Assessment of impacts on MNES and mitigation measures (in accordance with available guidelines and species recovery plans), including consideration of any potential offsets to ameliorate residual impacts 5. Conclusions 6. References.	

ToR Section and Requirement		EIS Section
2	**Description of the Project**	
	The EIS should describe the Project through its lifetime of construction and operation and decommissioning (including rehabilitation).	2
2.1	**Overview of Project**	
	The EIS should contain:	
	• a description of the key components of the Project through the use of text and design plans where applicable;	2.3
	• the expected cost and overall duration and timing of the Project ;	2.1
	• the employment benefits from the construction and operational phases of the Project; and	2.1, 2.7.1
	• a summary of any environmental design features of the Project.	2.4, 2.5, 2.6, 2.7, 2.8
2.1.1	**Mine**	
	This section should provide:	
	• the mine life and mineral resources;	2.1, 2.4.1
	• the mining methods and ore handling methods to be used, including the major equipment to be used in the various components of the operation;	2.4.2, 2.4.3, 2.4.4, 2.5
	• the location and boundaries of proposed mining areas, illustrated on maps;	Figures 1-1, 1-3 and 1-4
	• mine development sequence and timeframes;	2.4.2, Figure 1-3
	• any proposed stream diversions or public road diversions; and	No public road diversions planned - see 2.7.2, no watercourse diversions planned - see 2.7.3
	• the final landform and any final voids to be left at the cessation of mining.	2.4.4, no final voids
2.1.2	**Beneficiation**	
	The EIS should contain:	
	• a description of the bauxite beneficiation process and the layout of key components of the plant including:	Bauxite beneficiation and key components of the plants are described in 2.5
	• description of key plant and equipment, processes, capacities and raw materials to be used;	2.5
	• indicative material balances for the processing plant, and the anticipated rates of inputs along with similar data on products and tailings streams ;	2.5.2
	• data on any chemicals be used;	No chemicals to be used in beneficiation - see 2.5.1 and 2.5.2
	• location of proposed tailings disposal areas;	2.5.2, Figure 2-7, Figure 2-8
	• description of the types, quantities and characteristics of the products produced; and	2.5
	• product handling.	2.5

ToR Section and Requirement		EIS Section
2.1.3	**Port Facilities**	
	This EIS should contain a description of the port and the layout of key components including:	
	• port boundaries;	Figure 2-6
	• details of the port authority, existing port limits, facilities and Strategic Port Land in the area;	2.2, 2.6
	• details of area to be dredged and dredged spoil disposal areas;	Figure 2-6, 2.6.1
	• details of capital and maintenance dredging equipment and methods;	2.6.1
	• jetty and wharf alignment;	Figures 2-3, 2-4, 2-5, 2-6.
	• ship loading equipment;	2.5.3, 2.6
	• berths for tugs and other non-bulk carrier vessels;	2.6.1
	• offshore ship mooring locations; and	2.6.2, Figure 2-9
	• any other associated facilities including maritime safety.	2.6.1, 2.6.2
2.1.4	**Associated Infrastructure**	
	The EIS should contain the location and description of:	
	• power plant, power lines, workshops, offices and warehouses;	2.7.5, 2.7.6, Figures 2-7 and 2-8.
	• fuel and chemical storage facilities;	2.7.6, Figure 2-7
	• access roads and telecommunications;	2.7.2, 2.7.7, Figure 2-1
	• water supply dams and bores and water pipelines;	2.7.3, 2.7.6
	• barge landings and ferry terminals; and	2.7.2, Figures 2-3, 2-4 and 2-5.
	• permanent and temporary accommodation facilities.	2.3.1, 2.7.1, Figure 2-10.
2.2	**Location**	
	The EIS should provide:	
	• the regional and local context of the Project described and illustrated on maps at suitable scales and reference points;	Figures 1-1, 1-3, 1-4 and 2-1, section
	• real property descriptions of the Project site; and	Table 2-1
	• maps showing the precise location of the Project area, and in particular:	Figures 1-1, 1-3 and 1-4.
	• the location of the resource to be explored, developed or mined;	Figures 1-3 and 1-4
	• the location and boundaries of land tenures, in place or proposed, to which the Project area is or will be subject to (including tenures for facilities in marine waters);	Figure 2-1
	• the location and boundaries of mining tenures, granted or proposed, to which the Project area is or will be subject to;	Figure 2-1
	• the location and boundaries of the Project footprint showing all key aspects, including mine, beneficiation plant, port, power station, stockpiles, areas of fill, watercourses, plant locations, water storages, buildings, roads, bridges hardstands, car parks and any final void to be left at the cessation of mining etc;	Figures 1-3, 1-4 and 2-3 to 2-10.
	• any part of the resource not intended to be mined and any part of the resource that may be sterilised by the proposed mining operations;	The reserves to be mined over 40 years are shown in Figures 1-3 and 1-4. No economic bauxite reserves shall be sterilised see Figures 1-3, 1-4 and 3-5,
	• the location of all proposed Project transport infrastructure for inputs and outputs for each elements of the Project;	2.7.2, 2.7.6
	• the location of any proposed buffers surrounding the working areas ;	7.9.1, 7.9.2
	• the identification of all site access points to, from and within the Project on maps, to assist in the assessment of emergency planning;	Figures 1-3, 1-4, 2-1

ToR Section and Requirement		EIS Section
2.3	**Construction**	
	The EIS should describe:	
	• The extent and nature of the project's construction phase should be described (as well as any works required off site enabling construction to commence) ;	2.3.1, Construction of the wharf and jetty will utilise pre-assembled modules, see 2.3.1
	• a map at reasonable scale that shows the footprint of the mine and construction works;	Figures 1-3, 1-4, 2-3 to 2-8 and 2-10
	• the type and methods of construction;	2.3
	• the construction equipment to be used and the items to be transported onto the construction site; and	Table 2-2
	• Any staging of the project should be described and illustrated showing site boundaries, development sequencing and timeframes.	2.3
2.3.1	**Mine**	
	The EIS should provide a description of construction activities relating to the project including:	
	• site access;	
	- vegetation clearing;	2.4.2
	- provision of site access, power, telecommunications, water supply and other infrastructure;	2.3, 2.7
	- establishment requirements for construction facilities	2.3.1
	• construction requirements, including source and extraction of construction inputs and materials, including construction water	2.3
	- details of the method of construction of the mine and volumes of material required	2.3
	- any staging of construction activities	2.3
	• type, source, quantity and method of transport of construction materials;	2.3, 14.1.4, 14.4.4
	• general construction standards and site management, including environmental and safety management;	2.3. Management of safety during construction and operation is addressed in sections 18 and 19. Environmental management during construction and operation are addressed in relevant sections of the EIS.
	• an assessment of expected physical and chemical properties and quantities of soil/rock to be excavated;	13.3.3
	• details of any potential disruption to flows of waterways during construction and any diversion works required;	Not Relevant, No watercourses shall be diverted as part of the Project - see 2.7.3
	• details of any potential disruption to groundwater flow and groundwater/surface water interaction during construction and any aquifer dewatering works required;	Not Relevant, no dewatering during construction - see 2.7.3
	• relocation of existing infrastructure ;	Not Relevant, no infrastructure to be relocated
	• timetable for construction, particularly noting seasonal rainfall or flows;	2.3
	• the hours of operation;	2.3
	• emergency aid/medical facilities to be provided on site;	2.7.1
	• the construction methods and containment/disposal of construction spoil; and	2.3
	• solid and liquid waste handling.	2.5.2, 2.7.4, 13.3

ToR Section and Requirement		EIS Section
2.3.2	**Port, Beneficiation Plant and other Infrastructure**	
	The EIS should provide a description of construction activities relating to the project's associated infrastructure including:	
	• a map showing location of any works;	Figures 2-3 to 2-10.
	• on-site plans, layouts, boundaries and elevations;	Figures 2-3 to 2-10.
	• detailed concept and staging (if any proposed) for additional transport facilities and locations;	2.3, 2.7.2
	• plant and machinery likely to be involved;	2.3
	• supply and storage of materials—volume, composition, handling and storage during construction;	2.3
	• Where dredging is involved:	
	- expected frequency and duration	2.3, 2.6.1
	- volume of material to be disposed of and disposal area	2.3, 2.6.1, Figure 2-9
	- geotechnical properties of dredged material	6.5, 6.9.2.1
	- type of dredge	2.6.1, 6.5.1
	• extent that service corridors will be used during construction and maintenance;	2.7.6
	• width of vegetation clearing required. This information must indicate where vegetation to be cleared has significant conservation value (such as sensitive environmental areas and creek crossings), and must also reference where in the EIS the impacts on such vegetation have been addressed;	2.4.2
	• typical crossing techniques including restoration works that would be used at creek crossings, provisions for fish passage, road, rail, and other service corridor crossings;	2.7.2, 2.7.3, 7.9
	• disposal of plant-matter left after clearing vegetation;	2.4.2
	• cleanup and restoration (rehabilitation) of areas used during construction including any accommodation facilities and storage areas; and	2.8
	• disposal/reuse of surplus excavated material and if this material can be coordinated with concurrent construction activities in the vicinity.	2.3.1
2.4	**Operations**	
2.4.1	**Mine**	
2.4.1.1	**Mine Life and Mineral Resource Base**	
	The EIS should provide specific details on:	
	• the proposed mine life and an outline of the mineral resource base (further detail should be provided in section 3.2.2, Geology); and	Figures 1-3 and 1-4, 2.1, 2.4.1, 2.4.2
	• the quantity of mineral to be mined annually including any proposed ramping up of production or staging of development.	2.1, 2.3, 2.4.2
2.4.1.2	**Mining Methods and Equipment**	
	The EIS should provide specific details on:	
	• the mining type and methods to be used, including the major equipment to be used in the various components of the operation;	2.4.2, 2.4.3
	• the use of different techniques in areas of different topographic or geo-technical character	Not Relevant
	• chemicals to be used; and	Not Relevant - no chemicals to be used during mining or benefeciation (see 2.5). Fuel and dangerous good storage see
	• The description should refer to and be complemented by Figures presented in Section 2-2, showing the locations of key aspects of the project.	

ToR Section and Requirement		EIS Section
2.4.1.3	**Mine Sequencing**	
	The EIS should provide specific details on:	
	• the proposed sequence and timing of mining of each seam/ore body within the mining lease;	2.3, 2.4.2
	• the physical extent of excavations, location of stockpiles of overburden and/or mineral reject to be handled during the project's operation or left after mining ceases—the description should include the rate of throughput of stockpiles of product, reject and overburden;	2.3.1, 2.4.2, 2.4.4, 2.5
	• the proposed progressive backfilling of excavations;	2.4.2, 2.4.4, 2.8.2
	• the area disturbed at each major stage of the project; and	2.4.2, 7.9
	• the progressive rehabilitation of disturbed areas.	2.8.2
2.4.1.4	**Ongoing Evaluation and Exploration Activities**	
	The EIS should describe the extent and nature of any proposed ongoing exploration or geological/geo-technical evaluation within the project area that may be required over the life of the project.	2.4.1
2.4.2	**Bauxite Beneficiation Plant**	
	The EIS should describe:	
	• the quantities and characteristics of the products produced on an annual basis;	2.5.1
	• indicative process flow-sheets should be provided showing material balances for the processing plant, and the anticipated rates of inputs, along with similar data on products, wastes and recycle streams ;	Input, production and waste generation rates are described in 2.5, 13.2.2, and 13.3.4
	• the proposed mineral handling methods and facilities to be used for mineral product storage and transfer to the port facility;	2.5.3
	• the proposed methods and facilities to be used for bauxite storage and for transferring product to ship; and	2.5.3, 2.6.1
	• summary of any environmental design features of the new facilities should be provided.	2.7.3, Figures 2-7 and 2-8
2.4.3	**Port**	
	The EIS should describe:	
	• the location and nature of the processes and operations associated with the long term operation of the port including:	Figure 1-3 and 1-4, 2.6, Figure 2-6
	• a general description of the operations of the terminal;	2.6
	• the capacity of stockpiling, in loading and out loading operations for each stage of the port's development;	2.5.3, 2.6.1, 2.6.2
	• the expected shipping frequency and intensity;	2.6.2
	• tug operations;	2.6.1
	• refuelling arrangements;	2.6.1
	• hours of operation;	2.6.2
	• expected access, navigational and anchorage arrangements;	2.6.1, 2.6.2
	• capital and maintenance dredging operations;	2.6.1
	• potential threats from aquatic pests originating from ballast water or other discharges in the Gulf as shipping tonnages increase;	2.6.2
	• environmental management measures incorporated in the operation of the port ;	Addressed in relevant sections of the EIS, in particular Sections 6, 13 and 14
	• concept and layout plans highlighting the port boundary;	Figure 2-6
	• proposed structures, plant and equipment associated with port operations ; and	2.6.1
	• proposed methods and facilities to be used for loading product to ship.	2.5.3, 2.6.1

ToR Section and Requirement		EIS Section
2.5	**Decommissioning and Rehabilitation**	
	The EIS should include:	
	• the options, strategies and methods for progressive andfinal rehabilitation of the environment disturbed by the project;	2.8.2
	• the strategic approach to progressive and final rehabilitation;	2.8.2
	• the final topography of any excavations, waste areas and dam sites shown on maps at a suitable scale;	2.4.4, 2.8.1
	• the strategies and methods presented for progressive and final rehabilitation of disturbed areas should demonstrate compliance with the objectives of the Environmental Management Policy for Mining in Queensland (1991), and the EPA's A Policy Framework to Encourage Progressive Rehabilitation of Large Mines (2004), or with updated versions of that policy available at the time of drafting the EIS. Land suitability assessment should follow the technical guidelines for the Environmental Management of Exploration and Mining in Queensland (1995). In particular, the strategies and methods should have the following objectives: • Mining and rehabilitation should aim to create a landform with land use capability and/or suitability similar to that prior to disturbance unless other beneficial land and/or suitability similar to that prior to disturbance unless other beneficial land; • Mine wastes and disturbed land should be rehabilitated to a condition that is selfsustaining, or to a condition where the maintenance requirements are consistent with an agreed post-mining land use; • Surface and ground waters that leave the lease should not be degraded to a significant extent. Current and future water quality should be maintained at levels that are acceptable for users downstream of the site	2.8.2
	• The means of decommissioning the project, in terms of the removal of plant, equipment, structures and buildings should be described, and the methods proposed for the stabilisation of the affected areas should be given. Information should be provided regarding decommissioning and rehabilitation of the plant site, removal of processing plant, rehabilitation of concrete footings and foundations, hardstand areas, storage tanks and wharfage (including any potential for reuse of these facilities). Options and methods for the disposal of wastes from the demolition of plant and buildings should be discussed in sufficient detail for their feasibility and suitability to be established;	2.8.1
	• Proposals to divert creeks during operations, and, if applicable, for the reinstatement of the creeks after operations have ceased, should be provided. In this case, hydrological processes should be restored as far as possible to resemble those which occurred prior to mining. Where dams are to be constructed, proposals for the management of these structures after the completion of the project should be given. Also, the final drainage and seepage control systems and long-term monitoring plans should be described; and	No waterway diversions planned - see 2.7.3, 2.8.1, 2.8.2, 7.10.2
	• A description of topsoil management should consider transport, storage and replacement of topsoil to disturbed areas. The minimisation of topsoil storage times (to reduce fertility degradation).	2.8.2
	• Detail of the impacts of the preferred rehabilitation strategy should be discussed in the appropriate subsections of section 3—Environmental values and management of impacts, particularly with regard to such issues as final landform stability, rehabilitation of flora and the long-term quality of water in any final voids. Implications for the longterm use and fate of the site should also be addressed, particularly with regard to the on-site disposal of waste and the site's inclusion on the environmental management register or contaminated land register	
	• Future land tenure arrangements post decommissioning of the project.	3.10.1, 3.10.9

ToR Section and Requirement		EIS Section
2.6	**Associated Infrastructure**	
	The EIS should detail requirements for new infrastructure or the upgrading/ relocating of existing infrastructure to service the project.	2.7
2.6.1	**Workforce and Accommodation**	
	The EIS should describe/estimate:	
	• the number of personnel to be employed;	2.7.1, Table 2-3
	• the skills base of the required workforce and the likely sources (i.e. local, regional or overseas) for the workforce during the construction and operational phases for each component of the Project.;	2.7.1
	• the estimated number of people to be employed during construction and operations and arrangements for their transport to and from the project areas, including the proposed use of regional or charter air services;	2.7.1, 2.7.2, 14.1.5, 14.3, 14.4.5
	• reference to the expected cumulative impacts on local workforce and accommodation needs the Project would have in relation to other major projects currently occurring or planned for the region.. This information should also include the timing of employees travelling from larger urban centres, detailing likely routes on the state-controlled and local government road networks.	Not relevant - No other major projects in region currently approved or undergoing EIS process (see 1.4)
	• estimates should be provided according to occupational groupings and variations in the workforce numbers for the duration of the project. The information should showing anticipated peaks in worker numbers during the construction period;	2.7.1, Table 2-3
	• an outline of recruitment schedules and policies for recruitment of local indigenous and non-indigenous workers, and non-local workers;	2.7.1
	• an accommodation strategy for the construction workforce that addresses the estimated housing needs of both single and accompanied construction workers, detailing size, location and management of any temporary worker accommodation;	2.7.1
	• the strategy should include details of the operational workforce and how such accommodation is proposed to be supplied;	2.7.1
	• if camp sites are to be used to accommodate the workforce, details on the number, location (shown on a map), proximity to the construction site and typical facilities for these sites;	Figure 1-3, Figure 2-10
	• information should include data relating to facilities for:	
	- food preparation and storage;	2.7.1, 18.5.6
	- licensed premises or alcohol storage facilities;	2.7.1
	- ablution facilities;	2.7.1
	- vector and vermin control;	2.7.1, 18.5.3
	- fire safety;	2.7.1
	- dust and noise control in relation to proximity of camp site to the construction area;	Not Relevant - noise and dust control not required, see sections 9 and 10
	- the service personnel required to maintain the camp and the supply of services to each construction camp including visiting police and ;emergency services to deal with major incidents or investigations; and	2.7.1
	- any local government approvals required for establishment and operation of such camps should be outlined.	No approvals required, see 2.7

ToR Section and Requirement		EIS Section
2.6.2	**Transport**	
	The EIS should describe:	
	• arrangements for the transport of plant, equipment, products, wastes and personnel during both the construction phase and operational phases of the project;	2.7.1, 2.7.2, 13, 14.1.4, 14.1.5, 14.3, 14.4.3, 14.4.4, 14.4.5
	• the use of existing local and regional facilities and all requirements for the construction, upgrading or relocation of any transport related infrastructure (e.g. road, ports, airstrips, barge and ferry facilities etc.); and	2.7.1, 2.7.2, 14.1.4, 14.1.5, 14.1.7, 14.3, 14.4.3, 14.4.4, 14.4.5, 14.4.7
	• details of transport volumes, modes and routes available in both the wet and dry seasons along with the assessment of transport impacts on existing infrastructure and impact mitigation measures.	2.7.2, 14.1.4, 14.1.5, 14.1.6, 14.1.7, 14.4.4, 14.4.5, 14.4.6, 14.4.7
2.6.3	**Water Supply and Storage**	
	The EIS should provide/present:	
	• information on water usage by the project, including the quality and quantity of all water supplied to project sites;	2.7.3 ,Table 2-4
	• the proposed and optional sources of water supply (e.g. artesian and non-artesian bores, any surface storages, municipal water supply pipelines);	2.7.3
	• if infrastructure is required for the purpose of supplying water to the project, for example, pipelines from water supplies to the project, then the impacts of such infrastructure are to be assessed as part of the project and discussed at each of the relevant sub-sections in section 3;	Not Relevant - pipelines to Project area not required
	• estimated rates of supply from each source (average and maximum rates);	Table 2-4
	• estimates of demand from each source and an overall water balance;	Table 2-4
	• proposed water conservation and management measures;	2.7.3
	• proposed recycling measures including necessary storage and other infrastructure and estimated concentrations of potential contaminants in operational storages to enable hazard and risk assessments of those structures;	2.5.2, 2.7.3
	• determination of potable water demand for the project;	2.7.3
	• temporary demands during the construction period;	2.7.3
	• existing town water supply to meet such requirements; and	Not relevant - water supply for the Project will not be connected to water supply infrastructure for Weipa (see 2.7.3)
	• if water storage and treatment is proposed on site, for use by the site workforce, then this should be described.	2.7.3
2.6.4	**Stormwater Drainage**	
	The EIS should provide:	
	• a description of the proposed stormwater drainage system and the proposed disposal and/or re-use arrangements, including any off-site services and downstream impacts. Each element of the project needs to be addressed (e.g.mine, beneficiation and product handling) Further details should be provided in section 3.4	2.7.3, Figures 5-8 and 5-9
2.6.5	**Sewerage**	
	This EIS should describe:	
	• the sewerage infrastructure required to service each Project component;	2.7.4, 13.3.7
	• volume estimates of existing and likely industrial and domestic effluent that will be produced should be provided; and	13.2
	• the proposed method of disposal identified including the physical and chemical characteristics of such effluent.	13.3.7

ToR Section and Requirement		EIS Section
2.6.6	**Energy**	
	The EIS should describe:	
	• all energy requirements, including electricity, natural gas, and/or solid and liquid fuel requirements for the construction and operation of the project;	2.7.5
	• the locations of any easements;	There are no easements within the Project area - see Section 2.2
	• energy conservation in the context of Commonwealth, state and local government policies; and	2.7.5
	• proposed power stations, including type of equipment, fuel use and expected emissions to air .	2.7.5, 9.4.4, 9.6
2.6.7	**Telecommunications**	
	The EIS should describe:	
	• the telecommunications proposed for the project;	2.7.7
	• any impacts on existing telecommunications infrastructure (such as optical cables; microwave towers, etc); and	Not Relevant - new telecommunications will operate autonomously from the existing weipa telecommunications
	• identification of infrastructure owners.	2.7.7
3	**Environmental Values and Management Impacts**	
3.1	**Climate and Climate Change Adaption**	
3.1.1	**Climate**	
	This EIS should describe:	
	• the rainfall patterns (including magnitude and seasonal variability of rainfall), air temperatures, humidity, wind (direction and speed) and any other special factors (e.g. temperature inversions) that may affect management of the project;	4.1.1, 4.1.2, 4.1.3, 4.1.4, Table 4-1, Table 4-2.
	• historic weather patterns in the project area and seasonal conditions (e.g. cyclones, thunderstorms, floods and storms) that may influence timing and/or construction methods should be discussed, including how this would be managed; and	4.1.3, 4.2.1, 4.2.2
	• extremes of climate (e.g. droughts, floods, etc) should be discussed with particular reference to water management at the Project site.	4.1.3, 4.2.2.
3.1.2	**Climate Change Adaption**	
	The EIS should assess impacts of climate change risks and adaptation measures including:	
	• analyse risks to the project from climate change impacts (e.g. increased risk and severity of flood; increased vulnerability to more intense bushfires, sea level rise etc;	4.3.1, 4.3.2, 4.3.3, 4.3.4, 4.3.5
	• identify adaptation measures to minimise risk to the project from climate change impacts, particularly where there may be a significant impact to human safety or property.	4.3.6
3.2	**Land**	
	The EIS should contain:	
	• the existing environmental values of the land area that may be affected by the project;	EM Plan (section 21) - section 3.7.1
	• a definition and description of the objectives and practical measures for protecting or enhancing land-based environmental values;	EM Plan (section 21) - section 3.7.1, EM Plan (section 21) - section 3.7.3
	• how nominated quantitative standards and indicators may be achieved;	EM Plan (section 21) - section 3.7.1, EM Plan (section 21) - section 3.7.3
	• how the achievement of the objectives will be monitored, audited and managed.	EM Plan (section 21) - section 3.7.3

ToR Section and Requirement		EIS Section
3.2.1	**Topography and Geomorphology**	
3.2.1.1	**Description of Environmental Values**	
	The EIS should include:	
	• maps based on latitudes and longitudes using the Geocentric Datum of Australia (GDA94) should be provided locating the project in both regional and local contexts;	Figures 1-1, 1-3 and 1-4
	• the topography of the project site should be detailed with contours at suitable increments, shown with respect to Australian Height Datum;	Figure 3-2
	• commentary on the maps should be provided highlighting the significant topographical features;	3.3
	• the environmental values of the cultural landscapes of the affected area, in terms of the physical and cultural integrity of the area, should be described.	11.1.4, 11.2
3.2.1.2	**Potential Impacts and Mitigation Measures**	
	The EIS should include:	
	• the potential impacts of the landscape character of the project site and the surrounding area should be described. Particular mention should be made of any changes to the broad-scale topography and vegetation character of the area, such as due to spoil dumps, excavated voids and broad-scale clearing; and	3.10.2, 7.9
	• details of measures to be undertaken to mitigate or avoid the identified impacts.	3.10.2, 7.9.2
3.2.2	**Geology**	
3.2.2.1	**Description of Environmental Values**	
	The EIS should provide:	
	• a description, map and a series of cross-sections of the geology of the project area, with particular reference to the physical and chemical properties of surface and sub-surface materials and geological structures within the proposed areas of disturbance;	3.2, Figures 3-2 to 3-5
	• the general suitability of the mine site overburden material for road building (or other productive use) should be discussed briefly;	13.3.5
	• the geological properties of all project sites which may influence stability, occupational health and safety, rehabilitation programs, or the quality of waste water leaving any area disturbed by the project should be described;	13.3.4
	• investigations into the physical, geo-mechanical and chemical properties of waste rock in both fresh and weathered forms needs to be determined for slope stability, rehabilitation and possible acid generation for waste rock dump design;	Not relevant - no permanent out of pit waste dumps are proposed - see 3.10.2
	• the geology underlying the proposed infrastructure corridors for bauxite transport, electricity easements, pipeline easements and any off mine infrastructure and any other mineral resources that may be impacted or sterilised by the infrastructure;	2.2, 2.5.2, 3.2, Figure 3-5. No economic bauxite reserves shall be sterilised.
	• a summary of the results of studies and surveys undertaken to identify and delineate the bauxite mineral resources within the project area (including any areas underlying related infrastructure);	2.4.1, 3.2, Figures 1-3 and 1-4
	• the location, tonnage and quality of the bauxite resources within the project area including the modifying factors and assumptions made in arriving at the estimates;	2.4.1, 3.2, Figures 1-3 and 1-4
	• estimates should be made and reported in accordance with the Australasian code for reporting of mineral resources and ore reserves (the JORC Code) and the principles outlined in the Australia guidelines.	2.4.1, 3.2

ToR Section and Requirement		EIS Section
3.2.2.2	**Potential Impacts and Mitigation Measures**	
	The EIS should include:	
	• an analysis of the effectiveness of the mining proposal in achieving the optimum utilisation of the bauxite resources within the project area and consider its impacts on other resources;	2.4.2, 2.4.3, 2.5, 3.2
	• demonstrate that the mining proposal will 'best develop' the bauxite resources, minimise resource wastage and avoid any unnecessary sterilisation or loss of these or any other of the state's coal, mineral, and petroleum (including gas and coal seam methane) resources that may be impacted upon or sterilised by the mining activities or related infrastructure.	2.4.2, 2.4.3, 2.5, 3.2
3.2.3	**Soils**	
3.2.3.1	**Description of Environmental Values**	
	The EIS should include:	
	• Soil surveys of the project sites with reference to the physical and chemical properties of the materials that will influence erosion potential, storm water run-off quality, rehabilitation and agricultural productivity of the land;	3.4, 3.5, 3.6
	• information on soil stability, suitability for construction of proposed facilities and any approved soil conservation plans;	2.3, 3.6, 3.6.3
	• Soil profiles mapped and described according to the Australian Soil and Land Survey Field Handbook (McDonald et al, 1990) and Australian Soil Classification (Isbell, 1996);	Appendix 3A, Figure 3-7
	• an appraisal of the depth and quality of useable soil should be undertaken; and	3.4.6, 3.10.4
	• Information presented according to the standards required in the Planning Guidelines: The Identification of Good Quality Agricultural Land (DPI & DHLGP, 1993), and the State Planning Policy 1/92: Development and the Conservation of Agricultural Land (DME, 1995).	3.7.1
	• Acid sulphate soil (ASS) investigations are required to meet State Planning Policy 2/02, Planning and Managing Development involving ASS where the proposed development would trigger one of the criterion listed in section 2.3 of that policy. All investigations should be conducted in accordance with the SPP2/02 guideline and the Guidelines for Sampling and Analysis of Lowland Acid Sulfate Soils in Queensland 1998. Where disturbance to ASS is unavoidable, an ASS Management Plan should be prepared in accordance with the Queensland Acid Sulfate Soil Technical Manual – Soil Management Guidelines	3.9

ToR Section and Requirement		EIS Section
3.2.3.2	**Potential Impacts and Mitigation Measures**	
	The EIS should include:	
	• description of possible erosion rates and management techniques for all permanent and temporary landforms;	3.6
	• outline of erosion potential (wind and water) and erosion management techniques for each soil type identified;	3.6
	• outline of erosion-monitoring program, including rehabilitation measures for erosion problems during monitoring; and	3.6.3
	• mitigation strategies should be developed to achieve acceptable soil loss rates, levels of sediment in rainfall runoff and wind-generated dust concentrations.	
	• The EIS should contain an assessment of likely erosion effects for all disturbed areas such as;	3.6.2
	- areas cleared of vegetation	
	- waste dumps	
	- stockpiles	
	- dams, banks and creek crossings	
	- the port area and surrounding buildings	
	- the mine site, including building	
	- access roads or other transport corridors	
	- areas under rehabilitation.	
	• Methods to prevent or control erosion specified and developed with regard to preventing soil loss in order to maintain land capability / suitability, and preventing significant degradation of local waterways by suspended solids.	3.6.2, 5.1.3, 5.2.5
	• Consideration to the amendment or revocation of any approved soil conservation plans as a result of project activities	Not Relevant - no approved soil conservation plans, see 3.6

ToR Section and Requirement		EIS Section
3.2.4	**Land Use and Tenure**	
3.2.4.1	**Description of Environmental Values**	
	The EIS should contain:	
	• A description of current land tenures, current land uses and the areas covered by Native Title claims in all project and relevant adjacent areas, with mention of land with special purposes;	Figure 1-2, 1.9.9, 2.2, Figures 2-1 and 2-2, 3.1.1, 3.1.2, Figure 3-1, 11.1.1, 16.3.2. No local or regional planning provisions apply to the Project area or surrounds (see 3.1.2).
	• a list additional land tenures required for the project;	Not relevant, no additional tenures required - see 2.2
	• location and owner/custodians of all tenures, reserves, roads and road reserves, railways and rail reserves, stock routes and the like, covering the affected land shown on maps of a suitable scale;	2.2, Figures 2-1 and 2-2. There are no reserves, stock routes, easements or public road reserves within the Project
	• locations of gas and water pipelines, power lines and any other easements;	There are no easements or pipelines within the Project area - see 2.2
	• the environmental values affected by this infrastructure described;	7.8, 7.9, 7.10, 7.11, 8.13, 8.15, 8.16,
	• maps at suitable scales showing existing land uses, tenures and infrastructure such as roads, railways, stock routes, pipelines, electricity and the like, should be provided at the project component locations, as well as the surrounding land that could be affected by the development;	Figures 1-2, 1-3, 1-4, 2-1, 2-2, 3-1 and 12-1. There are no reserves, stock routes, easements or public road
	• areas of conservation value and marine areas in any locality that may be impacted by the project;	6.9, 7.11, 7.18, 8.14, 8.15, 8.16, 8.17
	• the location of existing dwellings and the zoning of all affected lands according to any existing town or strategic plan, or port land use plan;	Figures 2-2, 3-1 and 12-1, 2.2, 3.1, 12.3. No local or regional planning provisions apply to the Project area or surrounds (see 3.1.2).
	• a description of the land use suitability of the affected area in terms of the physical and economic attributes. The assessment should set out soil and landform subclasses assigned to soil mapping units in order to derive land suitability classes. The limitations and land suitability classification system to use is that in Attachment 2 of Land Suitability Assessment Techniques in the Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland (1995); and	3.7
	• a land suitability map of the proposed and adjacent area should setting out land suitability and current land uses, e.g. for Land classified as 'good quality agricultural land' in the Department of Natural Resources' land classification system should be shown in accordance with the planning guideline, The Identification of Good Quality Agricultural; and land, which supports State Planning Policy 1/92.	Figure 3-8
3.2.4.2	**Potential Impacts and Mitigation Measures**	
	The EIS should contain:	
	• details of the potential for the construction and operation of the project to change existing and potential land uses of the project site and adjacent areas. Consideration should be given to impacts arising from property disruption and severence, construction and maintenance.	3.1.2, 16.3.2
	• details of post operations land use options, including suitability of the area to be used for agriculture, forestry, industry, or nature conservation;	3.7.2, 3.10.1
	• the factors favouring or limiting the establishment of those options in the context of land use suitability prior to the project and minimising potential liabilities for long-term management;	3.7.2, 3.10.1
	• description of the potential environmental harm caused by the project on the adjacent areas currently used for agriculture, urban development, recreation, tourism or other business and the implications of the project for future developments in the impact area including constraints on surrounding land uses. Investigations should follow the procedures set out in the planning guideline, The Identification of Good Quality Agricultural Land, which supports State Planning Policy 1/92;	3.1.2, 16.3.2
	• incompatible land uses, whether existing or potential, adjacent to all aspects of the project, including essential and proposed ancillary developments or activities and areas directly or indirectly affected by the construction and operation of these activities and measures to avoid unacceptable impacts.	3.1.2, 16.3.2

ToR Section and Requirement		EIS Section
3.2.5	**Landscape Character and Visual Amenity**	
3.2.5.1	**Description of Environmental Values**	
	The EIS should describe:	
	• the existing character of the landscape that will be affected by the project. It should comment on any changes that have already been made to the natural landscape since European settlement. It should describe the general impression of the landscape that would be obtained while travelling through and around it; and	7.2.2.1, 12.2
	• existing landscape features, panoramas and views that have, or could be expected to have, value to the community whether of local, regional, state-wide, national or international significance.	12.2
3.2.5.2	**Potential Impacts and Mitigation Measures**	
	The EIS should describe:	
	• The potential impacts of the project landscape character of the site and the surrounding area;	12.4
	• any changes to the broad-scale topography and vegetation character of the area;	12.4, 3.10.2
	• details of measures to be undertaken to mitigate or avoid the identified impacts;	12.4, 3.10
	• analyse and discuss the visual impact of the project on particular panoramas and outlooks;	12.4
	• detail the design and colour of any major structures, buildings or fixed plant and all proposed screenings either vegetative or where relevant to the minimisation of the visual impacts of the project;	12.4
	• Management of the lighting of the project, during all stages, is to be provided, with particular reference to objectives to be achieved and management methods to be implemented to mitigate or avoid:	
	- the visual impact at night	12.4
	- night operations/maintenance and effects of lighting on fauna and residents	12.4
	- the potential impact of increased vehicular traffic	12.4.5, EM Plan (section 21) - section
	- changed habitat conditions for nocturnal fauna and associated impacts.	12.4.1, 12.4.2, 6.8.5
3.2.6	**Land Contamination**	
3.2.6.1	**Description of Environmental Values**	
	The EIS should:	
	• discuss the potential for land contamination within the project area from existing and past uses, based on known land use history and the nature and concentrations of any contaminants;	3.8.1
	• identify land within the proposed mine, associated infrastructure corridors and any other areas affected by the proposed works, which has been used, or is being used, for a Notifiable Activity as listed in Schedule 2 of the EP Act, or is potentially contaminated, or is on the environmental management register or contaminated land register; and	3.8.1
	• include a preliminary site investigation for all properties that have been impacted by existing and past land uses that could have resulted in land contamination.	Not relevant. No areas within the Project area and to be disturbed by Project activities are potentially contaminated - see 3.8.1

ToR Section and Requirement		EIS Section
3.2.6.2	**Potential Impacts and Mitigation Measures**	
	The EIS should include:	
	• discussion of the management of any contaminated land and potential for contamination from construction, commissioning and operation, in accordance with EPA's Draft Guidelines for the Assessment and Management of Contaminated Land in Queensland (1998) and the National Environment Protection (Assessment of Site Contamination) Measure 1999;	3.8.2, 13.3.3
	• describe the possible contamination of land from aspects of the project, including waste, saline water from coal seam gas extraction used for dust suppression, reject bauxite, overburden, bauxite washing plant and spills at chemical and fuel storage and handling areas; and	3.8.2, 13.3.3, 13.3.4
	• describe strategies and methods to be used to prevent and manage any land contamination resulting from the project, including the management of any acid generation or saline impacts from the mining activities and the management of chemicals and fuels to prevent spills or leaks.	3.8.2, 13.3.3, 13.3.4
3.2.7	**Land Disturbance**	
3.2.7.1	**Potential Impacts and Mitigation Measures**	
	The EIS should describe:	
	• strategies aimed at minimising the amount of land disturbed at any one time;	3.6.2, 3.10.3, 3.10.4, 7.17.2
	• the strategic approach to progressive rehabilitation and final decommissioning;	3.10
	• the consistency of the approach with relevant guidelines and the results of recent research;	3.10.3
	• management of all dams, roads, rail, port, electricity and other infrastructure during construction, operation and decommissioning phases	2.5, 2.6, 2.7, 2.8, 3.10.9, 5.2.1, 5.2.2,
	• the methods to be used for the project, including backfilling, covering, re-contouring, topsoil handling and revegetation	3.10.4, 3.10.5
	• the use of threatened plant species during any landscaping and revegetation;	3.10.5
	• where creeks and waterways are proposed to be diverted, the impact on land use due to hydrology changes, both upstream and downstream; and	No watercourse diversions are planned
	• where dams and roads and other infrastructure are to be constructed, proposals for the management of these structures after the completion of the project.	3.10.9
	• A contour map of the area should be provided, and the final drainage and seepage control systems and any long-term monitoring plans should be described.	Final landform is described in the text in 3.10.2. Hydrology of rehabilitated areas described in 5.2.4. See also 5.2.2 and 5.5 for seepage control and monitoring.
	• Proposed decommissioning of project operations should be described in detail, including consolidation, revegetation, fencing, and monitoring. Include rehabilitation of concrete footings and foundations, hard stand areas and storage tanks.	2.8, 3.10.5, 3.10.8, 3.10.9, 13.2.3

ToR Section and Requirement		EIS Section
3.3	**Nature Conservation**	
	This EIS should describe:	
	• the existing environmental values for nature conservation that may be affected by the project in terms of:	Sections 6, 7 and 8
	- integrity of ecological processes, including habitats of rare and threatened species and ecological communities	
	- conservation of resources	
	- biological diversity, including habitats of rare and threatened species	
	- integrity of landscapes and places including wilderness and similar natural places	
	- aquatic and terrestrial ecosystems.	
	In assessing environmental values and impacts, regard should be given to the regional, national and international environmental significance of the Cape York Peninsula	
3.3.1	**Sensitive Environmental Areas**	
3.3.1.1	**Description of Environmental Values**	
	The EIS should identify areas that are environmentally sensitive in proximity to the project. Environmentally sensitive areas should also include areas classified as having national, state, regional or local biodiversity significance, or flagged as important for their integrated biodiversity values. Consideration should be given to nature refuges, national parks, conservation parks, declared fish habitat areas, wilderness areas, aquatic reserves, declared wild rivers or rivers subject to a declaration proposal, heritage/historic areas or items relating to biodiversity, national estates, world heritage listings and sites covered by international treaties or agreements (e.g. Ramsar, Japan-Australia Migratory Bird Agreement, China-Australia Migratory Bird Agreement, Republic of Korea-Australia Migratory Bird Agreement), areas of cultural significance relating to biodiversity and scientific reserves.	6.2, 7.2, 7.3, 7.7, Figure 7-8, 8.2, Figure 8-1, 8.10, 8.12
	• The proximity of the project to any environmentally sensitive areas on a map	Figure 7-1 and 8-1.
	Areas that would be regarded as sensitive with regard to flora and fauna have one or more of the following features:	
	• important habitats of species listed under the *Nature Conservation Act 1992* and/or the EPBC Act as 'presumed extinct', 'critically endangered', 'endangered', 'vulnerable' or 'rare'	7.2, 7.3, 7.6.2, 7.6.3, 7.7
	• regional ecosystems recognised by the EPA as 'endangered' or 'of concern' or 'not of concern' but where permits are no longer granted due to being at threshold levels, and/or ecosystems listed as 'presumed extinct', 'critically endangered', 'endangered' or 'vulnerable' under the EPBC Act	7.3, 7.5.3. No EPBC Act listed endangered ecological communities (EEC) were returned by the database search or field surveys of the SoE Project area. A review of the regional ecosystem types that were mapped for the Project area indicates that EECs are not likely to occur (See EPBC
	• ecosystems that provide important ecological functions, such as riparian vegetation, important buffer to a protected area, refugia or important habitat corridor between areas and wetlands	7.7, 7.14.2, 7.15.2, 8.12
	• protected areas which have been proclaimed under the *Nature Conservation Act 1992* or are under consideration for proclamation.	7.2

ToR Section and Requirement		EIS Section
3.3.1.2	**Potential impacts and mitigation measures**	
	The EIS should discuss:	
	• the impact of the project on species, communities and habitats of local, regional or national significance;	6.9, 7.9, 7.10, 7.11, 7.18, 7.19, 7.20, 8.13, 8.14, 8.15, 8.16, 8.17
	• proposals to mitigate impacts (e.g. timing of works, minimise width of disturbance, proposed rehabilitation of in-stream and floodplain disturbances);	6.9, 7.9, 7.10, 7.11, 7.18, 7.19, 7.20, 8.13, 8.14, 8.15, 8.16, 8.17
	• planned rehabilitation of vegetation communities and any relevant previous experience/experiments rehabilitating these communities	3.10
	• offsets relating to residual impacts with regard to the Queensland Government specific-issues Environmental Offsets Policies, the Policy for Vegetation Management Offsets (NRW 2007)—refer to the Regional Vegetation Management Code for Western Bioregions, as well as the draft policy statement on the use of environmental offsets under the EPBC Act.	7.12
	Potential impacts and associated mitigation measures should be discussed further under section 3.3.2 Terrestrial flora, and section 3.4 Water resources.	

ToR Section and Requirement		EIS Section
3.3.2	**Terrestrial Flora**	
3.3.2.1	**Description of Environmental Values**	
	The terrestrial vegetation communities within the affected areas should be described at an appropriate scale with mapping produced from aerial photographs and ground truthing, showing the following:	
	• location and extent of vegetation types including recognised regional ecosystem type descriptions and any areas of national, state or regional significance;	7.3, 7.5, 7.6, 7.7, Figures 7-4, 7-4a, 7-4b, 7-4c, 7-4d, 7-6, 7-6a, 7-6b, 7-6c, 7-6d, 7-7, 7-7a, 7-7b, 7-8
	• location of vegetation types of conservation significance	As above
	• vegetation map unit descriptions, including their relationship to regional ecosystems. Sensitive or important vegetation types should be highlighted and their value as habitat for fauna and conservation of specific rare floral and faunal assemblages or community types ;	As above
	• the current extent (bioregional and catchment) of protected vegetation types of conservation significance within the protected areas (e.g. national parks, conservation parks, resource reserves, nature refuges);	7.2, Figure 7-1, Table 7-5
	• any plant communities of cultural, commercial or recreational significance; and	11.1.3
	• the distribution and abundance of significant exotic and weed species;	7.6.4
	The description should contain a review of published information regarding the assessment of the significance of the vegetation to conservation, recreation, scientific, educational and historical interests. The assessment should also include a description of vegetation (including re-growth and restored areas in addition to remnant vegetation) to indicate any areas of state, regional or local significance. The description should also include, where relevant, MNES identified within the EPBC Act.	
	For each defined vegetation community likely to be impacted by the project, vegetation surveys should be undertaken at an appropriate number of sites, allowing for seasonal factors, as follows:	
	• all data requirements of the Queensland Herbarium CORVEG database should be collected	Appendix 7A
	• appropriate minimum site sizes should be selected, observing recognised sampling approaches and to provide an adequate sample of surveyed communities	Appendix 7A
	• a list of species present at each site should be recorded	Appendices 7A, 7B and 7D
	• the relative abundance and community structure of plant species present should be recorded	Appendices 7A and 7B
	• any plant species of conservation, cultural, commercial or recreational significance should be identified	11.1.3, 7.5, 7.6, 7.7
	• vegetation mapping and data should be submitted to the Queensland Herbarium to assist the updating of the CORVEG database	Completed
	• specimens of species listed as 'protected plants' under the Nature Conservation (Wildlife) Regulation 1994, other than common species, are to be submitted to the Queensland Herbarium for identification and entry into the HERBRECS database.	Completed
	• The existence of rare or threatened species should be specifically addressed under sensitive areas. Any special landscape values of natural vegetation communities should be described.	7.2, 7.3, 7.5, 7.6, 7.7
	• Existing information on plant species may be used instead of new survey work provided that the data are derived from surveys consistent with the above methodology and describe existing conditions. Methodology used for flora surveys should be specified in the appendices to the report. Any existing information should be revised and comments provided on whether the areas are degraded, cleared or affected in ways that would affect their environmental value.	7.2, 7.4, Appendix 7A
	• The occurrence of pest plants (weeds), particularly declared plants under the Land Protection (Pest and Stock Route Management) Act 2002 and weeds of national significance (WONS) should be shown on a map at an appropriate scale. A weed management strategy should be provided.	7.6.4, 7.10.2.3
	The location of any horticultural crops in the vicinity of the project area should be shown.	Not relevant, see Section 3.1

ToR Section and Requirement		EIS Section
3.3.2.2	**Potential Impacts and Mitigation Measures**	
	• This section should discuss all foreseen direct and indirect effects on terrestrial flora and the potential level of environmental impact identified.	7.8, 7.9.1, 7.10.1, 7.11.1, 7.11.3, 8.14
	• Action plans for protecting rare or threatened species and vegetation types identified as having high conservation value should be described and any obligations imposed by state or federal government biodiversity protection legislation or policy should be discussed.	7.9.2, 7.10.2, 7.11.2
	• Construction and operation of the project involving clearing, salvaging or removal of vegetation should be described, and indirect impacts on vegetation not cleared should be discussed.	7.8, 7.9.1, 7.10.1, 7.11.1, 7.11.3, 8.14
	• Impacts during construction and operation of the project should be assessed. The number of hectares of remnant vegetation proposed to be cleared (by conservation status and regional ecosystem type) for the mine and each proposed infrastructure component should be identified. These figures should be discussed in terms of the long-term sustainability of these ecosystems to remain in the landscape at a regional level. Short- and long-term durations should be considered.	7.9, Table 7-10
	• Measures to mitigate the impacts of the project on vegetation types identified as having high conservation values, listed species and sensitive habitat or the inhibition of propagation should be described. This should also include the identification of potential offset areas, in an 'offset strategy', consistent with Queensland Government specific-issues offsets policies, to compensate for any loss of vegetation.	7.9.2, 7.10.2, 7.11.2, 7.12
	• With regard to the project area, this section should include:	
	- the significance of impacts at a local, catchment, bioregional, state or national levels	7.9.1, 7.10.1, 7.11.1, 7.11.3
	- impact on any plants of potential or recognised environmental or economic significance	7.11.1
	- a discussion of the ability of identified stands of vegetation to withstand any increased pressure resulting from the project and measures proposed to mitigate impacts	7.9.1, 7.9.2, 7.10, 7.11
	- a description of the methods to ensure rapid rehabilitation of disturbed areas following construction, including the species chosen for revegetation which should be consistent with the surrounding associations. Details of any post construction monitoring programs and what benchmarks would be used for review of monitoring should be included. Consideration should be given to the establishment of reference sites (at least two for each ecosystem type being rehabilitated) that could be established and monitored to provide benchmarking for rehabilitation activities	3.10, 7.10.2
	- a plan to systematically check areas to be cleared over the projected 40 years of the mine life. A commitment to undertake ongoing flora surveys should be a component of the EMP	7.9.2, 7.10.2, 20
	- a draft weed management plan in an EMP, to be developed and finalised in consultation with land protection officers from the Department of Primary Industries and Fisheries (DPIF) and local government environmental officers, to cover construction, rehabilitation and operation periods	Section 7.10.2.3 and section 3.8.3 of the EM Plan (section 21) detail the attributes for the weed management program that will form the basis of the Weed Management Plan to be developed prior to commencement of
	• a description of the potential for the introduction and/or spread of weeds or plant disease, including:	7.10.1.3
	• identification of the origin of construction materials, machinery and equipment	8.9
	• vehicle inspection regime, which addresses the need for vehicle and machinery wash-down and any other hygiene protocols, including the requirement that all vehicles and equipment must be cleaned before starting the job and that these wash down areas contain water/soil away from creeks and gullies	7.10.2.3
	• staff/operator education programs	7.10.2.3
	• determination of the potential for the introduction of, or facilitation of, exotic, non-indigenous and noxious plants.	7.10.1.3
	The above assessment should also include, where relevant, MNES identified within the EPBC Act.	EPBC Assessment Report (section 22) - Section 7.11

ToR Section and Requirement		EIS Section
3.3.3	**Terrestrial fauna**	
3.3.3.1	**Description of Environmental Values**	
	The EIS should describe:	
	• The terrestrial and riparian fauna occurring in the areas affected by the project and the broad distribution patterns in relation to vegetation, topography and substrate. Wildlife corridors and refuge should be identified and mapped;	7.14
	• The description of the fauna present or likely to be present in the area should include:	
	- species diversity (i.e. a species list) and indicative abundance of animals, including amphibians, birds, reptiles, mammals (including bats) any species that are poorly known but suspected of being rare or potentially threatened;	7.15, Appendix 7F
	- habitat requirements and sensitivity to changes; including movement corridors and barriers to movement ;	7.14, 7.15.2
	- the existence of feral or exotic animals, including maps of major pest infestations;	7.14.2, 7.15.3
	- existence of any rare, threatened or otherwise noteworthy species/communities in the study area, including discussion of range, habitat, breeding, recruitment, feeding and movement requirements, and current level of protection (e.g. any requirements of protected area management plans); and	7.15.4, 7.15.6
	- use of the area by migratory and nomadic birds in particular areas for breeding or significant congregations.	7.15.5
	• Results from surveys for species listed as threatened or migratory under the EPBC Act. Surveys should be conducted at the appropriate time of the year when the species is known to be present on the site, so that identification and location of these species is optimal;	7.13, 7.15.4, 7.15.5, Appendix 7E
	• Methodology used for fauna surveys should be specified in the appendices to the report;	7.13, Appendix 7E, Figure 7-10
	• The EIS should indicate how well any affected significant communities and species are represented and protected elsewhere in the region where the site of the project occurs.	7.16 to 7.20
	• Relevant site data should be provided to the EPA in a format compatible with EPA WildNet database for listed threatened species.	Sent to Queensland Herbarium Jan

ToR Section and Requirement		EIS Section
3.3.3.2	**Potential Impacts and Mitigation Measures**	
	The EIS should:	
	• discuss all foreseen direct and indirect effects on terrestrial fauna;	7.16 to 7.20
	• describe strategies for protecting rare or threatened species and discuss any obligations imposed by state or federal government threatened species legislation or policy;	7.18.2
	• outline any recovery plans for potentially affected threatened species and describe strategies for complying with the objectives and management practices of relevant recovery plans;	Not relevant - the Project does not include any critical habitat areas for any species that are identified in recovery plans. See 7.20.1
	• describe measures to mitigate the impact on habitat or the inhibition of normal movement, breeding or feeding patterns, and change to food chains should be described;	7.9.2, 7.17.1, 7.17.2, 7.18.2, 7.19.2
	• discuss any provision for buffer zones and movement corridors, or special provisions for migratory or nomadic animals.	7.9.2, 7.17.2, 7.18.2, 7.19.2
	With regard to terrestrial and riparian fauna, the assessment of potential impacts should consider:	
	• impacts the project may have on terrestrial fauna, relevant wildlife habitat and other fauna conservation values, including:	
	- direct and indirect impacts due to loss of range/habitat, food supply, nest sites, breeding/recruiting potential or movement corridors	7.9.1, 7.17.1, 7.18.1, 7.19.1, 7.20.1
	- cumulative effects of direct and indirect impacts	7.9.1, 7.17.1, 7.18.1, 7.19.1, 7.20.1, 20.6
	- impacts on rare and threatened or otherwise noteworthy animal species	7.18.1, 7.19.1, 7.20.1
	- identification of the conservation importance of identified populations at the regional, state and national levels	7.15.4, 7.15.5, 7.15.6
	• measures to minimise wildlife capture and mortality during construction and operation;	2.7.2, 7.9.2, 7.17.2, 7.18.2
	• details of the methodologies that would be used to avoid injuries to livestock and native fauna as a result of the project's construction and operational works, and if accidental injuries should occur the methodologies to assess and handle injuries;	2.7.2, 7.17.2
	• methods for minimising the introduction of feral animals, and other exotic fauna such as declared pest ant species (fire ants and yellow crazy ants); and	7.15.3, 7.10.2.5
	• review of control measures to prevent increases in local populations and spread of biting insect species of pest and health significance associated with construction activities and disposal of construction wastes.	18.5.3, 18.5.7, 18.5.8, 18.5.9
	• These would also include, where relevant, MNES identified within the EPBC Act.	EPBC Assessment Report (section 22) - Section 5

ToR Section and Requirement		EIS Section
3.3.4	**Freshwater aquatic Flora and Fauna**	
3.3.4.1	**Description of Environmental Values**	
	The EIS should describe:	
	• The aquatic flora and fauna occurring in the areas affected by the project, noting the patterns and distribution in the waterways;	8.4, 8.6, 8.7, 8.8, 8.9, 8.10
	• The habitat requirements and the sensitivity of aquatic flora and fauna species to changes in flow regime, water levels and water quality in the project areas should be provided;	8.5, 8.6, 8.7, 8.8
	• fish species, mammals, reptiles, amphibians and aquatic invertebrates occurring in the waterways within the project area, including any feral and exotic fauna species;	8.7, 8.8, 8.9, 8.10
	• aquatic (waterway) macrophytes including native and exotic/weed species;	8.6.2, 8.9
	• wetlands listed by the EPA as areas of national, state or regional significance, and their values and importance;	8.2.2, 8.12
	• a description of terrestrial species that are ecologically associated with wetlands or waterways and are likely to be affected by the project	8.4, 8.6
	• aquatic substrate and stream type; and	8.4
	• including where relevant, MNES identified within the EPBC Act	8.10
	• Wetlands should be mapped , described and analysed in a similar manner to that of regional ecosystems.	Table 8.3 and section 7.5, Figure 8-1, 8.3
3.3.4.2	**Potential Impacts and Mitigation Measures**	
	This EIS should discuss:	
	• all foreseen direct and indirect effects on aquatic flora and fauna, including strategies for protecting rare or threatened species and any obligations, legislation or policies imposed by the state and federal governments.	8.13, 8.14, 8.15, 8.16, 8.17
	The discussion should include:	
	• measures to minimise wildlife injury and mortality during construction and operation; and	2.7.2, 7.9.2, 7.17.2, 7.18.2
	• details of the methodologies that would be used to avoid injuries to native fauna as a result of the project's construction and operational works, and if accidental injuries should occur the methodologies to assess and handle injuries	2.7.2, 7.17.2
	• details of measures to be used to maintain fish passage in creeks that will be affected	8.16.2, 8.17
	• methods for minimising the introduction of feral species, and other exotic fauna	8.9, 7.10.2, 7.15.3
	• review of control measures to prevent increases in local populations and spread of biting insect species of pest and health significance associated with construction activities and disposal of construction wastes	18.5.3
	• identification of necessary permits/authorities required by the project	1.9
	• description of mitigation measures to prevent the creation of new mosquito and biting midge breeding sites during construction	18.5.3
	• description of the potential for and mitigation measures to prevent the introduction, transfer or facilitation of exotic, non-indigenous and noxious plants and water borne insect pests.	8.9

ToR Section and Requirement		EIS Section
3.3.5	**Marine Flora and Fauna**	
3.3.5.1	**Description of Environmental Values**	
	The EIS should describe:	
	• marine flora and fauna occurring in the areas affected by the proposal noting the patterns and distribution in coastal waters and estuaries.	6.3, 6.6
	The description of the fauna and flora present in the areas should include:	
	• fish species, mammals, reptiles and crustaceans occurring in marine waters, including pest species;	6.6
	• marine plants, including seagrass and mangroves;	6.3
	• benthic, rocky shore and reefal habitats;	6.3.1, 6.3.2
	• habitat for commercial and recreational fisheries;	6.3, 6.7
	• particular reference habitat of any rare or threatened species;	6.3, 6.6
	• proximity to declared Fish Habitat Areas;	6.2
	• presence of marine mammals and marine turtle foraging areas and nesting areas in vicinity of the proposed port;	6.6.1, 6.6.2, 6.6.3, 6.6.5
	• sea floor habitat and benthic macroinvertebrate communities in the vicinity of the spoil ground; and	6.3.5, 6.6.8
	• where relevant, MNES identified within the EPBC Act.	EPBC Assessment Report (section 22) - Section 4, 6.6.1
3.3.5.2	**Potential Impacts and Mitigation Measures**	
	The EIS should:	
	• assess the potential impacts of the project on benthic habitat and marine fauna and flora, including sea grass beds, marine plants, other fish habitats and other rare or threatened species;	6.9.3, 6.9.4, 6.9.5
	• discuss the potential for damage to these ecosystems (including dependent faunal species);	6.9.3, 6.9.4, 6.9.5
	• outline mitigation methods to reduce impacts on identified environmental values ;	6.9
	• outline restoration of the disturbed area (especially where marine plants have been removed)	6.9.3.2
	• identify and describe potential offsets, if required, for marine fish habitats and ecosystems in accordance with the Queensland Government Environmental Offsets Policy (QGEOP) and its specific issue policy, Fish Habitat Management Operational Policy (FHMOP005);	6.9.3.2
	• Vectors for an introduction of a marine pest, possible impacts of a marine pest incursion and proposed mitigation measures, with ongoing monitoring for marine pests in the port and proposed response arrangements if a marine pest incursion occurs; and	6.6.9, 6.9.4.6, 13.3.8
	• assessments should include, where relevant, MNES identified within the EPBC Act.	EPBC Assessment Report (section 22) - Section 5, 6.9.5
3.4	**Water Resources**	
	The EIS should describe:	
	• the existing environment for water resources that may be affected by the project in the context of environmental values as defined in the Queensland water quality guidelines for region-specific parameter values, and such documents as the EP Act, Environmental Protection (Water) Policy 1997 (EPP (Water)) and the Australian and New Zealand Environment and Conservation Council, State of the Environment Reporting Taskforce 2000 (ANZECC 2000). The definition of waters in the EPP(Water) includes the bed and banks of waters, so this section should address impacts on benthic sediments as well as the water column;	5.1, EMP section 3.5.1. Impacts on benthic sediments addressed in section 8.13 to 8.17.
	• Where a licence or permit will be required under the Water Act 2000 to take or interfere with the flow of water, this section of the EIS should describe the amount of water to be taken and the details of the works to be constructed, and impacts of the works under the Water Act 2000; and	5.1.3, 5.2.6, 5.4.3
	• works that may require a dam failure impact assessment under the Water Act, waterway barrier works may need approval under the Fisheries Act 1994, and if so should be addressed in the EIS.	5.2.6

ToR Section and Requirement		EIS Section
3.4.1	**Surface Water and Water Resources**	
3.4.1.1	Description of Environmental Values	
	The EIS should contain:	
	• a description of the surface watercourses and their quality and quantity in the area affected by the project with an outline of the significance of these waters to the river catchment system in which they occur;	5.1.1, 5.1.3, 5.1.4
	• a description of existing surface drainage patterns and existing and historical flow regimes in major streams and wetlands.	5.1.1, 5.1.3
	• likelihood of flooding, history of flooding including extent, levels and frequency, and a description of present and potential water uses downstream of the areas affected by the project;	5.1.1, 5.1.2, 5.2.3, 5.2.4
	• Flood studies including a range of annual exceedance probabilities for affected waterways, based on observed data if available or use appropriate modelling techniques and conservative assumptions if there are no suitable observations	5.1.1, 5.2.3, 5.2.4
	• Flood modelling including local flooding due to short duration events from contributing catchments on site, as well as larger scale regional flooding including waterways downstream;	5.1.1, 5.2.3, 5.2.4
	• a description, with photographic evidence of the geomorphic condition of any watercourses likely to be affected by disturbance or stream diversion. The results of this description should form the basis for the planning and subsequent monitoring of rehabilitation of the watercourses during or after the operation of the proposal;	5.1.3
	• An assessment of existing water quality in surface waters and wetlands likely to be affected by the proposal. The basis for this assessment should be a monitoring program, with sampling stations located upstream and downstream of the proposal. Complementary stream-flow data should also be obtained from historical records (if available) to aid in interpretation;	5.1.1, 5.1.4
	• Description of water quality including seasonal variations or variations with flow where applicable. A relevant range of physical, chemical and biological parameters should be measured to gauge the environmental harm on any affected creek or wetland system.	5.1.4
	The EIS should describe the environmental values of the surface waterways of the affected area in terms of:	
	• values identified in the EPP(Water)	5.1, EMP section 3.5.1
	• sustainability, including both quality and quantity	5.1
	• physical integrity, fluvial processes and morphology of watercourses, including riparian zone vegetation and form; and	5.1.3, 8.4, 8.5.2
	• any water resource plans, land and water management plans, declared or nominated wild river areas relevant to the affected catchment.	1.9, 5.2.6

ToR Section and Requirement		EIS Section
3.4.1.2	**Potential Impacts and Mitigation Measures**	
	The EIS should describe:	
	• the water management systems for all project elements, addressing surface water quality, quantity, drainage patterns and sediment movements;	5.2.2, 5.2.3, 5.2.4, 5.2.5
	• the beneficial (environmental, production and recreational) use of nearby surface water, along with any proposal for the diversion of affected creeks during mining, and the stabilisation of those works;	5.1.2. No waterway diversions planned
	• where it is proposed to divert creeks during construction or operations, provision should be made for either the reinstatement of the creeks or decommissioning and rehabilitation, such that the long-term risk of environmental harm, due to regional and local flooding, is no greater than that prior to mining;	No waterway diversions planned
	• address fish passage and access to fish habitats where creeks and waterways are to be diverted;	No waterway diversions planned
	• analysis of potential impacts of the diversion of affected creeks on existing and proposed relocated roads should also be carried out identifying any likely inundation and duration, that may affect emergency vehicle access;	No waterway diversions planned
	• monitoring programs which will assess the effectiveness of management strategies for protecting water quality during the construction, operation and decommissioning of the project. Monitoring programs should also be designed to evaluate changes in the physical integrity and geomorphic processes associated with stream diversions;	No waterway diversions planned. 5.5.1
	• if on-site storage of water sourced from waste water treatment plants is proposed, detail how this water would be managed to ensure environmental harm is avoided and describe design features of any such storages to effectively contain saline water and other harmful constituents;	13.3.7
	• include a risk assessment for uncontrolled emissions to water due to system or catastrophic failure, implications of such emissions for human health and natural ecosystems, and strategies to prevent, minimise and contain impacts;	19.2, 19.3, Appendix 19A. Preventive and mitigative strategies in relevant
	• The potential environmental harm to the flow and the quality of surface waters from all phases of the proposal with particular reference to their suitability for the current and potential downstream uses, including the requirements of any affected riparian area, wetland, estuary, littoral zone, and any marine and in-stream biological uses;	5.2, 8.13, 8.14, 8.15
	• Consider the impacts of surface water flow on existing infrastructure with reference to the EPP (Water) and Water Act 2000;	Not relevant. There are no existing dams or weirs in the project area - see EMP section 3.5.1
	• proposed mine stormwater drainage system and the proposed disposal arrangements, including any off-site services and downstream impacts;	5.2.2
	• identify options for storage and/or disposal of surplus groundwater (if applicable) should be discussed, including the beneficial and adverse impacts of each option identifying licensing requirements for each option;	Not relevant - no surplus groundwater
	• where dams, weirs, voids or ponds are proposed, investigate the effects of predictable climatic extremes (droughts, floods) upon the structural integrity of the containing walls, and the quality of water contained, and flows and quality of water discharged;	5.1.3, 5.2.2, 5.2.3, 5.2.5, 13.3.4
	• a dam failure impact assessment should be carried out for any proposed dams that, due to their size, trigger the need for such an assessment under the Water Act 2000;	5.2.6
	• any dams that are likely to be referrable under the Water Act 2000 should be noted and emergency response procedures incorporated into the project's environmental management plan (EMP);	Not relevant - dams are not referable, see 5.2.6
	• discuss the need, or otherwise, for licensing of any dams (including referable dams) or creek diversions, under the Water Act 2000	5.2.6. No waterway diversions are planned
	• the process for water allocation and water discharge should be established in consultation with the EPA and NRW;	5.2.6
	• consideration to any water allocation and management plans;	5.2.6
	• undertake hydrologic/hydraulic studies to estimate the impacts on operational water storages, drainage and containment systems from local and regional storm events of relevant annual exceedance probability (AEP), in accordance with EPA guidelines, commensurate with hazards associated with failure scenarios;	5.2.2, 5.2.3
	• consideration to the potential impacts of the project on floodplain hydrology (including changes to flooding characteristics), existing land use and infrastructure and the integrity of any watercourses;	5.1.3, 5.2.3, 5.2.4, 5.2.5
	• address issues such as minimising risk to life and property and the protection of water (flood harvesting) entitlements;	4.2.2, 5.2.3, 5.2.6, 13.3.4, 19.3.2
	• potential impacts to the natural environment from stream diversions;	No waterway diversions are planned
	• identify environmental values of the surface waters potentially affected by the project in accordance with the EPP (Water).	5.2.5, EMP section 3.5.1
	• Determine surface water quality objectives after consideration of the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (NWQMS 4, 2000);	5.1.4, 5.5, EMP section 3.5.1
	• assess risks to farmland from potentially contaminated surface water flow, particularly during flood events and/or failure of levee banks;	5.2.5
	• discuss options for flood mitigation and the effectiveness of mitigation measures with particular reference to sediment, salinity and other emissions of a hazardous or toxic nature to human health, flora or fauna ; and	Not relevant, flood mitigation infrastructure not proposed.
	• discuss proposals for maintenance of flood levees post-mining.	Not relevant - no flood levees proposed

ToR Section and Requirement		EIS Section
3.4.2	**Groundwater**	
3.4.2.1	**Description of Environmental Values**	
	The EIS should review the quality, quantity and significance of artesian and nonartesian groundwater resources within the project area. The review should include a survey of existing groundwater supply facilities (bores, wells, or excavations information to be gathered for analysis should include:	5.3.1
	• location and type of facilities	5.3.4
	• pumping parameters	5.3.4
	• draw down and recharge at normal pumping rates	5.3.4
	• seasonal variations (if records exist) of groundwater levels	5.3.2
	• a network of observation points which would satisfactorily monitor groundwater resources both before and after commencement of operations should be developed.	5.3.2, 5.3.4
	This section should include reference to:	
	• Nature of the aquifer(s):	
	- geology/stratigraphy—such as alluvium, volcanic, metamorphic	5.3.1
	- aquifer type—such as confined, unconfined	5.3.1
	- depth to and thickness of the aquifers	5.3.1, Figure 5-21
	• Hydrology of the aquifer(s):	
	- depth to water level and seasonal changes in levels	5.3.2, 5.3.4, 5.4.1
	- groundwater flow directions (defined from water level contours)	5.3.2, 5.3.4
	- interaction with surface water	5.3.2, 5.3.4
	- interaction with sea/salt water	5.3.3
	- possible sources of recharge	5.3.2, 5.3.4
	- vulnerability to pollution	5.2.5
	The environmental values of the underground waters of the affected area should be described in terms of:	
	• values identified in the EPP(Water)	5.3.1
	• sustainability, including both quality and quantity	5.3.2, 5.3.3, 5.3.4, 5.3.5
	• physical integrity, fluvial processes and morphology of groundwater resources.	5.3.1

ToR Section and Requirement		EIS Section
3.4.2.2	**Potential Impacts and Mitigation Measures**	
	The EIS should include:	
	• an assessment of the potential environmental impact caused by the project (and its associated project components) to local groundwater resources including the potential for groundwater induced salinity;	5.2.5, 5.4, 8.14
	• define the extent of the area within which groundwater resources are likely to be affected by the proposed operations and the significance of the project to groundwater depletion or recharge, and propose management options available to monitor and mitigate these effects;	5.2.4, 5.4, 5.5, 8.14
	• describe the response of the groundwater resource to the progression and finally cessation of the proposal;	5.2.4, 5.4.1, 5.4.2, 8.14
	• an assessment of the impact of the project on the local ground water regime caused by the altered porosity and permeability of any land disturbance;	5.2.4, 5.4.1, 8.14
	• assess and describe any potential for the project to impact on groundwater dependent ecosystems;	7.8, 7.10.1, 8.14
	• describe avoidance and mitigation measures ;	5.2.5, 5.5, 8.14.2
	• address potential impacts of surface water storage volumes on groundwater pressure and levels in relation to the sea/freshwater interface and associated ecology of wetlands; and	7.8, 7.10.1, 8.14
	• an assessment of the potential to contaminate groundwater resources and measures to prevent, mitigate and remediate such contamination.	5.2.5
3.5	**Coastal Environment**	
	The EIS should:	
	• describe the existing coastal environment, which may be affected by the project in the context of coastal values identified in State of the Coastal Zone Reports and environmental values as defined by the EP Act and environmental protection policies; and	6.0, 6.1, 6.2, 6.3, 6.8
	• identify actions associated with the project that are assessable development within the coastal zone and will require assessment under the provisions of the *Coastal Protection and Management Act 1995*.	Development of Gulf of Carpentaria and Cape York Peninsula Coast regional coastal plans has not yet commenced - see Section 1.9.16 and Section 6.0
3.5.1	**Marine Water and Sediment**	
3.5.1.1	**Description of Environmental Values**	
	The EIS should include:	
	• information on water quality in the sea and in estuaries below the limit of tidal influence, including salinity, heavy metals, acidity, turbidity and oil in water;	6.4
	• interaction of freshwater flows with marine waters, its significance in relation to marine flora and fauna in and adjacent to the port area;	6.3.4, 6.4.3
	• environmental values of the coastal seas of the affected area should be described, as relevant, in terms of values identified in EPP (water) and the state coastal management plan and any regional coastal plan :	6.0, 6.4.1, 6.8. Development of Gulf of Carpentaria and Cape York Peninsula Coast regional coastal plans has not yet
	• an assessment of physical and chemical characteristics of sediments should be provided for the area to be dredged and the disposal location of the dredged material ;	6.5
	• describe any contaminants and implications for management of the dredged material, description of sediment characteristics should be based on the results of sediment sampling and analysis conducted as per a sampling and analysis plan (SAP) approved under the Environment Protection (Sea Dumping) Act 1981;	6.5
	• the chemical and physical characteristics of the material to be dredged, the spoil ground and control sites should be summarised; and	6.5
	• If material to be disposed of is to be disposed in an offshore area, a statement as to the suitability of the sediment for unconfined ocean disposal should be made using the framework within the National Ocean Disposal Guidelines for Dredged Material (DEWHA 2002).	6.5

ToR Section and Requirement		EIS Section
3.5.1.2	**Potential Impacts and Mitigation Measures**	
	The EIS should define and describe:	
	• water quality objectives and practical measures for protecting or enhancing coastal environmental values, to describe how nominated quantitative standards and indicators may be achieved, and how the achievement of the water quality objectives will be monitored, audited and managed;	6.4.1, 6.8, 6.9.2, 6.9.3
	• water quality objectives used (including how they were developed), and how predicted activities will meet these objectives (refer to the EPA's Queensland water quality guidelines and the Australian and New Zealand guidelines for fresh and marine water quality, ANZECC, 2000);	6.4.1, 6.8, 6.9.2, 6.9.3
	• the potential environmental harm caused by the project on coastal resources and processes in the context of controlling such effects;	6.9
	• the State Planning Policy—Planning and Managing Development involving Acid Sulfate Soils 2002 should be addressed as should the State Coastal Management Plan 2001 and DPIF Guidelines for Marine Areas;	6.5.4. Development of Gulf of Carpentaria and Cape York Peninsula Coast regional coastal plans has not yet commenced - see Section 1.9.16 and Section 6.0
	• the role of buffer zones in sustaining fisheries resources through maintaining connectivity between coastal and riparian vegetation and estuarine and freshwater reaches of catchments; and	7.9.2, 8.12
	• impacts on water quality due to increased water turbidity and other contaminants from the sediment due to dredging and sea disposal of material and strategies developed to address potential impacts.	6.9.2, 6.9.3
	In addition to the above considerations, the following guidelines and standards should be considered:	
	• the EPP (Water), and any recent or proposed amendments that incorporate recommendations of the National Environment Protection Measures;	6.4, 6.9.2
	• ANZECC Australian Water Quality Guidelines for Fresh and Marine Waters (2000);	6.4, 6.9.2
	• amelioration or mitigation measures to address each activity identified to impact on local and regional water quality;	6.9.2, 6.9.3
	• any monitoring of water quality recommended during the dredging activities to ensure environmental values are protected;	6.9.2, 6.9.3
	The potential impacts of sediment quality on the marine environment should be discussed. This assessment should be guided by the suitability of the sediment for ocean disposal as determined by the framework outlined in the National Ocean Disposal Guidelines for Dredged Material (DEWHA 2002).	6.5, 6.9.2, 6.9.3
3.5.2	**Coastal Processes**	
3.5.2.1	**Description of Environmental Values**	
	The EIS should describe:	
	• the physical processes of the adjacent marine environment, including but not limited to currents, tides, storm surges, freshwater flows and their interaction in relation to the assimilation and transport of potential pollutants entering marine waters from the project area;	6.1
	• environmental values of the coastal resources of the affected area in terms of the physical integrity and morphology of landforms created or modified by coastal processes. Assessment should be based on hydrodynamic investigations and include a description of:	6.1, 6.8
	– the physical properties of the sediments likely to be dredged	6.5
	– sediment dynamics at the off-shore disposal ground based on the influence of tides, waves, currents and turbidity.	6.9.2.4
	• the relationship of these processes to marine flora and fauna and biological processes within the study area; and	6.3
	• the relationship between currents, wave actions and extreme events (such as cyclones) and how they influence coastal processes.	6.1

ToR Section and Requirement		EIS Section
3.5.2.2	**Potential Impacts and Mitigation Measures**	
	The EIS should include:	
	– the impacts of development of the berth area on hydrodynamic processes within the port study area;	6.9.1
	– impacts on siltation and any implications for marine flora and fauna and/or biological processes including generation and migration of turbid plumes. Information on currents in the region should be used to predict impacts and these impacts on marine environmental values should be assessed.	6.9.2, 6.9.3, 6.9.4, 6.9.5, 6.9.6
3.6	**Air Quality**	
3.6.1	**Description of Environmental Values**	
	This EIS should describe	
	• the existing air quality that may be affected by the project in the context of environmental values as defined by the EP Act and EPP (Air); and	9.1. 9.2
	• ambient air quality conditions in terms of particulate matter and any other major constituent of the air environment that may be affected by the proposal for any sensitive localities such as residences. Descriptions should include any baseline monitoring results.	9.1, Table 9-1.
3.6.2	**Potential Impacts and Mitigation Measures**	
	The EIS should consider the following air quality issues and their mitigation:	
	• quality and quantity of air emissions within the project area expected during construction and operational activities;	9.3, 9.4.3, 9.4.4, 9.5
	• impacts of dust generation from construction activities (including blasting, excavation and extraction), especially in areas where construction activities are adjacent existing road networks or are in close proximity to sensitive receivers;	9.5
	• identification of climatic patterns that could affect dust generation and movement;	9.4, 9.4.1
	• impact on terrestrial flora and fauna ;	
	• predicted changes to existing air quality from operational activities including mining, processing, stockpiling and loading of bauxite, dust generation along haulage roads, vehicle emissions, electricity generation and shipping;	9.4, 9.5
	• impacts on air quality from gaseous emissions including greenhouse gas emissions and ozone depleting substances; and	9.4, 9.5, 9.6
	• the human health risk associated with emissions from the project of all hazardous or toxic pollutants, whether they are or are not covered by the National Environmental Protection Council (Ambient Air Quality) Measure or the EPP (Air) that may reasonably be expected to impact human health.	9.5, 18.5.1, 18.5.8

ToR Section and Requirement		EIS Section
3.6.3	**Greenhouse Gas Emissions and Abatement**	
	The EIS should:	
	• provide an inventory of projected annual emissions for each relevant greenhouse gas, with total emissions expressed in 'CO2 equivalent' terms;	9.4.3, 9.4.4, 9.6.1, Table 9-9
	• estimate emissions from upstream activities associated with the proposed project, including fossil fuel based electricity consumed; and	9.6.1
	• briefly describe the method(s) by which estimates were made.	9.6.1
	Greenhouse gas abatement measures should be proposed, assessed and include:	
	• a description of the proposed measures (alternatives and preferred) to avoid and/or minimise greenhouse gas emissions directly resulting from activities of the project, including such activities as transportation of products and consumables, and energy use by the project;	9.6.2
	• an assessment of how the preferred measures minimise emissions and achieve energy efficiency;	9.6.2
	• a comparison between preferred measures for emission controls and energy consumption with best practice environmental management in the relevant sector of industry ; and	9.6.2
	• a description of any opportunities for further offsetting greenhouse gas emissions through indirect means.	9.6.2
	The environmental management plan in the EIS should include a specific module to address greenhouse abatement. That module should include consideration of the following:	EM Plan (section 21) - section 3.4
	• commitments to the abatement of greenhouse gas emissions from the project with details of the intended objectives, measures and performance standards to avoid, minimise and control emissions;	EM Plan (section 21) - section 3.4
	• commitments to energy management, including undertaking periodic energy audits with a view to progressively improving energy efficiency;	EM Plan (section 21) - section 3.4
	• a process for regular review of new technologies to identify opportunities to reduce emissions and use energy efficiently, consistent with best practice environmental management;	EM Plan (section 21) - section 3.4
	• any voluntary initiatives such as projects undertaken as a component of the national Greenhouse Challenge Plus program, or research into reducing the lifecycle and embodied energy carbon intensity of the project's processes or products;	EM Plan (section 21) - section 3.4
	• opportunities for offsetting greenhouse emissions, including, if appropriate, carbon sequestration and renewable energy uses; and	EM Plan (section 21) - section 3.4
	• commitments to monitor, audit and report on greenhouse emissions from all relevant activities and the success of offset measures.	EM Plan (section 21) - section 3.4

ToR Section and Requirement		EIS Section
3.7	**Noise and Vibration**	
3.7.1	**Description of Environmental Values**	
	The EIS should describe:	
	• the existing environment values that may be affected by noise and vibration;	10.1, 10.2
	• baseline monitoring and results at a selection of sensitive areas affected by the Project. Long-term measured background noise levels should take into account seasonal variations.	10.1, Table 10.1, Table 10.2
	• the locations of sensitive sites should be identified on a map at a suitable scale.	10.1, Figure 9-1
	• Sufficient data should be gathered to provide a baseline for later studies. The daily variation of background noise levels at nearby residences should be monitored and reported in the EIS, with particular regard given to detailing variations at different periods of the night; and	10.1
	• monitoring methods should adhere to accepted best practice methodologies, relevant EPA guidelines and Australian standards, and any relevant requirements of the EPP (Noise).	10.1, 10.3.1,
	• any current activities near the key Project areas which may cause a background level of ground vibration.	Not Relevant - no significant vibration sources and no blasting
3.7.2	**Potential Impacts and Mitigation Measures**	
	The EIS should describe:	
	• the modelled impacts of noise and vibration;	10.4, vibration not relevant
	• the potential environmental harm of noise and vibration at all potentially sensitive places, in particular, any places of work, residence, recreation, or worship should be quantified in terms of objectives, standards to be achieved and measurable indicators. This should also include environmental harm on terrestrial animals;	10.4, 10.5
	• potential impacts from blasting vibration on the structural integrity of neighbouring homesteads and farm buildings;	Not Relevant - no significant vibration sources and no blasting
	• proposals to minimise or eliminate these effects;	Not Relevant
	• timing schedules for operations with respect to minimising environmental harm, including environmental nuisance from noise, including temporary noise sensitive places, for example, the proposed Construction Camp;	10.5
	• information on blasting with particular attention given to places of work or residence, and general amenity; and the magnitude, duration and frequency of any vibration;	Not Relevant - no blasting
	• measures to prevent or minimise environmental harm, including nuisance;	10.5
	• off-site transport noise and vibration factors, including from road and overland conveyor transport; and	10.4, 10.5
	• any potential for ground vibration effects on underground pipelines and telecommunication lines.	Not Relevant -no significant vibration sources and no blasting

ToR Section and Requirement		EIS Section
3.8	**Waste**	
3.8.1	**Waste Generation**	
	The EIS should provide:	
	• technical details of waste generation, treatment, minimisation and management; and	13
	• identify and describe all sources of waste to be generated during the construction, operational and decommissioning stages of the project.	13.2, Tables 13-1, 13-2 & 13-3.
3.8.2	**Waste Management**	
	The EIS should provide:	
	• details of waste management strategies (including reduction, reuse, recycling, storage, transport and disposal of waste) which demonstrate that waste minimisation and cleaner production techniques and designs have been implemented through the selection of processes, equipment and facilities to prevent or minimise environmental impacts.	13.3, Figure 13-1
	The EIS should assess the potential impact of all wastes to be generated during the construction, operational and decommissioning stages of the project, and provide details of each waste in terms of:	
	• operational handling and fate of all wastes including storage;	13.3
	• on-site treatment methods proposed for the wastes;	13.3
	• methods of disposal (including the need to transport wastes off-site for disposal) proposed to be used for any trade wastes, liquid wastes and solid wastes;	13.3
	• the potential level of impact on environmental values;	13.3
	• proposed discharge/disposal criteria for liquid and solid wastes;	13.3.6, 13.3.7
	• measures to ensure stability of any dumps and impoundments should be described;	The final landform will not have any out of pit dumps of excavated wastes - see 13.3.3. Tailings discussed in 13.3.4
	• methods to prevent, seepage and contamination of groundwater from stockpiles and/or dumps should be given;	Seepage from tailings impoundments discussed in 13.3.4, 8.14.1.2. No long term waste stockpiles or dumps will be
	• market demand for recyclable waste (where appropriate) should be addressed;	13.3.1
	• waste minimisation techniques processes proposed; and	13.3.1
	• decommissioning of the site.	13.2.3
	The EIS should include:	
	• regard for best practice waste management strategies and the Environmental Protection (Waste) Policy 2000, the proposals for waste avoidance, reuse, recycling, treatment and disposal should be described in the appropriate sub-section	13.3
	• information on the variability, composition and generation rates of all waste produced at the site and processing plant.	13.2, 13.3
	• cleaner production waste management planning especially as to how these concepts have been applied to preventing or minimising environmental impacts at each stage of the proposal.	13.3.1
	• measures to improve natural resource use efficiency (e.g. energy and water), integrated processing design, any co-generation of power and by-product reuse as shown in a material/energy flow analysis	13.3.1

ToR Section and Requirement		EIS Section
	Air emissions	
	• The EIS should provide information on air emissions, including particulates, fumes and odours, during the construction and operation stages of the project.	9.4.3, 9.4.4, 9.5, 9.6.1
	Excavated waste	
	• The EIS should describe and show the location, design and methods for constructing dumps for waste rock and subsoil.	There wil be no out of pit dumps of excavated waste in final landform, see
	Tailings	
	The EIS should describe:	
	• the tailings waste produced by preparation and/or processing plants and the proposed methods for its disposal;	13.3.4
	• alternative options for tailings disposal including the proposed location, site suitability and volume of any tailings storage and/or disposal site(s), including the method of construction;	1.6.6, 1.6.7, 1.6.9
	• the approximate quantity of tailings to be produced by the project and its processing plant annually for the life of the mine;	Table 3-2, 13.3.4
	• tailings characterisation;	13.3.4, Table 13-4, 13-5.
	• the construction of the tailings storage facility;	2.5.2, 13.3.4, Figure 13-2
	• how the tailings storage facility complies with relevant codes for the construction of containment system;	13.3.4
	• strategies to monitor and manage seepage into ground and surface waters; and	13.3.4
	• the location of the storage and/or disposal site with regard to adjacent creeks and rivers.	13.3.4, Figure 13-1.
	Solid waste disposal	
	The EIS should describe:	
	• the quantity and quality of solid wastes (other than waste rock, subsoil and tailings addressed in other sections) and the proposed methods of their disposal; and	13.3.6, 13.3.8
	• the proposed location, site suitability, dimensions and volume of any landfill, including its method of construction	Not Relevant - Where practical, the existing Weipa Waste Management Facility will be expanded to accommodate waste from SoE as required. See 13.3.6
	Liquid waste	
	• The EIS should describe the origin, quality and quantity of wastewater, sewerage, contaminated runoff and any immiscible liquid waste originating from the project other than that addressed in other sections.	13.3.7. 13.3.8
	Ship waste	
	The EIS should provide details on the management of ship waste, including:	
	• handling, treatment and disposal of solid quarantine waste;	13.3.8
	• ship's sewage;	13.3.8
	• ship's washings and slops;	13.3.8
	• details of expected volumes of ballast water to be discharged in port, the source of the ballast, location of ship discharges, risk of introducing marine pests and proposed controls, including ballast water inspections; and	Table 13-2, 13.3.8
	• the management of ballast water and risk of introduced marine pests should be discussed in the context of Commonwealth requirements and systems.	13.3.8

ToR Section and Requirement		EIS Section
3.9	**Transport**	
3.9.1	**Transport Methods and Routes**	
	The EIS should detail:	
	• any proposed new or alterations to transport-related infrastructure required by the project (as distinct from impact mitigation works). This includes modifications to roads for access works and realignments, rail lines (including level crossings and services) and air and sea port facilities.	14.1.4, 14.1.7, 14.2, 14.3, 14.4.3
	• the construction of any project-related plant and utilities, within or impacting on the jurisdiction of any transport authority	Only relevant plant/utility is port (see
	• expected volumes/tonnage of project inputs and outputs of transported raw materials, wastes, hazardous goods, finished products and so on for all phases of the project	13.2, 14.1.5, Table 14-3, 14.4.5, Table 14-8, Table 14-9, Table 14-10
	• how identified project inputs and outputs will be moved through the transport network (volume/tonnage, composition, trip timing and routes)	14.1.4, 14.1.5, Table 14-3, Table 14-6, 14.4.4, Table 14-8 to Table 14-10,
	• traffic generated by workforce personnel including visitors (mode, volume, composition, timing and routes)	14.1.4, 14.1.5, Table 14-3, Table 14-6, 14.3, 14.4.4, 14.4.5, Table 14-8, Table
	• likely heavy and oversize/indivisible loads (volume, composition, timing and routes) highlighting any vulnerable bridges and structures along proposed routes.	14.1.1, 14.1.5, Table 14-3, 14.1.6, Table 14-7, 14.1.7

ToR Section and Requirement		EIS Section
3.9.2	**Potential Impacts and Mitigation Measures**	
	The impact assessment should include:	
	• details of assessment methodology adopted with a summary of consultation undertaken with transport authorities (for example, DMR, local government and Queensland Transport) regarding the scope of the impact assessment and methodology to be used	14.1.6
	• details of all base data assumptions, including current condition of the affected network and its performance	14.1.1, 14.1.2, 14.1.3, 14.1.6, 14.2, 14.3, 14.4.1, 14.4.2, 14.4.3
	• details on possible interruptions to transport operations	14.1.6, 14.4.6
	• details of any impacts on the natural environment within the jurisdiction of an affected transport authority (for example road and rail corridors)	The Project will not impact rail or road infrastructure under the jurisdiction of a transport authority (see 14.1.1 and 14.2).
	• details on the nature and likelihood of product-spill during transport if relevant	14.4.6, 14.4.7
	• road impacts using DMR, Guidelines for Assessment of Road Impacts of Development (2006) should include:	
	– assessment of project impacts (from either transport or project operations) on the safety, efficiency and condition of road operations and assets an assessment of project impacts on overland water-flows and their interaction with the road network	14.1.6
	– assessment of driver fatigue for workers travelling to and from regional centres and key destinations	14.1.6
	– assessment of project impacts on any existing or proposed pedestrian/ cycle networks	14.1.6
	– assessment of project impacts on any existing public transport networks (assets and services).	14.1.6
	• rail Impacts to should consider:	
	– project impacts on the amenity and health of adjacent land users as a result of dust, noise and vibration	14.2
	– impacts on passenger transport and services, should the project generate large public transport trip movements.	14.2
	• air and sea ports assessment should address:	
	– project impacts on the ongoing operation of existing air and sea port facilities, including capacity of throughput and any land-use impacts as a result of the project's operations	14.3, 14.4.3, 14.4.4, 14.4.5, 14.4.6, 14.4.7, 16.3.11
	– the impact of the project on the Port of Weipa, particularly, how the operation of a new port at Boyd Point will affect the existing Port of Weipa	14.4.6
	• The EIS should discuss and recommend how identified impacts will be mitigated so as to maintain safety, efficiency and condition of each mode and include:	
	– consideration of any transport authority's works program and forward planning	Not relevant - mitigation works will not impact on any transport authority
	– proposed construction plans of all required transport infrastructure works in accordance with relevant and accepted authority standards and practices	14.1.7, 14.4.4
	– timing and responsibilities of these works (when and by whom)	14.1.7, 2.3
	– a summary of relevant approvals and legislative requirements needed to implement mitigation strategies including transport infrastructure works required by the project.	14.1.7

ToR Section and Requirement		EIS Section
3.10	**Indigenous Cultural Heritage**	
3.10.1	**Description of Indigenous Cultural Heritage Values**	
	The EIS should describe and include:	
	• the known indigenous cultural heritage values that may be affected by the project; and	11.1.2, 11.1.3, 11.1.6
	• an indigenous cultural heritage survey (as part of the Cultural Heritage Management Plan (CHMP) process or otherwise) should be undertaken for significant indigenous objects and significant indigenous areas.	11.1.3
	The indigenous cultural heritage survey should:	
	• refer to the NRW Indigenous Site Database and any existing literature relating to the affected areas	11.1.2
	• refer to:	
	– the consultation and negotiation with traditional owners and the outcomes about:	
	• significant indigenous objects and significant indigenous areas	11.1.3, 11.1.5, 11.1.6
	• confidentiality of culturally sensitive information	11.1.3
	– the involvement of traditional owners in field surveys.	11.1.3, 11.1.6
	• include locations of significant indigenous objects and significant indigenous areas identified during the survey and which are likely to be impacted by the project	11.1.6
	• provide a report of work done which includes background research, relevant environmental data and methodology, as well as results of field surveys, significance assessment and conclusions and management recommendations	This information is presented in Section 11.1

ToR Section and Requirement		EIS Section
3.10.2	**Potential Impacts and Mitigation Measures**	
	The management of indigenous cultural heritage impacts should be detailed in either a native title agreement with traditional owners or in a CHMP, with the native title agreement or plan to be developed in a form that complies with the provisions of Part 7 of the Aboriginal Cultural Heritage Act 2003, thereby meeting the cultural heritage duty of care. The agreement or plan must provide a process for the conduct of comprehensive cultural heritage investigations and the identification of significant indigenous objects and significant indigenous areas in the proposed project area. It is also to provide a process for the management of those objects, areas and values identified in the proposed project area.	An Indigenous Land Use Agreement (ILUA) (known at the Western Cape Communities Coexistence Agreement (WCCCA)) provides the context for Indigenous cultural heritage management on ML7024 and ML6024 - see 2.2, 11.1.1 and Figure 2-2.
	The agreement or plan should include the following:	
	• a process for including indigenous communities or indigenous parties in the identification, management and protection of indigenous cultural heritage in the project area	11.1.1, 11.1.6
	• a process for undertaking a comprehensive and systematic cultural heritage assessment	11.1.1, 11.1.6
	• processes for the mitigation, management and protection of identified cultural heritage objects and areas in the project area, and in any areas to be affected by development of any associated infrastructure, both during construction and operational phases of the project	11.1.1, 11.1.6
	• provision for the management of the accidental discovery of cultural material, including burials, in the project area	11.1.1, 11.1.6
	• processes for determining any requirements for monitoring of the project during construction, and measures by which any monitoring program is to be implemented	11.1.1, 11.1.6
	• Indigenous cultural heritage induction and awareness programs for project staff, subcontractors and staff, consultants and agents of the project	11.1.1, 11.1.6
	• a conflict resolution process.	11.1.1, 11.1.6
	The development of the agreement or plan should be negotiated with all relevant stakeholder representatives, subject to any confidentiality specified by the indigenous community, registered native title applicants, and/or indigenous parties as appropriate.	11.1.1
	As a minimum, impact assessment, management and protection strategies should satisfy statutory responsibilities and duties of care under the Aboriginal Cultural Heritage Act 2003 and the Aboriginal and Torres Strait Islander Heritage Protection Act 1984 (Cwlth).	An Indigenous Land Use Agreement (ILUA) (known at the Western Cape Communities Coexistence Agreement (WCCCA)) provides the context for Indigenous cultural heritage management on ML7024 and ML6024 -
	If a CHMP has not been approved by the submission of the EIS to the CG then the following should be provided: • a outline of the draft CHMP, subject to any confidentiality provisions, with the position of the endorsed cultural heritage parties • details of the proposed steps and timeframes for seeking the ratification of the CHMP.	

ToR Section and Requirement		EIS Section
3.11	**Non-Indigenous Cultural Heritage**	
3.11.1	**Description of Non-Indigenous Cultural Heritage Values**	
	The EIS should describe the existing environmental values for non-indigenous cultural heritage that may be affected by the project activities and include a non-indigenous cultural heritage survey that should:	11.2.3
	• refer to:	
	– the Australian Heritage Places Inventory	11.2.3
	– the EPA Queensland Heritage Register and other information regarding places of potential non-indigenous cultural heritage significance	11.2.3
	– local government heritage register	11.2.3
	– any existing literature relating to the affected areas	11.2.2
	• refer to consultations and negotiations with the local community and historical societies about:	
	– places of non-indigenous cultural heritage significance	11.2.3, 11.2.4
	– the significance of any non-indigenous cultural heritage places located or identified	11.2.3, 11.2.4
	• include locations of culturally significant sites likely to be impacted by the project	11.2.3, Table 11-1, Figure 11-1
	• provide a constraints' analysis of the proposed development area to identify and record non-indigenous cultural heritage places	11.2.3
	• provides the location of mining areas with historical significance should be shown on maps	Figure 11-1
	• provides a report of work done which includes background research, relevant environmental data and methodology, as well as results of field surveys, significance assessment and conclusions and management recommendations (having due regard for any confidentiality requirements specified by community representatives).	This information is presented in section 11.2
	Investigations and consultation should be undertaken in such manner and detail to satisfy statutory responsibilities and duties of care, under the EPBC Act and *Queensland Heritage Act 1992*.	11.2.3
3.11.2	**Potential Impacts and Mitigation Measures**	
	The EIS should provide an assessment of any likely effects on sites of non-indigenous cultural heritage values, including but not limited to the following:	
	• description of the significance of artefacts, items or places of conservation or non-indigenous cultural heritage value likely to be affected by the project and their values at a local, regional and national level	11.2.3, 11.2.4,
	• recommended means of mitigating any negative impacts on non-indigenous cultural heritage values and enhancing any positive impacts	11.2.5
	• where relevant, negotiations with Queensland Heritage Council and the EPA regarding management of places of historic heritage significance, taking account also of community interests and concerns	Not Relevant - all sites were of low significance with no further heritage management required - see 11.2.5
	• documented management strategies in accordance with the outcomes of negotiations with Queensland Heritage Council, EPA and the community.	Management strategies described in 11.2.5. Negotiations not required at this stage - see above
	As a minimum, impact assessment, management and protection strategies should satisfy statutory responsibilities and duties of care, including those under the EPBC Act and Queensland Heritage Act 1992.	11.2.5

ToR Section and Requirement		EIS Section
4	**Social Values and Management of Impacts**	
4.1	**Social**	
4.1.1	**Description of Social Values**	16.2
	The EIS should describe	
	• the existing social values that may be affected by the project including effects at both footprint and benefited area locations	16.2
	• the social amenity and use of the project area and adjacent areas for rural, agricultural, forestry, fishing, recreation, industrial, educational, cultural or residential purposes	16.2
	In the development of this community profile, consideration should be given to:	
	• Indigenous communities;	16.1, 16.2.1, Table 16.3, Figure 16-1, Figure 16-2.
	• rural properties, farms, croplands and grazing areas;	16.2.8
	• community infrastructure and services, access and mobility;	16.2.2
	• population, demographics and family structure of the affected community;	16.2.1
	• local community characteristics, identity, values, vitality and lifestyles;	16.2.11
	• recreational, cultural, leisure and sporting facilities and activities in relation to the affected area;	16.2.7, 16.2.9
	• recreational, commercial and Indigenous fishing areas and livelihoods;	16.2.7, 16.2.9, 16.2.10
	• health and educational facilities;	16.2.3, 16.2.4
	• local government and public facilities; and	16.2.2, 16.2.3, 16.2.4, 16.2.9
	• number of properties directly affected by the project.	3.1
	• number of families directly affected by the project (including Indigenous Traditional Owners and their families), this should include not only property owners but also families of workers either living on the property or workers where the property is their primary employment;	Not Relevant (no properties directly affected – see 3.1 and Figure 3-1)
	The EIS should give an overview of the project's near neighbours and local communities at the level of Indigenous communities, townships, district, region and state and be comprised of;	16.2.1
	• a definition of the local community area, developed in consultation with the DIP Social Impact Unit;	16.1, Table 15-2
	• the location of other relevant proposals or projects within the local community area; and	16.3.12
	• other features in the local community area, including social infrastructure and human services.	16.2
	The EIS should include a social baseline study which describes the profile and demographics of the local community, including:	
	• the identity, characteristics and aspirations of each community within the project area, including Indigenous communities;	16.2.10, 16.2.11
	• the name and location of the community, size, history, and spatial distribution;	16.1, 16.2.1
	• land use and land ownership patterns;	2.2, 3.1, 16.2.7, 16.2.8, 16.3.2
	• key social and political organisations including local government, non-government organisations and other civil society organisations;	15.2, 16.2, 16.2.9
	• major trends/changes in the population make-up that may be occurring irrespective of the project;	16.2.1
	• total population (the total enumerated population for the local community area and the full time equivalent (FTE) transient population);	16.2.1
	• population growth and population forecasts with and without the project;	16.2.1, Table 16.2, Figure 16-9
	• age and gender distributions (including Indigenous communities);	16.2.1, Figure 16-3 to 16-8.
	• education including schooling levels;	16.2.4, 16.3.4, Table 16.10
	• occupation and ethnic characteristics;	16.2.5, Figure 16-11 &16-12,
	• median individual and household incomes;	16.2.5, Figure 16-14, Figure 16-15.
	• employment, unemployment and not in the labour force;	16.2.5, Figure 16-14 & 16-15.
	• housing costs (monthly housing repayments) (per cent of dwellings in each category), and weekly rent (per cent dwellings in each category), housing tenure type and landlord type, household and family type;	16.2.5, 16.2.6, Figures 16.16 to 16.21
	• social and economic index for areas and index of disadvantage—score and relative ranking ;	16.2
	• disability prevalence;	16.2.1, Table 16-5
	• crimes, including domestic violence and crimes against the person;	16.2, 16.3.5
	• a description of social issues currently faced by local communities should be outlined. Regard should be given to any other recent social impact work done in the Western Cape area other such indicators that may be determined by the community as relevant; and	16.3.5, 16.2.11
	• other such indicators that may be determined by the community as relevant.	16.3
	The EIS should provide a profile of the local business community including:	
	• a description of the key industries	16.2.5, 16.2.7, 16.2.8, Table 16.5, Table 16.6, Section 17

ToR Section and Requirement		EIS Section
	• the number of properties and families directly affected by the project including Indigenous families and families of workers either living on the property or workers where the property is their primary employment	Not Relevant (no properties directly affected – see 3.1 and Figure 3-1)
	• use of the project area for forestry, fishing and recreation tourism, if applicable	16.3.2
	• Indigenous and non-Indigenous traditional and significant sites.	16.2.10, 11.1, 11.2

ToR Section and Requirement		EIS Section
4.1.2	**Potential Impacts and Mitigation Measures**	
	The social impact assessment of the project should be carried out in consultation with affected local authorities/communities and relevant state authorities including the DIP Social Impact Unit.	16.3
	The assessment of impacts should describe the likely response of affected communities and identify possible beneficial and adverse impacts (both immediate and cumulative). These impacts should be considered both at the local and regional level.	16.3
	The social impact assessment of the project should consider the information gathered through a community engagement program (public consultation program – section 1.9) and the analysis of the existing socio-economic environment, and describe the project's impact, both beneficial and adverse, on the Indigenous, local and regional community.	16.3, 15
	The impacts of the project on Indigenous, local and regional residents' community services and recreational activities should be analysed and discussed for all stages of the development.	16.3
	The nature and extent of the community engagement program should be described and a summary of the results incorporated in the EIS.	15
	The social impact assessment should include sufficient data to enable affected local authorities and state authorities, to make informed decisions about how the project may affect their business and plan for the continuing provision of public services in the region of the project.	16.3
	Cumulative impacts–direct, indirect and secondary impacts resulting from existing projects, the proposed project and anticipated future projects, should be identified including the important cause and effect of relationships between human activities and resources, ecosystems, traditional Indigenous lands, and human communities. The magnitude and significance of these cumulative effects should be determined.	16.3.12
	The EIS should provide an assessment of the following, taking into account relevant demographic, social, cultural, Indigenous, and economic profiles:	
	• impacts on Indigenous, local and regional residents, current land uses, cultural land use and existing lifestyles and enterprises	16.3.2, 16.3.5, 16.3.6
	• impacts on local, regional and state labour markets, with regard to the source of the workforce. This information should be presented according to occupational groupings and whether the proponent, and/or contractors, are likely to employ local and Indigenous residents or through other means and whether there are initiatives for local Indigenous business opportunities.	16.3.7, 16.3.8
	• impacts on both construction and operational workforces and associated contractors on housing demand, housing affordability, community services and community cohesion. The capability of the existing housing stock, including rental accommodation, to meet any additional demands created by the project should be discussed at a local, regional and state scale, including direct impacts on Indigenous people.	16.3.5, 16.3.8, 16.3.11
	• proposed new skills and training related to the project, including the occupational skill groups required and potential skill shortages anticipated	16.3.4, 16.5
	• the degree of service revenue and project work (e.g. provisioning, catering and site maintenance) likely to flow to existing communities in the area of the project, particularly if a fly-in, fly-out workforce is proposed	17.4
	• the ability of both affected Indigenous and non-Indigenous communities to live in accordance with their own values and priorities	16.3.5, 16.3.6
	• use of, and access to, culturally important areas and landscapes	11, 16.3.2, 16.3.6
	• access to existing human and commercial services and housing	16.3
	• ability to participate in local and regional employment and training opportunities	16.3.4, 16.3.7, 16.5
	• any influx of a new project workforce and their families	16.3.8, 16.3.9
	• impacts on the various educational sectors.	16.3.4
	The proponents initiatives to promote environmental and cultural awareness for the general public should be described.	16.3.2, 16.3.4
	Mitigation and enhancement strategies for identified impacts to social values should be outlined. .	16.3
	Practical monitoring regimes for project-related impacts should be recommended and a procedure to establish a complaints register and a conflict resolution mechanism should be incorporated	16.3.3
	The social impact mitigation strategies should address:	
	• strategies to address all project-related Indigenous issues including effective ongoing consultation	11.1, 15.4, 16.3.2, 16.3.3, 16.3.4, 16.5
	• the sourcing of the construction and operational workforce and the social and cultural implications this may have for the host community, particularly if any part of the workforce is sourced from overseas	16.3.4, 16.3.7, 16.3.8, 16.3.9
	• an accommodation strategy, where necessary, in consultation with relevant state government agencies, with proposals that avoid, mitigate or offset any short and medium term adverse effects on the local and regional housing market	16.3.8, 16.3.11
	• the demographic changes in the profile of the region and the associated sufficiency of current infrastructure and services	16.3, 16.3.9
	• the development of a community engagement plan that promotes an active and ongoing role for impacted communities including Indigenous communities and is inclusive of relevant demographic groups such as young people, men, women, elders etc.	15.4, 16.3.3
	The social impact assessment should contain an evaluation of the net social impacts of the proposed project including a summary table of net social impacts identified by the study, and an estimation of the overall significance of those impacts.	Table 16-21
	The EIS should discuss any social responsibility initiatives proposed by the proponent, including:	
	• modifications or alternatives to avoid, minimise, or mitigate significant cumulative effects	16.3.12
	• key policies and procedures to be adopted or used by the proponent that would mitigate or enhance impacts	16.3.4, 16.3.7, 16.5

ToR Section and Requirement		EIS Section
	• key government documents outlining proposed local, state or Australian Government initiatives or plans that would mitigate or enhance impacts. Uncertainty should be addressed through the design of an effective monitoring system.	16.3.4
	A Social Impact Management Plan should be prepared to address social impacts arising from the project. In particular, the plan should identify potential impacts and outline mitigation strategies, commitments and management measures to ameliorate the impacts identified.	Table 16-21

ToR Section and Requirement		EIS Section
4.2	**Health and Safety**	
4.2.1	**Description of Environmental Values**	
	The EIS should describe:	
	• the existing community values for public health and safety that may be affected by the proposal; and	16
	• nearby and other potentially affected populations from air emissions, and potential odours.	9.4.4, 9.5
4.2.2	**Potential Impacts and Mitigation Measures**	
	The EIS should include:	
	• define and describe the objectives and practical measures for protecting or enhancing health and safety community values;	9.2, 9.3, 10.2, 10.5, 16.3
	• describe how nominated quantitative standards and indicators may be achieved for social impacts management, and how the achievement of the objectives will be monitored, audited and managed;	9.3, 10.5
	• assess the effects on the project workforce of occupational health and safety risks and the impacts on the community in terms of health, safety, and quality of life from project operations and emissions;	9.4.4, 9.5, 10.4, 10.5, 16, 18.5, 18.6
	• detail impacts on the health and safety of the community, workforce, suppliers and other stakeholders in terms of health, safety, quality of life from factors such as lighting, air emissions, odour, dust, noise and vibration;	9.4.4, 9.5, 10.4, 10.5, 12.4, 18.5, 18.6
	• Map(s) showing the locations of sensitive receptors, such as, but not limited to, kindergartens, schools, hospitals, aged care facilities, residential areas, and centres of work (e.g. office buildings, factories and workshops);	Figure 9-1
	• discuss how planned discharges from the project could impact on public health in the short and long term, and should include an assessment of the cumulative impacts on public health values caused by the proposal, either in isolation or by combination with other known existing or planned sources of contamination;	9, 9.4.4, 9.5, 10.4, 10.5
	• address the project's potential for providing disease vectors;	18.5.3
	• measures to control mosquito and biting midge breeding ;	18.5.3
	• assess and outline potential public health risks to drinking water supplies and mitigation measures to ensure compliance with the Australian Drinking Water Guideline 2004;	18.5.4
	• assess any use of recycled water for its potential to cause infection by the transmission of bacteria and/or viruses by contact, dispersion of aerosols, and ingestion (e.g. via use on food crops);	13.3.7, 18.5.5
	• assess the use of recycled water for its potential to cause harm to health via the food chain due to contaminants such as heavy metals and persistent organic chemicals; and	Not relevant - Recycled water will not be used for irrigation of food crops or in other areas that may impact the food
	• practical monitoring regimes.	13.3.7, 18.5.5

ToR Section and Requirement		EIS Section
5	**Impacts on the State and Local Economies and Management of Impacts**	
5.1	**Economy**	
5.1.1	**Description of Affected Local and Regional Economies**	
	The EIS should describe:	
	• the existing economy in which the project is located and the economies materially impacted by the project	17.1, 17.2
	• the economy in which the project is to be located	17.1, 17.2
	• the economy including:	
	– gross regional product or other appropriate measure of annual economic production	17.2
	– population	16.2.1, 17.2
	– labour force statistics	16.2.5, 17.2
	– infrastructure	16.2.2, 16.2.3, 16.2.4, 17.2
	• the regional economy's key industries and their contribution to regional economic income	16.2.5, 17.2
	• regional resource endowment, competitive advantage and expected future growth	17.1, 17.4.3, 17.4.4, 17.4.5, 17.4.6, 1.3
	• the key regional markets relevant to the project:	
	– labour market	16.2.5, 17.2
	– housing and land markets	16.2.6, 17.2
	– construction services and building inputs market	16.2.5, 17.2
	• with regard to the region's key industries:	
	– provide information on current input costs (wage rates, building costs, housing rent etc)	16.2.5, 16.2.6, 17.2
	– provide information on land values in the region by type of use.	16.2.6
5.1.2	**Potential Impacts and Mitigation Measures**	
	The potential impacts should consider regional, state and national perspective as appropriate to the scale of the project.	17.4, Table 17-1 to 17-8
	The analysis should include the direct economic impacts on industry and the community including:	
	– property values	16.3.11, 17.4.9
	– industry output	17.4
	– employment	17.4
	– factor incomes.	17.4
	– assess any forgone industry output from the project	There is not expected to be any significant forgone industry outputs as a result of the Project, see 17.1
	– assess any forgone opportunities and impacts to households (eg recreation, increased travel times)	16.3.2, 17.1
	– assess the indirect impacts likely to flow to other industries and economies from the development of the project implications of the project for future development	17.4, 16.3.2, 16.3.7, 16.3.10

ToR Section and Requirement		EIS Section
5.1.2.1	**Strategies for Local Participation**	
	The assessment of economic impacts should outline:	
	• strategies for assessing the cost effectiveness of sourcing local inputs from the regional economy during the construction, rehabilitation and operation of the project;	17.4.7
	• employment strategies for local residents including members of Indigenous communities including a skills assessment and recruitment and training programs to be offered;	16.3.4, 16.3.7, 17.4.7
	• strategies to meet obligations under any existing Indigenous Land Use Agreement; and	11.1, 16.3.4, 17.4.7
	• strategies responding to government policy, where relevant, relating to:	
	– employment opportunities for Indigenous people arising from the Western Cape Regional Partnership Agreement;	16.3.4, 16.3.7, 17.4.7
	– the level of training provided for construction contracts on Queensland Government building and construction contracts, with regard to the Queensland Government Building and Construction Contracts Structured Training Policy (the 10 per cent policy); – indigenous employment opportunities, with regard to the Indigenous Employment Policy for Queensland Government building and Civil Construction projects (the 20 per cent policy); and – the use of locally sourced goods and services, with regard to the Local Industry Policy (Department of State Development, 1999).	The Queensland Government Building and Construction Contracts Structured Training Policy (DET undated), the Indigenous Employment Policy for Queensland Government Building and Civil Construction Projects (DEIR 2008), and the Local Industry Policy (DTRDI, 2008) are not relevant to the Project as it is not a Government contract or
5.1.2.2	**Strategies to Mitigate Disruption to the Local Economy During Construction and Operation**	
	The economic assessment should:	
	• identify all potential changes to industry practices likely to occur during construction and operation of the project	16.3.7, 17.4.8, 17.4.9, 17.4.10
	• identify all potential impacts on households (travel time, noise etc) likely to occur during construction and operation of the project	17.4.8. See relevant impact sections of Sections 9, 10, 12 and 16
	• estimate the cost of these changes if material	17.4.8. No material changes in relation to noise, air, visual amenity or social impacts
	• describe the measures to be taken to minimise disruption or alleviate cost impacts of the project.	17.4.8. Strategies to minimise disruption are in impact mitigration sections of relevant sections (9, 10, 12 and 16)
5.1.2.3	**Impact Upon Property Management**	
	This section should address the current and future management processes for adjacent properties which are likely to be impacted by the project during construction and/or operation. Mention should be made of:	3.1, Figure 3-1, 17.4.10. No local or regional planning provisions apply to the Project area or surrounds (see 3.1.2).
	• the impact of the project on existing agricultural land uses and management practices, e.g. disruption to stockyards, fences, water points, sowing or harvesting of crops, movement of livestock, agricultural machinery and any loss of agricultural land	Figure 3-1, 3.1.2, 17.4.10
	• the range of measures required to mitigate real and potential disruptions to rural practices and management of properties	3.1.2, 3.7.2, 17.4.10
5.2	**Sustainable Development**	
	The EIS should provide a comparative analysis of how the project conforms to the objectives for 'sustainable development' (see the National Strategy for Ecologically Sustainable Development (1992), available from the Australian Government Publishing Service).The analysis should consider the cumulative impacts (both beneficial and adverse)of the project from a life-of-project perspective, taking into consideration the scale, intensity, duration and frequency of the impacts to demonstrate a balance between environmental integrity, social development and economic development.	17.5

ToR Section and Requirement		EIS Section
6	**Hazard and Risk**	
6.1	**Hazard and Risk Assessment**	
	The EIS should describe the potential hazards and risks that may be associated with the project and should incorporate all known hazards, which may include:	
	• identification of potential hazards, accidents, spillages and abnormal events occurring during all stages of the project, including possible frequency of occurrence	19.1, 19.2.2, Appendix 19A, 19.3
	• indication of cumulative risk levels to surrounding land uses	16.3, 19.2.2, Appendix 19A, 20
	• identification of all hazardous substance to be used, stored, processed or produced and the rate of usage	19.1, Table 19-1, Table 19-2, Table 19-3
	• potential wildlife hazards such as snakes and disease vectors.	18.5.3, Appendix 19A
	The EIS should deal with on-site risks. The study should assess risks during the construction, operational and decommissioning phases associated with the project. These risks should be assessed in quantitative terms where possible. Possible hazards, accidents, and abnormal events that may arise for the project, both during construction and in operation should be described, including:	Appendix 19A
	• accidental release of hazardous goods or other materials	19.1, Table 19.6, 19.3.1, Appendix 19A
	• fires associated with incidents arising from the project activities	Table 19.6, 19.3.3, Appendix 19A
	• vulnerability of the project area to bushfire, flooding and cyclones and other natural disasters.	4.2, 19.3.2, 19.3.3, 19.3.4, Appendix 19A
	The EIS should detail the safeguards that would be employed or installed to reduce the likelihood and severity of hazards, consequences and risks to persons, fauna and environmentally sensitive sites within and adjacent to the project area.	Table 19.6, 19.3. Appendix 19A cross references relevant sections of EIS where impacts and mitigation measures for each identified hazard are discussed. Note that risks and associated mitigation measures arising from nomral construction and operational activities are also addressed in relevant sections of the EIS and are not addressed in Section 19
6.2	**Emergency Management Plan**	
	The EIS should provide an outline of the proposed emergency management procedures for the range of situations identified in the above risk assessment where there are measurable risks. This should include an overview of the objectives and management principles to be adopted for the preparation of a detailed emergency plan (including emergency response and recovery/cleanup procedures) in consultation with the relevant emergency services. Planning should include reference to State Planning Policy 1/03, Mitigating the Adverse Impacts of Flood, Bushfire and Landslide.	19.1, 19.3
	The EIS should present:	
	• contingency plans to deal with hydrocarbon (e.g. diesel, lubricating oils) oil spills during construction, operation and maintenance of the project	19.3.1
	• contingency plans to account for natural disasters such as storms, flooding and fires during the construction, operation and maintenance phases	19.3.2, 19.3.3, 19.3.4
	• emergency planning and response procedures that have been determined in consultation with state and regional emergency service providers	19.3 , 16.3.1
	• plans for involvement of the relevant state agencies (such as the Department of Emergency Services, which includes the Queensland Ambulance Service, Queensland Fire and Rescue Service, Queensland Police Service and Emergency Management Queensland) in relation to emergency medical response and transport and first aid matters.	19.3

ToR Section and Requirement		EIS Section
7	**Cumulative Impacts**	
	The EIS should describe	
	• information on the overall impacts of the project, and the interrelationship of these impacts;	20
	• the cumulative impacts as they relate to particular issues (e.g. water management, cultural heritage, social and economic costs and benefits, community disruption and accommodation etc.);	20
	• the cumulative impacts of the project, in combination with other proposed mining projects , on the biodiversity and ecological function of the Western Peninsula bauxite plateau, should be assessed within the EIS;	20
	• specific issues covered include impacts on:	
	– regional ecosystems associated with the western Cape York Peninsula bauxite plateau	20.6
	– the natural integrity of Cape York Peninsula as a whole	20.2 to 20.12
	– key habitats (e.g. riparian, wetland, threatened species habitat) which retain connections with adjacent remnant vegetation and habitat	20.6, 20.7
	– hydrologically connected surface water and groundwater systems that support wetlands and base flows in rivers and creeks.	20.4
	• the requirements of any relevant state planning policies, environmental protection policies, national environmental protection measures, water resource planning and any other relevant plans; and	20.0 The requirements of policies and plans and how RTA proposes to design and operate the Project in a way that is consistent with these policies and plans, and hence minimise cumulative impacts, has been addressed in the relevant [illegible] EIS
	• the methodology to be used to determine the cumulative impacts of the project detailing the range of variables to be considered including, where applicable, relevant baseline or other criteria upon which the incremental aspects of the project should be assessed.	20.0, 20.3, 20.4, 20.7, 20.14
8	**Environmental Management Plan**	
	The EIS should detail:	
	• the EMP for the project developed from, and consistent with, the preceding information in the EIS and be consistent with the EPA Guideline 'Preparing an Environmental Management Overview Strategy for non-standard mining projects'.	EM Plan (Section 21)
	• control actions in accordance with agreed performance criteria for specified acceptable levels of environmental harm.	EM Plan (Section 21) - Section 3
	• identify:	
	– potential impacts on environmental values	EM Plan (Section 21) - Section 3
	– mitigation strategies	EM Plan (Section 21) - Section 3
	– relevant monitoring	EM Plan (Section 21) - Section 3 and 4.2
	– appropriate indicators and performance criteria	EM Plan (Section 21) - Section 3
	– reporting requirements	EM Plan (Section 21) - Section 4.3
	– appropriate corrective actions, should an undesirable impact or unforeseen level of impact occur	EM Plan (Section 21) - Section 3
	– the recording of and response to complaints.	EM Plan (Section 21) - Section 3.2
9	**Conclusions and Recommendations**	
	The EIS should make conclusions and recommendations with respect to the project based on the studies presented, the EMP and conformity of the project with legislative and policy requirements	Conclusions and recommendations included in relevant sections of EIS. Therefore a separate section on conclusions an recommendations will [illegible]
10	**References**	References

ToR Section and Requirement		EIS Section
11	**Recommended Appendices**	
11.1	**Final TOR for this EIS**	Appendix 1B and Appendix 1C
11.2	**TOR Cross-Reference Table**	Appendix 1D
11.3	**Development Approvals**	1.9
11.4	**EPBC Report**	Section 22
11.5	**Consultation Report**	Section 15
	The EIS should include:	
	• a list of advisory agencies should be provided in a summary consultation report, which should also list the federal, state and local government agencies consulted, and the individuals and groups of stakeholders consulted;	Tables 15-1 to Table 15-10 (in Section 15)
	• a summary of the issues raised by these groups, and the means by which the issues have been addressed, should be provided in the text of the EIS;	15.2, 15.3
	• a summary of the results of the community consultation program, providing a summary of the groups and individuals consulted, the issues raised, and the means by which the issues were addressed;	15.2, Tables 15-1 to 15-10, 15.3
	• the methodology used in the community consultation program including criteria for identifying stakeholders and the communication methods used; and	15.1
	• information about identifying affected parties (as defined by the EPBC Act) and interested and/or affected persons (as defined by the EP Act).	15.1.1
11.6	**Study Team**	Appendix 1E
11.7	**Glossary of Terms**	"Definitions, abbreviations and units" section
11.8	**Specialist Studies**	All specialist studies were prepared as discrete sections of this EIS. Therefore there are no separate specialist studies to be incorporated into the appendices.
11.9	**Corporate Environmental Policy**	Appendix 1A
11.1	**List of Proponent Commitments**	Appendix 1F

APPENDIX 1E

EIS STUDY TEAM

Section No.	Section Name	Study Component	Team Member Name and Company	Qualifications and experience
All	All	All (Review and Quality Assurance)	▪ Alan Irving, Rio Tinto Technology & Innovation (T&I) ▪ Tina Girard, T&I ▪ Fiona Talbot, T&I ▪ Alexandra Mayes, T&I ▪ Robyn Mountford, RTA	▪ B.For.Sc., M.Ag.Sc; 25 yrs ▪ B.Sc. (Nat Res Mgt), 11 yrs ▪ B.Sc. (Res Env Mgt), Grad Cert Sc. Comm, 12 yrs ▪ B.AppSc. (Env Res Mgt) ; 11 yrs ▪ B.Nat.Res (Hons), M.Res.Sc; 15 yrs
	Executive Summary	All	▪ Robyn Mountford, T&I	▪ B.Nat.Res (Hons), M.Res.Sc; 14 yrs
	Introduction	All	▪ Alan Irving, T&I	▪ B.For.Sc., M.Ag.Sc; 25 yrs
	Project Description	All	▪ Tina Girard, T&I ▪ Alan Irving, T&I	▪ B.Sc. (Nat Res Mgt), 11 yrs ▪ B.For.Sc., M.Ag.Sc; 25 yrs
	Land Resources	All	▪ Robyn Mountford, RTA	▪ B.Nat.Res (Hons), M.Res.Sc; 15 yrs
	Climate	All	▪ Fiona Talbot, T&I	▪ B.Sc. (Res Env Mgt), Grad Cert Sc. Comm, 12 yrs
	Water Resources	Artesian Aquifer	▪ Ewan Wilson, Golder Associates ▪ Nigel Moon, Golder	▪ BScEng, PhD, 29 yrs ▪ BEng (Env.), 5 yrs
		Shallow Aquifer	▪ Ewan Wilson, Golder Associates ▪ Nigel Moon, Golder ▪ David Whiting, Golder	▪ BScEng, PhD, 29 yrs ▪ BEng (Env.), 5 yrs ▪ BAppSci(Hons), MSc, 14 yrs
		Hydrology/Water Balance	▪ Scott Weeks, Golder ▪ Andrew Davison ▪ David Whiting, Golder	▪ BSc(Hons), PhD, 13 yrs ▪ BSc, CEP, 17 yrs ▪ BAppSci(Hons), MSc, 14 yrs
		Stream Geomorphology	▪ Ben Pearson, Hydrobiology	▪ B. App. Sc. (Tropical Env Mgt & Geog) (Hons), Ph.D. (awaiting examination)
		Surface Water Quality	▪ Dr. Ross Smith, Hydrobiology	▪ B. Sc (Marine Biology & Zoology) (Hons), PhD (Zoology) ▪ B.Sc. (Nat Res Mgt), 11

Section No.	Section Name	Study Component	Team Member Name and Company	Qualifications and experience
			▪ Tina Girard, T&I	yrs
		Water Management	▪ Alan Irving, T&I	▪ B.For.Sc., M.Ag.Sc; 25 yrs
	Marine	All	▪ John Kennedy, Worley Parsons	▪ M.Sc., 19 yrs
		Marine Flora and Fauna	▪ Daryl McPhee, Worley Parsons	▪ Ph.D., 14 yrs.
		Water Quality	▪ Tom Koskela, Worley Parsons	▪ B. App. Sci., 12 yrs.
			▪ Daniel Collins, Worley Parsons	▪ B.Sc. (Hons.), 9 yrs.
		Sediment Charactarisation	▪ John Kennedy, Worley Parsons	▪ M.Sc., 19 yrs.
			▪ Vivian Seto, Worley Parsons	▪ B.Sc., 5 yrs.
		Physical environment and coastal processes (including sediment plume modelling)	▪ Stephen Victory, Worley Parsons	▪ B.E. (Civil) 27 yrs.
			▪ Mathew Barnes, Worley Parsons	▪ Ph.D, 2 yrs.
	Terrestrial Flora and Fauna	All	▪ Morgan Thomas, Ecotone Environmental Services	▪ B. Nat Res, 19yrs
		All	▪ Jason Searle, Ecotone Environmental Services	▪ M. Urban & Regional Planning, B. Sc. (Biological Science) (Hons), 17yrs
		All	▪ Garry Thomas, Ecotone Environmental Services	▪ B. Sc.
		Flora Survey and Assessment	▪ Bryan Robinson, Queensland Fauna Consultancy	▪ 12yrs
		Fauna Survey and Assessment	▪ Stephanie Goebel, Queensland Fauna Consultancy	▪ B. App. Sc (Wildlife Biology)(Hons)
	Freshwater Aquatic Ecosystems	All	▪ Morgan Thomas, Ecotone	▪ B. Nat Res, 19yrs
		All	▪ Dr. Ross Smith, Hydrobiology	▪ B. Sc (Marine Biology and Zoology) (Hons), PhD (Zoology)
		All	▪ Jim Tait, Econcern	▪ B. Sc (Zoology & Geography) (Hons), 24 yrs

Section No.	Section Name	Study Component	Team Member Name and Company	Qualifications and experience
		All	▪ Michelle Hobbs, Hydrobiology	▪ B. Marine Studies (Hons), 7 yrs
		Aquatic Biology Survey and Assessment	▪ James Shelley, Hydrobiology	▪ B. Sc. (Marine Biology), 3 yrs
		Surface Water Quality	▪ Ben Pearson, Hydrobiology	▪ B. App. Sc. (Tropical Env Mgt & Geog) (Hons), Ph.D. (awaiting examination)
	Air Quality	Air Quality	▪ Mark Simpson, Noise Mapping Australia	▪ B. Eng. (Mechanical), 25 yrs
		Greenhouse Gas Emissions	▪ Tina Girard, T&I	▪ B.Sc. (Nat Res Mgt), 11 yrs
	Noise and Vibration	All	▪ Mark Simpson, Noise Mapping Australia	▪ B. Eng. (Mechanical), 25 yrs
			▪ Michael Caley, Savery and Associates	▪ Adv Marine Acoustics Coursework, M.E (Research), B.E (Hons) (Mechanical); 16 yrs
	Cultural Heritage	All	▪ Justin Shiner, RTA	▪ Ph.D (Anthropology), 10 yrs
		Non-Indigenous cultural heritage	▪ Stuart Huys, Australian Archaeological Survey Consultants	▪ B.A. (Hons), 17yrs
	Visual	All	▪ Tina Girard, T&I	▪ B.Sc. (Nat Res Mgt), 11 yrs
	Waste Management	All	▪ Fiona Talbot, T&I	▪ B.Sc. (Res Env Mgt), Grad Cert Sc. Comm, 12 yrs
	Transport	▪ Road	▪ Mac Hulbert, Halcrow	▪ Assoc.Dip. (Civil), B.Tech. (Civil), MIEAust, RPEQ, 17 yrs
		▪ Road	▪ Trish Robertson, Halcrow	▪ B.Eng. (Civil), AITPM, MIEAust, 5 yrs
		▪ Rail, Air, Sea	▪ Fiona Talbot, T&I	▪ B.Sc. (Res Env Mgt), Grad Cert Sc. Comm, 12 yrs
	Community Consultation	All	▪ Geraldine McGuire, Sustainable Solutions	▪ B.Ag.Sc., PhD Ag.Sc., GradDipEd, 16yrs
		All	▪ Ben Laidlaw, RTA	▪ BEd (Phys Ed), 4 yrs
		All	▪ Michelle Fulcher, Commercial Dispute Resolution International	▪ BA.Hons(Sociology), MA (Anthropology), PhD Anthropology, 25 yrs
	Social Impact Assessment	All	▪ Ben Laidlaw, RTA	▪ BEd (Phys Ed), 4 yrs

Section No.	Section Name	Study Component	Team Member Name and Company	Qualifications and experience
		▪ Socioeconomic data	▪ Sasha Lennon, SGS Economics and Planning	▪ B.Ec, Grad Dip. Advanced Ec., 16 yrs
		▪ Impacts	▪ Geraldine McGuire, Sustainable Solutions	▪ B.Ag.Sc., PhD Ag.Sc., GradDipEd, 16yrs
		All	▪ Michelle Fulcher, Commercial Dispute Resolution International	▪ BA.Hons(Sociology), MA (Anthropology), PhD Anthropology, 25 yrs
		▪ Review	▪ Alan Irving, T&I	▪ B.For.Sc., M.Ag.Sc, 25 yrs
	Economics	▪ Economic Impacts	▪ Sasha Lennon, SGS Economics and Planning	▪ B.Ec, Grad Dip. Advanced Ec. (La Trobe), 16 yrs
		▪ Economic Impacts	▪ Mark Donaldson, SGS Economics and Planning	▪ B.Econ (Quant Methods), 1-2yrs
		▪ Mitigation Measures	▪ Ben Laidlaw, RTA	▪ BEd (Phys Ed), 4 yrs
		▪ Sustainable Development	▪ Fiona Talbot, T&I	▪ B.Sc. (Res Env Mgt), Grad Cert Sc. Comm, 12 yrs
	Health and Safety	All	▪ Fiona Talbot, T&I	▪ B.Sc. (Res Env Mgt), Grad Cert Sc. Comm, 12 yrs
	Hazard and Risk	All	▪ Fiona Talbot, T&I	▪ B.Sc. (Res Env Mgt), Grad Cert Sc. Comm, 12 yrs
	Cumulative Impacts	All (collated from other section)	▪ Robyn Mountford, RTA	▪ B.Nat.Res (Hons), M.Res.Sc., 15 yrs
	EM Plan	All	▪ Fiona Talbot, T&I	▪ B.Sc. (Res Env Mgt), Grad Cert Sc. Comm, 12 yrs
			▪ Robyn Mountford, RTA	▪ B.Nat.Res (Hons), M.Res.Sc., 15 yrs
	Figures	Maps and Diagrams	▪ Ian Hubbard, Resource Exploration Mapping	▪ B.App.Sc Cartography (QUT), GradDip Computing (Monash), 17 yrs

APPENDIX 1F

SUMMARY OF COMMITMENTS

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Section 2 – Project Description

2.1 RTA will design the port and stockpile configuration to allow the option to ship product from third parties, subject to commercial agreement with RTA.

Section 3 – Land

3.1 In collaboration with Traditional Owners, RTA will develop a land access strategy to manage access for Traditional Owners to specific areas (including Hey Point, Boyd Bay, Pera Head, Amban, Norman Creek, Waterfall and Six Ti-Tree) in accordance with its obligations outlined within the Western Cape Communities Co-existence Agreement (WCCCA). This will be monitored on a regular basis in line with the mine plan, safety requirements and the needs of Traditional Owners of the Project area during construction, operational and non-active mining phases.

3.2 RTA will work with Traditional Owners and other relevant stakeholders to develop an effective permit system to protect significant cultural heritage sites and environmental values and allow controlled access for recreational purposes. The administration of such a system by Traditional Owners would be subject to discussions between Traditional Owners, RTA and other stakeholders.

3.3 The economic bauxite reserves from the Boyd tailings storage facility and the Norman Creek tailings storage facility will be mined before tailings are deposited so as not to sterilise economic reserves.

3.4 The following proposed erosion and sediment control measures will be employed throughout the life of the Project:

- Restrict clearing to areas essential for mining and associated facilities.
- Vegetation clearing and topsoil stripping will occur following the wet season where possible.
- Backfilled pits will be revegetated as soon as is practicable.
- In the event that active or backfilled pits are not fully internally draining, storm water runoff will be directed via a sediment pond.
- Disturbed areas around construction sites will be rehabilitated promptly.
- Sediment traps will be included as part of the drainage designs at points where haul roads cross watercourses.

3.5 An erosion monitoring procedure will be developed and implemented for the Project.

3.6 RTA has commitments under the WCCCA to surrender parts of the mining lease after their rehabilitation. Such surrendering of parts of the mining lease will be undertaken where it is practical to do so, and will be subject to Government approvals.

3.7 Consultation regarding rehabilitation and post-mining land use will continue to be undertaken with the Traditional Owners and the relevant Western Cape Communities Coordinating Committee (WCCCC) sub-committee.

3.8 RTA will jointly develop a rehabilitation process with the Traditional Owners and relevant WCCCC Sub-committee prior to the commencement of mining. RTA will also consult regarding time lines for development of rehabilitated land completion criteria aiming to have these within three years of commencement of mining. RTA will continue to report annually to the relevant WCCCC sub-committee on rehabilitation programs

3.9 The final landform will not have any out of pit dumps of excavated overburden or soil.

3.10 The tailings storage facility embankments and surface will be revegetated after decommissioning and minor earthworks are undertaken to install suitable water management features.

3.11 Rehabilitation will commence progressively as areas become available and in accordance with the Plan of Operations. The Plan of Operations will be provided to the relevant WCCCC Sub-committee in accordance with the WCCCA.

3.12 A detailed operational rehabilitation procedure, including a quality assurance process, will be developed and implemented. Procedures for topsoil stripping, stockpiling and placement activities, including a quality assurance process will be included in the site rehabilitation procedure.

3.13 Soil will be stripped and directly placed on mined out areas in readiness for regeneration, where possible, or otherwise stockpiled.

3.14 Any soil stockpiled for more than one year will be sown with a native local seed mix to control weeds and erosion.

3.15 Native species seed mixes would be tailored to the anticipated post-mining conditions of the area to be rehabilitated.

3.16 Preliminary rehabilitation success criteria for the Project area will be developed within three years of commencement of bauxite mining.

3.17 On-site revegetation trials will be undertaken to test selected species, seeding rates and establishment methodologies.

3.18 Any controlled burning of rehabilitation will be accompanied by a monitoring program including a pre- and post-burn vegetation survey, fuel load estimations and fire intensity calculations, and spatial data of burnt areas and degree of vegetation removal, including canopy scorch. The impacts of both controlled burning and wildfire on rehabilitation areas will be monitored.

3.19 A Final Rehabilitation Report, which includes a contaminated site assessment, will be prepared prior to surrender of the Mining Lease.

3.20 A contaminated site register will be maintained for the operation.

3.21 Any contaminated sites will be managed using methods developed on a case by case basis in accordance with DERM guidelines.

3.22 On the completion of mining, subject to agreement with relevant regulators and Traditional Owners, the barge/ferry terminals, port, water storage dams and certain roads may be left in place. Otherwise, RTA shall remove these facilities.

3.23 RTA will jointly develop an initial mine closure plan with the Traditional Owners and relevant WCCCC Sub-committee prior to the commencement of mining and update this plan every five years.

3.24 RTA will provide Traditional Owners with the opportunity to purchase decommissioned construction camp accommodation once the construction phase is complete

Section 4 – Climate

4.1 The proposed port has been designed to 1:500 year ARI maximum breaking wave height. On-shore product stockpile pad levels will also be above this level.

4.2 The proposed Humbug RORO barge terminal, Hornibrook ferry terminal, and Hey River barge/ferry terminal have fixed facilities designed to at least the Highest Astronomical Tide level. Floating pontoons and ramps have been designed to move down to Lowest Astronomical Tide level and up to a level higher than the 1:100 year ARI level. The facilities will incorporate foreshore protection designed to withstand water levels in excess of the 1:200 year ARI level. Car parking access for the ferry terminals are above the 1:100 year ARI level.

4.3 RTA will adopt best practice safety design for major infrastructure to minimise impact caused by extreme events.

4.4 The RTA Cyclone Emergency Procedure will be updated as required for the Project area.

Section 5 – Water Resources

5.1 Land-based infrastructure will be designed to appropriate criteria for storms (the current criteria are shown in tables below.)

Relevant Infrastructure	Flood Design Criteria (ARI)
Mine Infrastructure Areas	1:100yr
Mine Access Road	>300mm over top once in 10yr
Creek crossings for conveyor and for water pipelines	1:100yr
Water Storage Dam – spillway	1:2,000 yr

Tailings Storage Facility Design Criteria

Location	Design Storage Allowance	Spillway Critical Design Storm	Mandatory Reporting Level
Boyd Tailings Storage Facility	0.02 AEP, 2 month wet season plus other inputs for the 2 month wet season, to be available on 1st November each year	0.001 AEP	72 hour 0.01 AEP
Norman Creek Tailings Storage Facility	0.02 AEP, 2 month wet season plus other inputs for the 2 month wet season, to be available on 1st November each year	0.001 AEP	72 hour 0.01 AEP

AEP = Average Exceedance Probability

5.2 RTA will continue to extract water from the artesian aquifer in accordance with existing Water Act licence conditions. These include restricting drawdown at designated monitoring bores.

5.3 A network of shallow groundwater bores will be maintained. Water levels will be measured manually on a monthly basis (subject to site access).

5.4 Ongoing monitoring of geomorphic assessment sites in Norman Creek will be conducted. In addition, baseline monitoring sites will be established in the Ward River.

5.5 Stream flow gauging stations will be used to monitor stream flows upstream and downstream of Dams C, as well as two Norman Creek sub-catchments (one to be mined and one non-mined).

5.6 Stormwater runoff from product stockpiles will be directed to sediment ponds sized to a volume equivalent to the runoff volume from a 1:10 ARI 24 hour rainfall event, plus 20% for sediment storage.

5.7 Water from the heavy and light vehicle wash bays will be treated in oil water separators prior to recycling.

5.8 Dam C spillways will be at a low gradient and be designed to facilitate fish passage during spillway flow events. RTA will collaborate with Traditional Owners and the Department of Employment, Economic Development and Innovation (DEEDI) (Fisheries Services) to ensure the most appropriate and best final design is selected for the circumstances.

5.9 Relevant aspects of the Engineering Guidelines for Queensland for Soil Erosion and Sediment Control will be followed.

5.10 Dam C water storage dam will be fitted with a low level outlet pipe which will permit the controlled release of environmental flows when required. Sufficient water will be reserved for environmental flows to enable continued release in the driest months (August to October) of up to 25% of dam inflows. The release pipe will be sized to enable peak discharge of up to 1,000L/s, if required. When dam inflows cease, environmental flow releases will cease. If environmental flow releases are required during the wet season, they will commence after the dams are full. These criteria will be subject to change based on operation experience and the results of monitoring.

5.11 The annual volume of water pumped from the Ward River will be capped at 1% of mean annual river flow at the pump station (2.67GL). In additional, no pumping will occur when Ward River flow is less than 1,000L/s and the rate of pumping at all times will be less than 20% of the river flow rate.

5.12 A surface water monitoring program is proposed to provide an early indicator of potential impacts. Locations will be monitored monthly until a statistical baseline is established (consistent with ANZECC requirements) and then quarterly thereafter. Project-specific trigger values will be developed for key water quality parameters.

5.13 Quarterly vertical salinity profiling of Norman Creek upper estuary is proposed to evaluate if the Project has had any impact on the fresh/salt water interface.

Section 6 – Marine

6.1 All vessels owned and contracted by Rio Tinto will manage ballast water through a Ballast Water Management Plan which will comply with Australian mandatory requirements and the *International Convention for the Control and Management of Ships Ballast Water and Sediments.*

6.2 There will be no hull cleaning at the proposed port.

6.3 RTA will undertake regular mussel trap monitoring in the vicinity of the new port when overseas ships are used.

6.4 RTA will designate a safe passage underneath the proposed jetty for small recreational and charter boat users to prevent the need to travel around the wharf and jetty, in accordance with Maritime Safety Queensland (MSQ) requirements.

6.5 For Port area capital dredging, monitoring of turbidity, deposition, and Photosynthetically Active Radiation shall be undertaken at Boyd Point, Pera Head and Thud Point reef areas and at a control location beyond the modelled turbid plume. Monitoring would begin a month prior to dredging and extend until two months after the completion of dredging. Fixed point photo-quadrat monitoring shall be undertaken of hard coral reefs at Boyd Point, Pera Head and reefs south of Thud Point. Should signs of unacceptable coral stress become apparent, opportunities for manipulation of dredging operations would be reviewed (e.g. located to offshore in the departure channel to allow corals a period of respite and return to more favourable light conditions).

6.6 RTA will develop a Dredge Management Plan which will include:

- validation of plume dispersion modelling predictions (first six to eight weeks);
- marine water quality monitoring (loggers – TSS, light (PAR) and deposition); and
- coral health monitoring (fixed impact and control sites).

A monitoring response protocol, including management triggers, will be developed as part of the Dredge Management Plan.

6.7 RTA will ensure that, before beginning Trailing Suction Hopper Dredging and dumping activities during daylight hours, a check will be undertaken, using binoculars from a high observation platform, for Dugongs and whales within a monitoring zone (approximately 300 metres of any point on the dredging/dumping run about to be commenced). If any Dugong or whales are

sighted in the monitoring zone, dredging/dumping activities will not commence until after the last Dugong or whale is observed to leave the monitoring zone; or alternatively the dredge will to move to another area of the dredge or disposal site to maintain a minimum distance of approximately 300 metres between the vessel and any Dugong or whale. Any injury or death of a Dugong or cetacean from dredging would be documented and reported within 24 hours of the incident to DERM and DSEWPaC and further monitoring and/or management requirements discussed.

6.8 No fuel or chemicals will be unloaded at the proposed port facilities.

6.9 RTA will work with Traditional Owners and the relevant WCCCC Sub-committee on design principles for port lighting. Monitoring, review and evaluation of port lighting will be included as part of the Community, Heritage and Environmental Management Plan (CHEMP) development.

6.10 RTA will implement a lighting plan at the port to mitigate the potential effects of lighting on sea turtle hatchlings. RTA will work with the Department of Environment and Resource Management (DERM) through an adaptive approach to minimise the impacts of changes to the light regime during both the construction and operation phases of the proposed port on marine turtles, while still allowing a safe working environment. The following factors will be considered:

- ensuring lighting is minimised overall to that which is essential for safe and efficient operation of the facility;
- installation of timer switches or movement sensors where applicable;
- shielding and/or recessing of lights to minimise light spill;
- installation of long wavelength lights; and,
- any other lighting options that further reduce impacts to marine turtles while allowing for the safe and efficient operation of the port facility ensuring lighting is minimised overall to that which is essential for safe and efficient operation of the port facility

6.11 RTA will work with DERM to reduce threats to marine turtles in the Project area and assist with marine turtle research programs.

6.12 RTA will document any strandings of marine turtles (e.g. animals entangled in ghost nets) and report these to DERM for inclusion in the Wildlife Stranding database and remove ghost nets from beaches adjacent to the port area.

6.13 RTA will work with Traditional Owners on a program to reduce feral pigs in the Pera Head to Boyd Point area.

6.14 A sea turtle monitoring program will be developed with consideration of turtle nesting activities (number, type, predation, success), behaviour (hatchling activity) and incident reporting.

6.15 Monitoring of infauna will be undertaken at the new spoil ground location following capital dredging at the proposed port.

6.16 Trigger levels for water quality parameters would be developed primarily as alerts for coral health reactive monitoring. These levels would be identified within a Dredge Management Plan.

6.17 Turbidity plume monitoring will be undertaken for spoil disposal from dredging activities. If monitoring determines that there are unacceptable impacts to Nine Mine Reef due to the turbidity plume associated with the spoil ground, then appropriate management measures would be developed and implemented in consultation with DSEWPaC.

Section 7 – Terrestrial Flora and Fauna

7.1 The following vegetation types will be protected from mining by an environmental buffer system; riparian, wetland, estuarine, vine forest and coastal vegetation on sand. The buffer system will meet or exceed the minimum requirements of the Queensland Government's Regional Vegetation Management Codes as they relate to clearing set-back distances from watercourses and wetlands.

RTA will work with Traditional Owners and the relevant WCCCC Sub-committee on establishment of environmental buffers as part of the CHEMP.

7.2 Surveys will be carried out to define the boundaries of mapped sensitive vegetation types in the field prior to disturbance.

7.3 Authorisation for clearing would be managed through a ground disturbance approval system.

7.4 A vegetation monitoring program will be developed and implemented to assess mining impacts. The monitoring program will include monitoring sites in representative areas of sensitive vegetation units adjacent to and downstream of mining areas, as well as control sites away from mining and infrastructure areas. Monitoring would be undertaken periodically and specimens will be collected for herbarium identification if the plant cannot be identified.

7.5 A weed management program will be developed and implemented prior to commencement of construction, and will include weed surveys annually (post wet season) targeting operational areas and site access. The weed management program will be developed in cooperation with Traditional Owners and the relevant WCCCC Sub-committee as part of the CHEMP.

7.6 A fire management program will be developed in cooperation with Traditional Owners and the relevant WCCCC Sub-committee as part of the CHEMP

7.7 RTA will work with Traditional Owners on a program to reduce feral animals (focussing on feral pigs) between Boyd Point and Pera Head.

7.8 Clearing of vegetation for mining and infrastructure will be restricted to the minimum required for the safe operation of mining equipment and infrastructure.

7.10 Constructed access road crossings of Winda Winda Creek and the southern branch of Norman Creek will incorporate 'dry culvert' cells to maintain habitat continuity along the riparian corridor.

7.11 Surveys for Red Goshawk nests will be undertaken in parts of the mine plan and water supply dams located within 1km of permanent water supporting riparian gallery forest of Paperbark wetland, seasonally inundated Paperbark wetlands, seasonal water courses supporting riparian gallery forest, or an estuary.

If any active Red Goshawk nests are found within mining areas, a 200m buffer around the nesting tree would be excised from the mining plan until the end of the breeding season.

7.12 Targeted pre-clearing surveys will be undertaken to determine the presence of the Bare-rumped Sheathtail Bat within the Dam C disturbance area, and if present, disturbance of habitat trees would be avoided until after the breeding season (i.e. clearing to commence no earlier than May and be completed by end of November). If the species is present, all potential roost trees will also be identified within the Dam C disturbance area and pushed over in a manner that would allow any bats present to leave the roosts unharmed.

Section 8 – Aquatic Ecology

8.1 Aquatic ecology monitoring will include:

- Seasonal salinity regimes in upper Norman Creek estuarine reaches and their relationship to surface base flows, groundwater inflows and reach habitats (quarterly vertical salinity profiling and macrophyte community monitoring at upper estuary water quality sampling sites);
- Baseflow water quality in receiving reaches and their relationship to ambient dissolved oxygen levels, soluble aluminium, iron and manganese concentrations (at least quarterly water quality monitoring);
- Salt water/freshwater interface mapping will be undertaken downstream of Dam C. Mapping of representative vegetation ecotonal boundaries (e.g. sclerophyll, riparian/wetland/estuarine) from aerial photography to detect any long-term (decadal) shift, and surface water will be monitored for salinity; and

- Maintenance of aquatic faunal communities in receiving reaches and Dam C (fish and other aquatic fauna surveys on a 3-5 yearly frequency).

Section 9 – Air Quality

9.1 Conventional haul road watering will be undertaken.

9.2 Water sprays will be used at the chutes where trucks dump crude ore into the beneficiation plant. Water is used in the beneficiation to remove fine material from the bauxite.

9.3 Water sprays will also be used to clean the ship-loading conveyor belt which will reduce build-up of any fine material.

9.4 Energy use will be metered and an inventory of greenhouse gas emissions and sinks will be developed and maintained.

9.5 Regular energy audits will be conducted to identify inefficient equipment or operating procedures in order to assist with minimising greenhouse gas emissions.

Section 10 – Noise and Vibration

10.1 Baseline noise monitoring will be undertaken at Napranum prior to the commencement of construction. A noise monitoring campaign, including attended monitoring at Napranum, will also be conducted after operation commences to validate the noise model.

10.2 It is proposed that an exclusion zone be established and monitored by an observer around pile driving activities and that a "soft start" approach be undertaken prior to normal pile driving. Normal pile driving would not be conducted while threatened marine fauna species are indentified within the nominated exclusion zone. The extent of the exclusion zone would be defined based on further literature review and quantitative analysis of the potential underwater noise impacts from pile driving relating to threatened marine fauna. The final extent of the exclusion zone would be defined in consultation with DSEWPaC.

Section 11 – Cultural Heritage

11.1 Further management work will be undertaken in accordance with the WCCCA process to fully assess the impact of the proposed Project on Aboriginal cultural heritage and development mitigation strategies where required. This will include progressive detailed surveys of all areas identified for future development which have not already been surveyed.

11.2 RTA will work with Traditional Owners and the WCCCC SoE Sub-Committee to develop a CHEMP. The CHEMP shall be developed as a long term strategy for the management of land access, fire, flora, and fauna, signage, feral animals, weeds, environmental buffer establishment and management, land and sea management, ballast water management, environmental monitoring and cultural heritage.

11.3 The CHEMP will include protocols for managing culturally sensitive information and procedures to manage the accidental discovery of cultural heritage materials, including human remains, in the Project area. These procedures will be developed in consultation with the Traditional Owners through the relevant WCCCC Sub-Committee and will comply with relevant requirements of the *Aboriginal Cultural Heritage Act 2003*. The procedure will take into consideration the DNRM (2005) guidelines on *The Discovery, Handling, and Management of Human Remains.*

11.4 RTA is committed to ensuring no impacts from mining on story places and to consult with Traditional Owners regarding their management.

11.5 Impacts on scarred trees and stone artefact scatters will be mitigated in consultation with Traditional Owners.

11.6 The Hey River barge/ferry terminal will be positioned to avoid large shell mound complexes. If any shell material is uncovered during construction works mitigation measures will be

developed through consultation with Traditional Owners and the relevant WCCCC Sub-committee.

11.7 RTA will take a proactive approach to the management of places of cultural significance and initiate discussions with the WCCCA and the Traditional Owners to establish separate heritage action plans for each location.

11.8 The dispute resolution process outlined in the WCCCA will apply if RTA, the Traditional Owners and the WCCCA representatives fail to negotiate a Site Protection Plan.

11.9 RTA will evaluate options to work collaboratively with WCCCA and Traditional Owners to develop a knowledge database of flora and fauna species of cultural significance in the region.

11.10 In the event that previously unidentified non-indigenous heritage sites are located within the Project area during the course of mining activity, an unanticipated discovery process would be implemented.

Section 12 – Visual Amenity

12.1 Where possible, the port approach jetty, wharf and ship loaders would be painted in a colour that minimises visual impacts, while adhering to marine safety standards.

12.2 Lighting at the barge/ferry terminals will be designed to minimise nuisance lighting (e.g. shielding, low pressure sodium lighting)

Section 13 – Waste Management

13.1 Waste streams will be assessed regularly for potential reuse and if a feasible reuse option is not available the waste will be transported to a licensed disposal facility by a licensed waste transporter.

13.2 RTA will consult with the relevant WCCCC Sub-committee about waste management strategies for the Project.

13.3 Wastes will be separated to allow for recovery where feasible, and will be stored appropriately to prevent pollution until they are transferred off-site.

13.4 The sewage treatment plants will be designed and operated to treat water to meet Class A Recycled Water quality. Treated effluent will be recycled on-site.

13.5 All vessels owned and contracted by Rio Tinto will manage ballast water through a Ballast Water Management Plan which will comply with mandatory requirements.

Section 14 – Transport

14.1 The PDR/Hornibrook ferry terminal intersection will be upgraded.

14.2 The Kerr Point Road/Humbug barge terminal intersection will be upgraded.

14.3 Materials will be brought in via the Aurukun Road only when the road is declared open by the Police and Department of Transport (i.e. not during wet season closures).

14.4 RTA will monitor the road condition and repair any damage to the PDR or Aurukun Road resulting directly from project-related haulage, but will not be responsible for general wear and tear from normal use. RTA will consult with Aurukun Shire Council to develop a suitable monitoring approach.

14.5 Navigational aids will be installed for the proposed port in accordance with MSQ requirements.

Section 15 – Consultation

15.1 The EIS consultation and engagement program will continue throughout the EIS process.

15.2 The WCCCC and relevant WCCCC Sub-Committees will continue to provide the consultative mechanism for ongoing consultation and engagement with Traditional Owners.

15.3 A program of consultation will be undertaken by RTA to address community issues as the Project progresses.

15.4 Interaction with stakeholders who have already been consulted as part of the Project planning phase will continue over the remainder of the of the EIS process and throughout the construction and operational phases.

Section 16 – Social Impact Assessment

16.1 RTA proposes to restrict access to the barge, ferry and Mine Access Road to persons and vehicles entering the Project area for the purpose of authorised mine-related business. The control points will be at the Humbug barge terminal, Hornibrook ferry terminal and Hey River barge/ferry terminal. Security measures will be implemented at each terminal.

16.2 Signage will be installed to ensure that the public is informed about the restricted usage of the terminals, controls on alcohol, and the restricted access to the Mine Access Road. Signage will be installed along access tracks on the eastern boundary of the mining lease restricting access to active mining areas to authorised Project personnel and restricting access to other on-lease areas to persons with appropriate permits.

16.3 RTA will continue to work collaboratively with WCCCA on future requests for outstation development.

16.4 RTA will designate a safe passage underneath the proposed jetty for small recreational and charter boat users to prevent the need to travel around the wharf and jetty, in accordance with MSQ requirements.

16.5 Access to moorings at Boyd Bay will not be restricted.

16.6 The WCCCC SoE Sub-Committee would provide the primary consultation mechanism for development of the CHEMP. The final CHEMP would be endorsed by the WCCCC prior to implementation.

16.7 As part of the CHEMP, RTA will work with Traditional Owners, Western Cape Communities Trust (WCCT) and other key stakeholders to establish a program to support caring for land and sea, including assistance with the development and implementation of a ranger program and a permit system for the Project area.

16.8 The CHEMP will provide details of buffer zones and land management strategies for Waterfall (Ina Creek), False Pera Head (Amban), Pera Head and Boyd Bay.

16.9 A comprehensive stakeholder engagement plan for ongoing consultation and engagement will be developed prior to the commencement of construction.

16.10 Progress reports and forward looking plans on all activities associated with the Project, including heritage surveys and development of management plans, Traditional Owner consultation and engagement activities, drilling programs and ongoing environmental work, will be submitted for consideration at least quarterly to the WCCCC SoE Sub-Committee. Formal recommendations will be forwarded to the WCCCC for endorsement prior to implementation.

16.11 RTA will support Traditional Owner initiatives which provide greater recognition of traditional connections to the land south of the Embley River and will work collaboratively with the WCCT and Traditional Owners to develop and implement these initiatives.

16.12 RTA will facilitate the provision of access and transport for Traditional Owners living in Aurukun and working in the mine. RTA will work with the WCCCC E&T Sub-Committee to identify opportunities for training and employment for residents of Aurukun and ways to provide appropriate access to the mine site and where appropriate engage with other local

stakeholders regarding impacts and opportunities associated with improved access to the Project area.

16.13 RTA will continue to work with the local communities to invest in employment and training to create a locally-based labour pool with the appropriate skill sets and knowledge to meet the particular employment needs of the Project, in accordance with the WCCCA.

16.14 RTA will continue initiatives targeting pre-work development employment and training for local Indigenous people. As part of the Project RTA will:

- continue to actively participate as a member of the Regional Partnership Agreement (RPA) Steering Committee, WCCCC and Ely Coordinating Committee to develop and implement pre-employment and job-readiness programs to support local Indigenous employment across the Western Cape region;
- develop and implement culturally appropriate recruitment practices for positions at all levels and across various disciplines within the operations;
- develop and implement programs and services to support the retention of Indigenous employees including mentoring, employee and family support strategies that aim to address the root causes of socio-economic disadvantage;
- develop and implement long-term career planning strategies, including professional development and leadership programs for local Indigenous employees;
- in collaboration with Traditional Owners, continue to deliver cross-cultural awareness programs for all employees and contractors, including curriculum with specific reference with Wik and Wik Way traditional culture and values;
- proactively consider tenders for Project contracts which involve local Indigenous people and/or local Indigenous enterprises. This may include joint ventures, direct employment, training opportunities, equipment usage or cooperative arrangements with local Indigenous people and enterprises; and
- provide a supportive career development pathway for local Indigenous people and youth, including traineeships and apprenticeships across a range of disciplines during the construction and operational phases of the Project.

16.15 As part of the Project, RTA will continue to work in partnership with the Western Cape College to provide supportive school-to-work pathways and effective case management for students looking to pursue careers at all levels in the mining industry. Where possible, RTA will also support initiatives to enhance educational outcomes for Western Cape College students. This includes the delivery of work experience programs, school-based traineeships, curriculum support, support for academic awards, career talks, university scholarships and development of curricula relevant to the mining industry.

16.16 As part of the Project, RTA will continue to support the implementation of the Rio Tinto Graduate Program with the aim of developing future leaders in both management and technical streams by providing experience at RTA operations in addition to structured learning and development received during university studies.

16.17 RTA proposes to address any potential skills shortages and labour impacts in the region by working collaboratively with various State and Commonwealth Government agencies, regional stakeholders (including TAFE and other training and education providers) and job network provider to build a locally based skilled labour pool for construction and operational phases of the Project.

16.18 RTA will implement strict policies for employees and contractors in relation to fitness for work, including alcohol and other drugs, with strict pre employment medical programs and an ongoing random drug and alcohol testing regime.

16.19 RTA will continue to support the implementation of alcohol management plans for each community, with inclusion of this information in employee and contractor induction programs.

16.20 RTA will continue to liaise with Queensland Police Service and other Government agencies to develop strategies to ensure an effective response to incidents and to raise awareness of regional law and order and alcohol management initiatives.

16.21 RTA will reinforce the required code of conduct for employees and contractors on the mining leases and emphasise need for appropriate behaviour at all times.

16.22 Inductions will be adapted to raise awareness of regional alcohol management initiatives and land access requirements.

16.23 Ongoing consultation with Traditional Owners will be undertaken to investigate potential post-mining land uses associated with dams.

16.24 RTA will consult with Traditional Owners to explore ways for ongoing involvement in environmental monitoring, biological surveys and management of dams during operations.

16.25 In order to continue supporting the development of Indigenous businesses in the Western Cape, particularly as it relates to the Project, RTA will:

- continue to work collaboratively with key regional stakeholders, including the WCCT, Western Cape Chamber of Commerce and the RPA Steering Committee to identify and support the ongoing development of Indigenous businesses through the region;
- examine applicable contracts for local and Indigenous business opportunities, including the breakdown of larger contracts into smaller jobs to increase the potential opportunities for awarding contracts to local providers of goods and services;
- work collaboratively with the WCCT and Traditional Owners to identify and pursue social, commercial and economic development opportunities associated with the Project;
- provide updates to the WCCT on the status of Indigenous business spending across the RTA Weipa operations in line with RTA's existing reporting requirements for employment and training; and
- in collaboration with key local and regional stakeholders, RTA will identify opportunities to support and implementation of a range of business development programs and support services.

16.26 RTA supports the establishment of a timber harvest operation south of the Embley River that would harvest timber on areas of the mining lease proposed to be mined, or cleared for development of Project infrastructure in a manner that does not impede development work.

16.27 RTA, through its membership of the Western Cape Chamber of Commerce, will continue to monitor the impact of its activities on local businesses and work with businesses to address concerns, where possible.

16.28 Local businesses will be provided with relevant information on future opportunities that arise from RTA's proposed development activities.

16.29 The Humbug barge terminal shall be designed to minimise interference with the adjacent live cattle export facility.

16.30 A licensed wet mess will be available in the construction camp for the responsible service of alcohol to camp occupants only. The consumption of alcohol will be regulated and confined to the wet mess and designated areas within the camp. Alcohol will not be allowed to be taken outside the camp.

16.30 Any activities outside the camp will be controlled via a permit system developed in collaboration with Traditional Owners in order to minimise any potentially adverse impacts on the places or environmental and cultural heritage significance.

16.31 RTA, in liaison with other adjacent project proponents, will endeavour to identify cumulative impacts and opportunities associated with employment, training and business development for the local communities. RTA will seek to co-ordinate its' programs with others, including

government programs and services currently being implemented in the region and, where appropriate, will partner with the relevant Government agencies.

Section 17 – Economics

17.1 RTA's current obligations under WCCCA related to the Weipa operations will also apply to the Project, these commitments include:

- proactively consider tenders which involve local Indigenous people and/or local Indigenous enterprises;
- work collaboratively with key regional stakeholders, including the WCCT, Western Cape Chamber of Commerce and the RPA Steering Committee to identify and support the ongoing development of Indigenous and non-Indigenous businesses;
- examine applicable contracts for local and Indigenous business opportunities, including the breakdown of larger contracts to smaller jobs to increase the potential opportunities for awarding contracts to local providers of goods and services;
- provide updates to the WCCT on the status of Indigenous business spending across the RTA Weipa operations in line with RTA's existing reporting requirements for employment and training;
- in collaboration with key local and regional stakeholders, RTA will identify opportunities to support the implementation of a range of business development programs and support services;
- initiatives targeting pre-work development, employment and training for local Indigenous people;
- continuation of partnership with the Western Cape College to provide supportive school-to-work pathways and effective case management for students looking to pursue careers at all levels in the mining industry; and
- continuation of support the implementation of the Rio Tinto Graduate Program.

17.2 RTA will work with WTA to develop additional subdivisions as required to allow for the construction of additional houses.

17.3 RTA will work with Weipa Town Authority to expand the town boundary and develop industrial lots if required.

Section 18 – Health and Safety

18.1 RTA will implement the existing CLASSIC Health Safety and Environment (HSE) Management System as part of the Project (RTA Weipa's existing integrated HSE Management System is known as CLASSIC)

18.2 Rio Tinto Marine, as operators of the Port, will implement their existing MarineSafe system.

18.3 Control programs for disease vectors such as rats, mosquitoes and other insects will be undertaken on a regular basis by a licensed Pest Control Technician.

18.4 Water storages and other impoundments of water constructed on the Project site will be greater than 60cm deep and not conductive to mosquito breeding, in accordance with the Queensland Health *Guidelines to minimise mosquito and biting midge problems in new development areas.*

18.5 RTA will regularly monitor potable water quality to ensure compliance with the *Australian Drinking Water Guidelines.*

18.6 Recycled water will be managed in accordance with the *Water Supply (Safety and Reliability) Act 2008* and relevant environmental and health regulatory guidelines. This will include

monitoring to ensure water quality meets the DNRW (2008) *Water quality guidelines for recycled water schemes.*

18.7 Clinical waste will be segregated and disposed of at the Evans Landing Landfill (in accordance with the existing Licence).

18.8 Regular testing for Legionella bacteria at at-risk water sources (e.g. beneficiation plant, hot water storages etc) will be carried out and the water treated where required.

18.9 A register of all approved chemicals will be maintained.

18.10 Training on chemical use and storage will be provided to employees and contractors through the site induction and specific chemical awareness programs will be undertaken for relevant workers.

18.11 To minimise the hazards associated with fuel oil leaking during road tanker unloading, the following controls will be implemented to reduce risks to health and safety of site personnel and potential adverse impacts to the environment:

- equipment inspection and testing programs will be undertaken to ensure reliable performance of fuel tanks and bunds;
- Standard Operating Procedures (SOPs)will be prepared to address the refilling of fuel storage tanks and mine vehicles, maintenance and spill response;
- Operator training will be provided in the safe operation of the equipment and knowledge of emergency response procedures in the event of a fuel oil leakage;
- Spill containment bunds will be installed to contain any spillage of liquids;
- Sumps will be constructed to collect any spillage and allow recovery;
- Ignition sources will be strictly monitored and maintained to avoid fire;
- Appropriate fire fighting facilities and suppression systems will be installed, maintained and available to extinguish fires;
- An approved fire protection system is to be installed and maintained around hydrocarbon storage areas; and
- Inspections of all storage facilities shall be carried out on a regular basis.

18.12 Where relevant, vessels will comply with the National Standard for Commercial Vessels, which defines safety equipment standards for various classes of commercial ships.

18.13 Vessels will be operated in accordance with MSQ requirements and SOPs will be developed for these activities in consultation with the local MSQ personnel.

Section 19 – Hazard and Risk

19.1 Strategies will be employed to minimise risks associated with dangerous goods and hazardous substances, including:

- Storage, handling and use in accordance with relevant Australian Standards;
- Secondary containment will be utilised to reduce the risk of spills occurring as a result of accidental rupture of tanks or leaks from transfer points;
- The transfer of dangerous goods and hazardous substances by barge will be carried out in accordance with relevant regulatory requirements;
- Procedures will be developed for storage, handling, transfer and disposal of hazardous substances to minimise the risk of spills;
- Relevant employees and contractors involved in the storage, handling use and disposal of hazardous substances and materials will be trained to ensure that they are aware of their responsibilities in relation to hazardous substances; and

- Procedures will be developed for spill cleanup and appropriate emergency response equipment provided at key locations to reduce the risk of harm resulting from a spill.

19.2 Designated first aid and emergency rescue facilities and equipment will be available on-site during the construction and operation phases.

19.3 A paramedic and ambulance will be based at the Boyd infrastructure area (on shift).

19.4 A two kilometre section of the Mine Access Road near the Boyd infrastructure area will be designed to accommodate Royal Flying Doctor Service aircraft landings and take-offs and provision for temporary night-time lighting will be made. Helicopters will be able to land on this portion of the road as well.

19.5 The transfer of dangerous goods and hazardous substances by barge will be carried out in accordance with Australian Maritime Safety Authority guidelines. RTA will prepare an oil spill response plan for the barge carrying fuel tankers.

19.6 Spill prevention measures will be implemented and the existing RTA spill response procedures will be utilised.

19.7 The existing Weipa Business Resilience and Recovery (BRR) Plan (otherwise known as an 'Emergency Management Plan') will be updated to include the Project area and updated regularly throughout each stage of the Project to ensure that it continues to appropriately manage risks.

19.8 The site will have fire brigade-approved fire fighting equipment and fire alarms.

19.9 All fire fighting facilities and equipment will be installed, serviced, maintained and inspected by a certified body.

19.10 Stores, workshops and offices will be fitted with approved and certified fire detection systems (smoke and thermal detectors) and sprinkler systems.

19.11 Permanent facilities, such as fuel storage areas, will have a dedicated fire alarm, suppression and fire fighting equipment.

19.12 The Project will maintain a Fire and Rescue Service trained and equipped to appropriately respond to fire risk.

19.13 The risk of bushfire damage to people and property shall me mitigated by:

- Appropriate siting of buildings;
- Provision of fire breaks;
- Provision of adequate vehicle access for fire-fighting; and
- Provision of adequate water supplies for fire-fighting.

19.14 The Project will maintain a detailed Cyclone Emergency Procedure detailing specific requirements and responsibilities for each of the cyclone conditions for each operational area.

Environmental Impact Statement

for South of Embley Project

Section 3
Appendix

APPENDIX 3A

DETAILED SOIL DESCRIPTIONS FOR THE PROJECT AREA

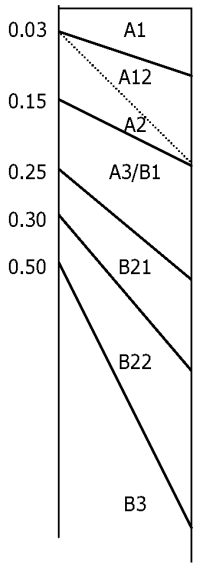
Aus Soil Classification (Isbell 1992)	**Yellow Kandosol**
Concept:	Deep gradational, occasionally uniform, yellow massive soils with aluminous concretions
Classification:	
Biggs and Philips (1995)	Affinities with Andoom **(Ada)**
Great Soil Group (Stace et.al. 1968)	Yellow Earth
Principal Profile Form (Northcote 1974)	Gn2.62, Gn2.21, 2.22, Gn2.25
Landform:	Level to gently undulating plains on low plateaux – Less well-drained mid and lower slopes
Geology:	Tertiary and Quaternary aluminous laterite (T & Qa)
Vegetation:	*E. tetrodonta* and bloodwood tall woodland
Microrelief:	None
Surface condition:	Hardsetting
Surface coarse fragments	Few to many 2-6 mm aluminous concretions often present

Land Use Limitations

Climate:	<35°C, >1500 mm (C1)
Moisture supply:	60 – 80 mm/m (M4)
Fertility:	<3 mg/kg P, (<4 mg/kg SO_4 S) (N8)
Wetness:	Imperfectly drained, moderately permeable (W4m)
Flooding frequency:	No flooding (F0)
Rockiness:	2-6 mm, 20-50% (Rf4)
Topography:	No microrelief (T0)
Soil Physical condition:	Slightly adhesive soils, moderate moisture range, Moderately hardsetting (P1)
Vegetation factor:	Regrowth poses a problem, existing vegetation a problem (Vc2e2)
Erodibility:	1-3 %, stable (E2s)
Landscape complexity:	Unit size >20 ha (X0)
Salinity:	Moderate risk transmission zone (St2)

Land use limitation codes from Biggs and Philips (1995)

Soil Description:



A1	0 – 0.10	Dark, grey or brown (10YR 3-4/2-3); Sandy loam to sandy clay loam; Massive or weak 2-5 mm granular; Dry, firm to very firm; Few to common 2-6 mm aluminous to ferruginous concretions; Field pH 6.0 to 6.5; Clear boundary to;
A12	0.10 – 0.20	Brown (10YR 4/3 or 7.5YR 4/3); Sandy clay loam to clay loam; Massive or weak 2-5 mm granular; Dry, weak to firm; Few 2-6 mm aluminous or ferruginous concretions; Field pH 6.0 to 6.5; Gradual boundary to;
		OR
A2	0.10 – 0.20	Yellow-brown or brown (10YR 6/4 or 7.5YR 4/3); Sandy clay loam light to clay loam; Massive ; Dry, firm to weak; Very few to few 2-6 mm aluminous concretions; Field pH 6.0; Gradual boundary to;
A3/B1	0.20 – 0.30	Yellow, brown or yellow-brown (10YR 3/3 or 4-5/3-6 or 7/4-5; 7.5YR 5/5); Sandy clay loam to clay loam; Massive; Dry, weak to firm; Very few to common 2-6 mm aluminous to ferruginous concretions; Field pH 6.0; Gradual or diffuse boundary to;
B21	0.30 – 0.50	Yellow or brown (10YR 7/6 or 6/6 or 7.5YR 6/4); Sandy clay loam to clay loam heavy; Massive; Dry weak to firm; Few to many 2-6 mm aluminous concretions; Field pH 6.5 to 7.0; Gradual boundary to;
B22	0.50 – 0.70	Yellow or yellow-brown or red-brown (10YR 6-7/6 or 7.5YR 5-6/6 or 5YR 5/8); Sandy clay loam to clay loam heavy; Common medium faint to distinct orange and red mottles; Massive; Moderately moist, firm; Few to common 6-20 mm aluminous concretions; Field pH 7.0, occasionally 5.5; Gradual boundary to;
B3	0.70 – 1.20	Red or red-brown (2.5YR 3/8 or 4/6-8; or 5YR 4/6 or 5/8); Sandy clay loam to clay loam; Massive; Dry, weak ; Very many 6-20 mm aluminous concretions, some ferruginous and manganiferous nodules occasionally present; Field pH 7.0 to 7.5, occasionally 5.5;

Number of sites: 7

Limit of augering

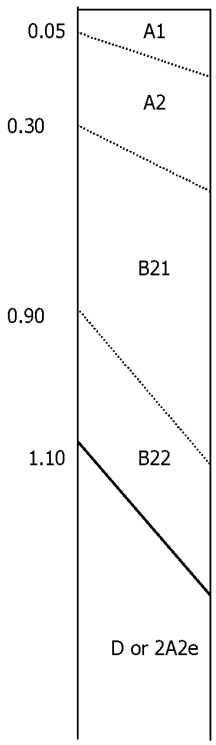
Aus Soil Classification (Isbell 1992)	**Orthic Tenosol**
Concept:	Deep to very deep coloured Uniform sands formed in beach ridges on chenier and beach ridge plains
Classification:	
Biggs and Philips (1995)	Caravan **(Cv)**
Great Soil Group (Stace et.al. 1968)	(Rudimentary) Podzol/Siliceous Sand
Principal Profile Form (Northcote 1974)	Uc2.32, Uc2.21, Uc2.34, Uc5.11
Landform:	Beach ridges
Geology:	Quaternary (Holocene) beach ridge deposits (Qhm), Quaternary (Pleistocene) beach ridge deposits (Qpm)
Vegetation:	Woodlands and herblands on beach ridges and the littoral margins, minor open heath or dwarf-open heath
Microrelief:	None
Surface condition:	Loose
Surface coarse fragments	None

Land Use Limitations

Climate:	<35°C, >1500 mm (C1)
Moisture supply:	<40 mm/m (M6)
Fertility:	<3 mg/kg P, (<4 mg/kg SO_4 S) (N8)
Wetness:	Imperfectly drained, highly permeable (W4h)
Flooding frequency:	No flooding (F0)
Rockiness:	No rock (R0)
Topography:	No microrelief (T0)
Soil Physical condition:	No restriction (P0)
Vegetation factor:	Regrowth poses a problem, existing vegetation a problem (Vc2e2)
Erodibility:	1-3 %, unstable (E2u)
Landscape complexity:	Isolated unit (Xi)
Salinity:	Non-saline (Sn)

Land use limitation codes from Biggs and Philips (1995)

Soil Description:



A1	0 – 0.10	Dark or grey (10YR 2-4/1-2 or 5/1); Sand; Single grain; Dry, very weak; Field pH 5.5 to 7.5; Gradual or diffuse boundary to;
A2	0.10 – 0.45	Pale or grey or yellow-brown (10YR 5-6/1-4); Sand; Single grain; Dry to moderately moist, very weak to weak; Field pH 6.0 to 7.0; Diffuse boundary to;
B21	0.45 – 0.95	Yellow-brown or yellow or pale (10YR 5-6/3 or 6/5-6 or 8/2); Many medium distinct or prominent yellow or orange mottles; Sand; Single grain to massive; Moderately moist, very weak to weak; Field pH 6.0; Gradual boundary to;
B22	0.95 – 1.30	Pale or grey (10YR 8/1 or 2.5Y 6/1); Common to many fine to medium prominent yellow or orange mottles; Sand to light fine sandy loam; Single grain to massive; Moderately moist, very weak; Field pH 5.0 to 7.0; Clear or diffuse boundary to;
		Either
D	1.30 – 1.70	Grey (5Y 6/1); Fine sandy medium clay; Moderate 2-5 mm lenticular; Moderately moist, strong; Field pH 7.0;
		Or
2A2e	1.30 – 1.45	Conspicuously bleached - pale or yellow-brown (10YR 8/1-3 or 5/4); Few fine or medium faint to distinct yellow mottles occasionally present; Sand; Few to common 2-20 mm sub-angular platy shells or sub-rounded quartz occasionally present; Single grain; Moderately moist, very weak; Field pH 5.5 to 9.5; Gradual boundary to;
2B21	1.45 – 1.65	Pale (10YR 8/1-2); Many prominent medium yellow mottles; Sand; Single grain; Moderately moist, very weak; Field pH 5.5 to 6.0; Diffuse boundary to;
2B22	1.65 – 1.80	Pale-yellow (10YR 7/8); Few fine prominent pale mottles; Sand; Single grain; Wet, very weak;

Limit of augering

Number of sites: 0

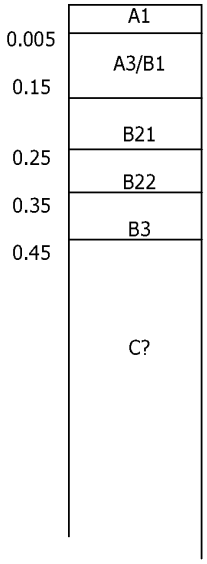
Aus Soil Classification (Isbell 1992)	**Supratidal hydrosol**
Concept:	Moderately deep Uniform saline mottled clays formed in recent estuarine deposits
Classification:	
Biggs and Philips (1995)	George **(Go)**
Great Soil Group (Stace et.al. 1968)	Solonchak
Principal Profile Form (Northcote 1974)	No provision
Landform:	Supra-tidal and inter-tidal flats
Geology:	Quaternary coastal alluvium (Qac)
Vegetation:	Bare, occasionally mangroves or halophytes
Microrelief:	None
Surface condition:	Soft, cracking
Surface coarse fragments	None

Land Use Limitations

Climate:	<35°C, >1500 mm (C1)
Moisture supply:	<40 mm/m (M6)
Fertility:	<3 mg/kg P, (<4 mg/kg SO_4 S) (N8)
Wetness:	Very poorly drained, very slowly permeable (W6v)
Flooding frequency:	Every year (F3)
Rockiness:	No rock (R0)
Topography:	No microrelief (T0)
Soil Physical condition:	Strongly adhesive soils, narrow moisture range, moderately hardsetting (P7)
Vegetation factor:	Regrowth control no problem, existing vegetation no problem (Vc1e1)
Erodibility:	0-1 %, very unstable (E1v)
Landscape complexity:	Isolated unit (Xi)
Salinity:	Naturally saline (Ss)

Land use limitation codes from Biggs and Philips (1995)

Soil Description:



A1	0 – 0.005	Yellow-brown (Light medium clay; Massive? Moist, weak; Field pH 9.0; Sharp boundary to;
A3/B1	0.005 – 0.15	Grey (10YR 4/2); Light medium clay; Strong 2-5 mm polyhedral? Moist, weak; Field pH 8.0; Clear boundary to;
B21	0.15 – 0.25	Brown (10YR 4/4); Medium heavy clay; Strong 2-5 mm polyhedral? Moist, firm; Field pH 6.0; Clear boundary to;
B22	0.25 – 0.35	Brown (7.5YR 4/6); Medium clay; Strong 2-5 mm polyhedral? Moist, firm; Field pH 6.0; Abrupt boundary to;
B3	0.35 – 0.45	Yellow (2.5Y 7/6); Many fine prominent grey mottles; Medium clay; Weak 2-5 mm lenticular; Moist, firm; Field pH 5.0; Abrupt boundary to;
C?	0.45 – 0.60	Grey (10YR 5/4); Clay; Wet; Field pH 7.0;

Limit of augering

Number of sites: 0

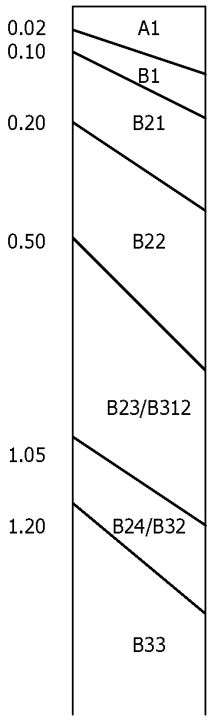
Aus Soil Classification (Isbell 1992)	**Grey or Aquic Vertisol**
Concept:	Very deep Uniform frequently cracking saline grey clays formed on marine plains
Classification:	
Biggs and Philips (1995)	Marina **(Mn)**
Great Soil Group (Stace et.al. 1968)	Grey Clay
Principal Profile Form (Northcote 1974)	Ug5.24, Ug5.5, Ug5.29, Uf6.41, Uf6.42
Landform:	Level to gently undulating plains on beach ridge or chenier plains
Geology:	Quaternary coastal alluvium (Qac)
Vegetation:	Tussock grasslands
Microrelief:	Normal gilgai; vertical interval 0.2-0.3 m; horizontal interval 8-10 m
Surface condition:	Hardsetting, and frequently cracking
Surface coarse fragments	None

Land Use Limitations

Climate:	<35°C, >1500 mm (C1)
Moisture supply:	40-60 mm/m (M5)
Fertility:	<3 mg/kg P, (>4 mg/kg SO_4 S) (N7)
Wetness:	Very poorly drained, very slowly permeable (W6v)
Flooding frequency:	Every year (F3)
Rockiness:	No rock (R0)
Topography:	Microrelief vertical interval 0.1-0.3 m (T2)
Soil Physical condition:	Strongly adhesive soils, narrow moisture range, hardsetting (including large aggregates)(P8)
Vegetation factor:	Regrowth control no problem, existing vegetation no problem (Vc1e1)
Erodibility:	1-3 %, unstable (E2u)
Landscape complexity:	Unit size >20 ha (X0)
Salinity:	Naturally saline (Ss)

Land use limitation codes from Biggs and Philips (1995)

Soil Description:



A1	0 – 0.04	Dark or grey (10YR 3-4/1 or 2.5Y 4/1); Few to many fine distinct to prominent orange mottles; Light clay to light medium clay; Moderate2-5 mm sub-angular blocky, occasionally massive; Dry, firm to strong; Field pH 4.0 to 6.0; Sharp or clear boundary to;
B1	0.04 – 0.15	Dark or grey (10YR 3-4/1 or 5/2); Common fine distinct orange or red mottles; Light clay to light medium clay; Moderate to strong 2-5 mm sub-angular or angular blocky; Dry to moderately moist, very firm to very strong; Field pH 5.0 to 6.0; Clear or gradual boundary to;
B21	0.15 – 0.30	Grey (10YR 4/1-2 or 5/1 or 2.5Y 3/I); Common to many fine to medium distinct to prominent orange or red mottles; Medium clay to medium heavy clay; Strong 2-10 mm sub-angular or angular blocky; Dry to moderately moist, very firm to strong; Field pH 5.0 to 6.0; Clear or diffuse boundary to;
B22	0.30 – 0.70	Grey (10YR 4-5/1-2 or 2.5Y 4/1-2); Few to many fine to medium distinct to prominent red mottles; Medium heavy clay to heavy clay; Moderate to strong 2-5 mm sub-angular blocky, angular blocky or lenticular; Moderately moist, very strong to moist, firm; Few 2-6 mm manganiferous nodules occasionally present; Field pH 5.0 to 8.5; Clear or gradual boundary to;
B23/B31	0.70 – 1.10	Grey or yellow (10YR 5/1 or 6/6); Common fine prominent yellow mottles; Medium heavy clay; Strong 2-5 mm lenticular or angular blocky; Moderately moist, firm; Field pH 6.0 to 9.5; Clear to;
B24/B32	1.10 – 1.30	Grey (10YR 5-6/1); Common fine prominent yellow mottles; Sandy light clay to medium clay; Massive to strong 2-5 mm lenticular; Moderately moist to wet, weak; Field pH 6.5 to 8.0;Clear boundary to;
B33	1.30 – 1.60	Grey (10YR 5/1); Light medium clay; Wet, weak; Field pH 8.5;
Limit of augering		

Number of sites: 0

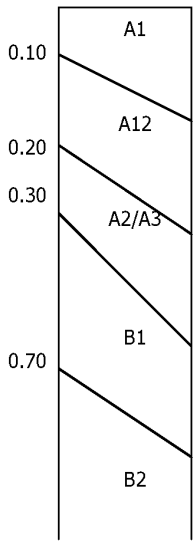
Aus Soil Classification (Isbell 1992)	**Redoxic Hydrosol**
Concept:	Deep Duplex or Gradational soils with a dark loamy surface over a mottled grey clay or clay loam formed in broad drainage depressions and swamps
Classification:	
Biggs and Philips (1995)	Affinities with Mapoon **(Mpa)**
Great Soil Group (Stace et.al. 1968)	Humic Gley, Gleyed podzolic
Principal Profile Form (Northcote 1974)	Dg4.11, Gn2.81, Gn2.64
Landform:	Broad drainage depressions and swamps on level plains to undulating rises
Geology:	Tertiary and Quaternary aluminous Laterite (T & Qa), Quaternary alluvia (Qa)
Vegetation:	Bloodwood and *E. tetrodonta* tall open woodlands with *Banksia* sp., swamp mahogany, areas *Melaleuca* sp
Microrelief:	None
Surface condition:	Soft to firm
Surface coarse fragments	None

Land Use Limitations

Climate:	<35°C, >1500 mm (C1)
Moisture supply:	60-80 mm/m (M4)
Fertility:	<3 mg/kg P, (<4 mg/kg SO_4 S) (N8)
Wetness:	Poorly drained, slowly permeable (W5s)
Flooding frequency:	Every year (F3)
Rockiness:	No rock (R0)
Topography:	No microrelief (T0)
Soil Physical condition:	No restriction (P0)
Vegetation factor:	Regrowth poses a problem, existing vegetation a problem (Vc2e2)
Erodibility:	0-1 %, stable (E1s)
Landscape complexity:	Unit size <20 ha (X1), unit size >20 ha (X0)
Salinity:	Non saline (Sn)

Land use limitation codes from Biggs and Philips (1995)

Soil Description:



A1	0 – 0.05	Black or dark (10YR 2/2; or 7.5YR 3/2); Sandy loam to fine sandy loam; Massive to weak 2-5 mm granular; Moist, weak to firm; Field pH 6.0 to 6.5; Clear or gradual boundary to;
A12	0.05 – 0.35	Black or dark (10YR 2/2, 3/1 or 7.5YR 3/2); Sandy loam to fine sandy loam; Massive to weak 2-5 mm granular; Dry to moist, weak; Occasionally few 6-20 mm coarse fragments of mottled sandstone; Field pH 5.5 to 6.0; Abrupt or clear boundary to;
A2/A3	0.35 – 0.50	Grey or brown (10YR 3-4/1-2 or 7.5YR 5/3); Sandy clay loam to light clay fine sandy; Massive; dry to moderately moist, weak to firm; Field pH 4.5 to 5.5; Clear or gradual boundary to;
B1	0.50 – 0.80	Pale or pale-yellow or brown (10YR 7/4; or 7.5YR 7/2 or 5/3); sandy or silty clay loam heavy to light clay; Few to many faint to distinct red, orange or grey mottles; Moderate 2-5 mm polyhedral or sub-angular blocky; Moderately moist to moist, firm; Few 2-6 mm manganiferous or ferruginous concretions; Field pH 4.5 to 5.0; Gradual or diffuse boundary to;
B2	0.80 – 1.20	Pale or yellow-brown or brown (10YR 7/4; or 7.5YR 8/2 or 5/4 or 6/6); Clay loam heavy to (silty) light clay heavy; Common to many fine to medium distinct orange to red mottles; Massive or weak to moderate 2-5 mm polyhedral; Moderately moist to moist, firm to very firm; Few to common 2-6 mm feromanganiferous segregations or concretions; Field pH 4.5 to 5.0;

Number of sites: 4

Limit of augering

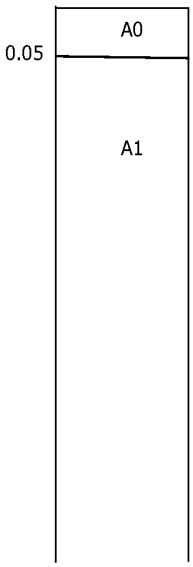
Aus Soil Classification (Isbell 1992)	**Intertidal Hydrosol**
Concept:	Recent estuarine deposits under mangroves
Classification:	
Biggs and Philips (1995)	Skardon **(Sd)**
Great Soil Group (Stace et.al. 1968)	No suitable group
Principal Profile Form (Northcote 1974)	No provision
Landform:	Intertidal flats
Geology:	Quaternary coastal alluvium (Qac)
Vegetation:	Mangroves
Microrelief:	None
Surface condition:	Soft
Surface coarse fragments	None

Land Use Limitations

Climate:	<35°C, >1500 mm (C1)
Moisture supply:	<40 mm / m (M6)
Fertility:	<3 mg/kg P, (<4 mg/kg SO_4 S) (N8)
Wetness:	Very poorly drained, moderately permeable (W6m)
Flooding frequency:	Every year (F3)
Rockiness:	No rock (R0)
Topography:	No microrelief (T0)
Soil Physical condition:	No restriction (P0)
Vegetation factor:	Regrowth control no problem, existing vegetation no problem (Vc1e1)
Erodibility:	0-1 %, very unstable (E1u)
Landscape complexity:	Isolated unit (Xi)
Salinity:	Naturally saline (Ss)

Land use limitation codes from Biggs and Philips (1995)

Soil Description:



A0	0 – 0.05	Leaf litter (layered); Dark (7.5YR 2/2); Wet, weak; Field pH 6.0; Clear boundary to;
A1	0.05 – 0.30	Dark (10YR 3/1); Sandy loam; Wet, very weak; Field pH 6.0.

Limit of augering

Number of sites: 0

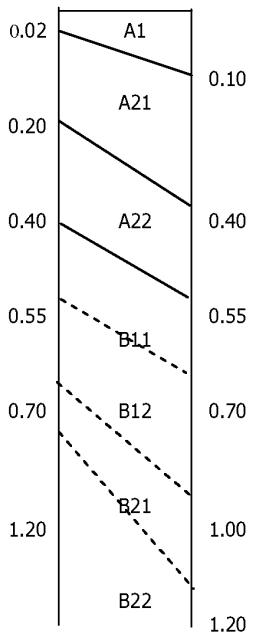
Aus Soil Classification (Isbell 1992)	**Orthic Tenosol**
Concept:	Very deep uniform coastal sands deposited on laterite and other surfaces
Classification:	
Biggs and Philips (1995)	Somerset **(Ss)**
Great Soil Group (Stace et.al. 1968)	Siliceous Sand/ (Red) Earthy Sand
Principal Profile Form (Northcote 1974)	Uc4.22, Uc5.11
Landform:	Dunes, beach ridges
Geology:	Quaternary younger dunes (Qd), Holocene (Qhm) and Pleistocene (Qpm) beach ridge deposits
Vegetation:	*E. tetrodonta* woodlands and tall woodlands, open heaths and dwarf open heaths
Microrelief:	None
Surface condition:	Loose
Surface coarse fragments	None

Land Use Limitations

Climate:	<35°C, >1500 mm (C1)
Moisture supply:	<40 mm / m (M6)
Fertility:	<3 mg/kg P, (<4 mg/kg SO_4 S) (N8)
Wetness:	Rapidly drained, highly permeable (W1h)
Flooding frequency:	No flooding (F0)
Rockiness:	No rock (R0)
Topography:	No microrelief (T0)
Soil Physical condition:	No restriction (P0)
Vegetation factor:	Regrowth control no problem, existing vegetation a problem (Vc1e2)
Erodibility:	1-3 %, very unstable (E2u)
Landscape complexity:	Isolated unit (Xi)
Salinity:	Non-saline (Sn)

Land use limitation codes from Biggs and Philips (1995)

Soil Description:



A1	0 – 0.05	Dark (10YR 3/1-2 or 7.5Y 3/2); Sand to loamy fine sand; Single grain; Dry, loose; Field pH 6.0; Abrupt or clear boundary to;
A21	0.05 – 0.30	Dark or brown or grey-brown (5YR 3/2 or 7.5YR 4/2 or 3/4); Sand to loamy fine sand; Single grain; Dry, very weak; Field pH 6.0 to 7.0; Clear or diffuse boundary to
A22	0.30 – 0.45	Red-brown or brown (5YR 4/4 or 7.5Y 4/3); Sand to loamy fine sand; Single grain; Dry, very weak; Field pH 7.0; Clear or gradual boundary to
B11	0.45 – 0.65	Red-brown or red (5YR 4/3 or 2.5YR 4/6 or 5YR 3/6); Sand to loamy fine sand; Single grain; Dry, very weak; Field pH 6.0 to 7.0; Diffuse boundary to
B12	0.65 – 0.75	Red-brown or red (5YR 4/4 or 2.5YR 4/8 or 3/6); Sand to loamy fine sand; Single grain; Dry, very weak; Field pH 6.0 to 7.0; Diffuse boundary to
B21	0.75 – 0.85	Red-brown or red (5YR 3/3 or 2.5YR 4/6); Sand to loamy fine sand; Single grain; Dry, very weak; Field pH 6.0 to 7.0; Gradual or diffuse boundary to;
B22	0.85 – 1.20	Red-brown or red (5YR 3/3 or 2.5YR 4/6); Loamy sand to loamy fine sand; Single grain; Dry, weak; Field pH 6.0 to 7.0;

Limit of augering

Number of sites: 0

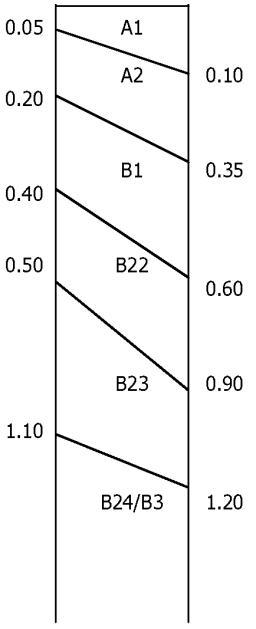
Aus Soil Classification (Isbell 1992)	**Yellow Kandosol**
Concept:	Deep gradational, occasionally uniform, yellow massive mottled with ferruginous concretions
Classification:	
Biggs and Philips (1995)	Yellow Kandosols (predominantly acidic) **(YKa)**
Great Soil Group (Stace et.al. 1968)	Yellow Earth
Principal Profile Form (Northcote 1974)	Gn2.21, Gn2.64, 2.61, Gn2.22, 2.72
Landform:	Level to gently undulating plains on low plateaux – lower slopes and drainage areas
Geology:	Tertiary and Quaternary aluminous laterite (T & Qa)
Vegetation:	*E. tetrodonta* and bloodwood tall woodlands, with *Banksia* sp., *Grevillea* sp. or *Acacia* sp. variously associated in drainage areas
Microrelief:	None
Surface condition:	Hardsetting
Surface coarse fragments	Few 2-6 mm ferruginous concretions

Land Use Limitations

Climate:	<35°C, >1500 mm (C1)
Moisture supply:	60 – 80 mm / m (M4)
Fertility:	<3 mg/kg P, (<4 mg/kg SO_4 S) (N8)
Wetness:	Imperfectly drained, slowly permeable (W4s)
Flooding frequency:	No flooding (F0)
Rockiness:	No rock (R0)
Topography:	No microrelief (T0)
Soil Physical condition:	Slightly adhesive soils, moderate moisture range, Moderately hardsetting (P1)
Vegetation factor:	Regrowth poses a problem, existing vegetation a problem (Vc2e2)
Erodibility:	1-3 %, stable (E2s)
Landscape complexity:	Isolated areas 20-100 ha (Xi)
Salinity:	Moderate risk discharge zone (So2)

Land use limitation codes from Biggs and Philips (1995)

Soil Description:



A1	0 – 0.05	Dark or brown (10YR 2/3 or 3-4/2-3; 7.5YR 2/1); Sandy loam to occasional loamy sand; Massive or weak 2-5 mm granular; Dry, weak; Field pH 5.5 to 6.0; Clear boundary to;
A2	0.05 – 0.20	Grey or yellow-brown or brown (10YR 4/1-4, 5/2-4); Occasional sporadic bleach; Sandy loam to clay loam; Massive; Dry, weak to firm; Field pH 6.0 to 6.5; Clear to gradual boundary to;
B1	0.20 – 0.50	Yellow, yellow-brown or brown (10YR 4-6/4-6 or 7/6); Sandy clay loam to clay loam heavy; Very few fine faint red mottles; Massive; Dry, weak to firm; Field pH 5.5 to 6.5; Gradual or diffuse boundary to;
B22	0.45 – 0.80	Yellow (10YR 6/6-8 or 7/6); Sandy clay loam to clay loam heavy; Few medium distinct red mottles; Massive; Dry, weak to firm; Few to common <2 mm ferromanganiferous concretions and 2-6 mm ferruginous segregations; Field pH 5.0 to 6.5; Gradual or diffuse boundary to;
B23	0.80 – 1.10	Yellow or yellow-brown (10YR 7/6 or 7.5YR 5/8); Sandy clay loam to clay loam heavy; Common medium faint to distinct red and orange mottles; Massive; Moderately moist, firm; Very few to common 2-6 mm ferromanganiferous concretions and 6-20 mm ferruginous segregations; Field pH 5.0 to occasionally 7.0; Diffuse boundary to;
B24/B3		1.10 – 1.20 Yellow (10YR 7/6); Clay loam light; Massive; Dry, firm; Field pH 5.0 to occasionally 7.0;
		Limit of augering

Number of sites: 8

Aus Soil Classification (Isbell 1992)	Red Kandosol
Concept:	Deep gradational, occasionally uniform, red massive soil with aluminous concretions
Classification:	
Biggs and Philips (1995)	Based on Weipa **(Wpa)**
Great Soil Group (Stace et.al. 1968)	Red Earth
Principal Profile Form (Northcote 1974)	Gn2.12, Gn2.15, Gn2.22, 2.25, 2.42, 2.65, Um4.21
Landform:	Level to gently undulating plains on low plateaux
Geology:	Tertiary and Quaternary aluminous Laterite (T & Qa)
Vegetation:	*E. tetrodonta* and bloodwood tall woodlands
Microrelief:	None
Surface condition:	Firm to hardsetting
Surface coarse fragments	Many 2-6 mm aluminous concretions

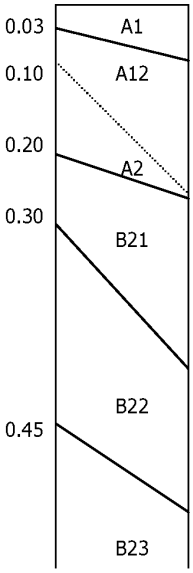
Land Use Limitations

Climate:	<35°C, >1500 mm (C1)
Moisture supply:	60 – 80 mm / m (M4)
Fertility:	<3 mg/kg P, (<4 mg/kg SO_4 S) (N8)
Wetness:	Well drained, moderately permeable (W2m)
Flooding frequency:	No flooding (F0)
Rockiness:	2-6 mm, 20-50% (Rf4)
Topography:	No microrelief (T0)
Soil Physical condition:	Slightly to moderately adhesive soils, moderate moisture range, moderately hardsetting (P1)
Vegetation factor:	Regrowth poses a problem, existing vegetation a problem (Vc2e2)
Erodibility:	1-3 %, stable (E2s)
Landscape complexity:	Unit size >20 ha (X0)
Salinity:	Low risk inflow zone (Si1)

Land use limitation codes from Biggs and Philips (1995)

Soil Description:

Phase: Ferric phase (WpFp): Bands of iron cemented concretions in the B horizon in lower slope positions and on steeper slopes



A1	0 – 0.05	Dark or grey or brown or red-brown (5YR 2-3/2-3 or 4/3; or 7.5YR 3-4/2-4; or 10YR 3/2-3 or 4/4); Sandy loam to Fine sandy clay loam; Massive or weak 2-5 mm granular; Dry, firm; Few 2-6 mm aluminous to ferruginous concretions; Field pH 6.0 to 7.0; Abrupt or clear boundary to;
A12	0.05 – 0.20	Brown, yellow-brown or red-brown or grey (5YR 3-4/3-6 or 5/5; or 7.5YR 4/3-4; or 10YR 5/4); Sandy loam to sandy clay loam; Massive or weak 2-5 mm granular; Dry firm; Few 2-6 mm aluminous to ferruginous concretions; Field pH 6.0 to 7.0; Abrupt or clear boundary to;
A2	0.10 – 0.20	Brown or red-brown or grey (5YR 3/4 or 4/6 or 5/5; or 7.5YR 4/3 or 3/6; or 10YR 4/2-4); Clay loam sandy to clay loam heavy; Massive ; Dry, firm; Very few to few 2-6 mm aluminous to ferruginous concretions; Field pH 6.0 to 6.5; Gradual boundary to;
B21	0.20 – 0.40	Red or red-brown (2.5YR 3/8 or 4/6-8; or 5YR 3-4/6-8 or 5/6-8; or 7.5yr 4-5/6); Fine sandy clay loam to clay loam heavy; Massive; Dry weak to firm; Few to many 6-20 mm aluminous concretions; Field pH 6.5 to 7.0; Gradual boundary to;
B22	0.40 – 0.70	Red or red-brown (2.5YR 4/6-8 or 5YR 3-4/6-8 or 5/6-8); Fine sandy clay loam to clay loam or light clay; Occasionally few fine faint red or orange mottles; Massive; Dry, weak; Many to very many 6-20 mm aluminous concretions; Field pH 6.5 to 7.0; Gradual boundary to;
B23	0.70 –	Red or red-brown (2.5YR 3/8 or 4/6-8; or 5YR 4/6 or 5/8); Fine sandy clay loam to light clay; Massive; Dry, weak; Very many 6-20 mm aluminous concretions; Field pH 7.0;

Number of sites: 143

Limit of augering

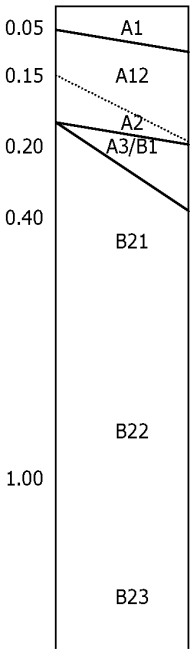
Aus Soil Classification (Isbell 1992)	**Red Kandosol**
Concept:	Deep gradational, occasionally uniform, red massive soil with aluminous concretions
Classification:	
Biggs and Philip (1995)	Affinities with Weipa (Wp)– Deep red phase **(WpDr)**
Great Soil Group (Stace et.al. 1968)	Red Earth
Principal Profile Form (Northcote 1974)	Gn2.12, Gn2.15, Gn2.22, minor Gn2.14
Landform:	Upper slopes of level to gently undulating plains on low plateaux
Geology:	Tertiary and Quaternary aluminous Laterite (T & Qa)
Vegetation:	*E. tetrodonta* and bloodwood tall woodlands
Microrelief:	None
Surface condition:	Firm to hardsetting
Surface coarse fragments	None to few 2-6 mm aluminous concretions

Land Use Limitations

Climate:	<35°C, >1500 mm (C1)
Moisture supply:	60 – 80 mm / m (M4)
Fertility:	<3 mg/kg P, (<4 mg/kg SO_4 S) (N8)
Wetness:	Well drained, moderately permeable (W2m)
Flooding frequency:	No flooding (F0)
Rockiness:	2-6 mm, 20-50% (Rf4)
Topography:	No microrelief (T0)
Soil Physical condition:	Slightly to moderately adhesive soils, moderate moisture range, moderately hardsetting (P1)
Vegetation factor:	Regrowth poses a problem, existing vegetation a problem (Vc2e2)
Erodibility:	1-3 %, stable (E2s)
Landscape complexity:	Unit size >20 ha (X0)
Salinity:	Low risk inflow zone (Si1)

Land use limitation codes from Biggs and Philips (1995)

Soil Description:



A1	0 – 0.05	Dark or brown or red-brown (5YR 2-3/2-4; or 7.5YR 2-3/3); Loam to sandy clay loam light; Massive or weak 2-5 mm granular; Dry, weak; None or very few 2-6 mm aluminous to ferruginous concretions; Field pH 6.0 to 6.5; Abrupt or clear boundary to;
A12	0.05 – 0.25	Dark or red-brown (5YR 3/2-4); Sandy clay loam to clay loam light; Massive or Dry, weak to firm; None to few 2-6 mm aluminous to ferruginous concretions; Field pH 6.0 to 6.5; Gradual or clear boundary to;
A2	0.15 – 0.25	(occasionally present); Red-brown (5YR 3/4-6); Sandy clay loam to clay loam light; Massive; Dry, firm; None to very few 2-6 mm aluminous to ferruginous concretions; Field pH 6.0 to 6.5; Gradual boundary to;
A3/B1	0.25 – 0.35	Red (2.5YR 3-4/6); Clay loam; Massive or weak 2-5 mm granular; Dry, firm; Very few 2-6 mm aluminous to ferruginous concretions; Field pH 6.0 to 6.5; Gradual or diffuse boundary to;
B21	0.35 – 0.60	Red or red-brown (2.5YR 3-4/6; or 5YR 3-4/4-6); Clay loam to light clay light; Massive; Dry, firm; Very few to few 2-6 mm aluminous concretions; Field pH 6.5 to 7.0; Diffuse boundary to;
B22	0.60 – 1.30	Red (2.5YR 3-4/6-8); Sandy clay loam to clay loam or light clay; Massive; Dry, weak or firm; Few to many 2-6 mm aluminous concretions; Field pH 7.0; Clear to gradual boundary to;
B3	1.30 – 1.80	Red or red-brown (2.5YR 4/6-8); Clay loam to light clay light; Massive; Dry, weak; Few to very many 6-20 mm aluminous concretions; Field pH 7.0;
		Limit of augering

Number of sites: 12

APPENDIX 3B

RESULTS OF SOIL CHEMICAL AND PHYSICAL ANALYSES FOR 14 SOIL PROFILES IN THE PROJECT AREA

Table 1: Results of Soil Chemical Analyses for 14 Soil Profiles in the South of Embley Project Area

Soil Type	Site ID &	pH	pH	EC	Chloride	Nitrate N	Colwell P	Sulphur - KCl	Ca	Mg	K	Na	Al	Ca:Mg	CEC	ESP
	Depth (cm)	$CaCl_2$	H_2O	dS/m	mg/kg	mg/kg	mg/kg	mg/kg	Exchangeable cations me/100g						me/100g	%
Red Kandosol	S 1 / 0-10	5.7	6.5	0.05	35	2	1	4.4	4.71	2.32	<0.01	0.19	0.18	2.0	7.40	2.5
	S 1 /20-30	5.6	6.2	0.03	29	1	<1	9.5	2.19	1.63	<0.01	0.17	0.12	1.3	4.11	4.1
	S 1 /50-60	5.6	5.9	0.02	21	<1	<1	10.9	1.29	1.12	<0.01	0.11	0.18	1.2	2.70	4.0
	S 1 / 70-80	6.1	6.3	0.02	20	3	<1	12.5	1.04	0.98	<0.01	0.08	0.42	1.1	2.52	3.1
Red Kandosol	S 2 / 0-10	5.3	6.1	0.03	17	5	<1	2.8	2.78	1.39	<0.01	0.12	0.14	2.0	4.43	2.7
	S 2 / 20-30	5.3	5.9	0.02	18	1	<1	3.0	1.88	1.16	<0.01	0.12	0.25	1.6	3.41	3.5
	S 2 / 20-30	5.6	6.0	0.01	12	1	<1	2.6	1.24	1.17	<0.01	0.12	0.15	1.1	2.68	4.5
	S 2 / 50-60	5.9	6.2	0.02	15	1	<1	5.3	0.79	0.99	<0.01	0.08	0.20	0.8	2.06	3.9
Red Kandosol	S 3 / 0-10	5.4	6.1	0.03	24	2	<1	4.8	2.49	1.59	<0.01	0.12	0.18	1.6	4.38	2.7
	S 3 / 20-30	5.4	5.9	0.03	29	1	<1	6.1	1.26	1.20	<0.01	0.09	0.18	1.1	2.73	3.3
	S 3 / 50-60	5.6	5.9	0.02	17	1	<1	5.0	0.94	0.91	<0.01	0.11	0.27	1.0	2.23	4.9
	S 3 / 70-80	5.7	5.8	0.01	15	<1	<1	7.5	0.78	0.71	<0.01	0.10	0.25	1.1	1.84	5.4
Red Kandosol	S 4 / 0-10	5.4	6.2	0.04	36	2	1	4.9	2.13	1.46	<0.01	0.13	0.18	1.5	3.90	3.3
	S 4 / 20-30	5.3	5.8	0.02	29	<1	<1	3.8	0.97	1.06	<0.01	0.11	0.25	0.9	2.39	4.6
	S 4 / 50-60	5.7	5.8	0.02	19	<1	<1	11.4	0.83	0.86	<0.01	0.08	0.28	1.0	2.05	3.9
	S 4 / 70-80	6.1	6.1	0.02	19	<1	<1	13.5	0.59	0.84	<0.01	0.11	0.29	0.9	1.83	6.0
Red Kandosol	S 5 / 0-10	5.3	6.2	0.04	35	1	1	2.7	3.87	2.44	<0.01	0.24	0.17	1.6	6.72	3.6
	S 5 / 20-30	5.3	6.1	0.03	30	<1	<1	6.0	1.69	1.28	<0.01	0.13	0.11	1.3	3.21	4.1
	S 5 / 50-60	5.8	6.0	0.02	22	1	<1	13.1	0.73	0.72	<0.01	0.11	0.26	1.0	1.82	6.0
Red Kandosol	S 34 / 0-10	5.5	6.2	0.04	36	2	<1	3.2	5.14	2.60	0.34	0.17	0.58	2.0	8.83	1.9
	S 34 / 20-30	5.7	6.0	0.02	24	2	<1	8.9	1.46	1.05	0.20	0.08	0.83	1.4	3.62	2.2
	S 34 / 50-60	6.0	6.1	0.02	25	1	<1	17.1	0.78	0.83	0.18	0.08	0.68	0.9	2.55	3.1
Red	S 48 / 0-10	5.1	5.7	0.03	21	7	<1	3.7	1.38	0.99	0.20	0.11	0.58	1.4	3.26	3.4

Soil Type	Site ID &	pH	pH	EC	Chloride	Nitrate N	Colwell P	Sulphur - KCl	Ca	Mg	K	Na	Al	Ca:Mg	CEC	ESP
	Depth (cm)	$CaCl_2$	H_2O	dS/m	mg/kg	mg/kg	mg/kg	mg/kg	Exchangeable cations me/100g						me/100g	%
Kandosol	S 48 / 20-30	5.4	5.9	0.02	13	3	<1	6.0	1.72	0.96	0.14	0.09	0.52	1.8	3.43	2.6
	S 48 / 50-60	5.4	6.0	0.02	12	2	<1	9.5	1.40	0.93	0.11	0.04	0.53	1.5	3.01	1.3
	S 48 / 80-90	5.9	6.0	0.01	9	2	<1	12.4	0.75	0.92	0.08	0.06	0.55	0.8	2.36	2.5
Red Kandosol	S 74 / 0-10	5.2	5.9	0.02	77	4	<1	2.0	2.76	1.39	0.10	0.09	0.65	2.0	4.99	1.8
	S 74 / 20-30	5.4	5.8	0.02	81	2	<1	2.8	1.51	0.73	0.07	0.08	0.69	2.1	3.08	2.6
	S 74 / 50-60	5.7	5.9	0.01	14	2	<1	12.0	0.64	0.76	0.05	0.06	0.77	0.8	2.28	2.6
	S 74 / 80-90	6.0	6.0	0.01	10	2	<1	14.1	0.40	0.80	0.03	0.03	0.53	0.5	1.79	1.7
Red Kandosol	S 106 / 0-10	5.5	6.3	0.03	25	1	<1	2.4	5.67	3.03	0.15	0.14	0.68	1.9	9.67	1.5
	S 106 / 20-30	5.7	6.2	0.02	29	1	<1	3.8	1.78	1.21	0.04	0.04	0.72	1.5	3.79	1.1
	S 106 / 50-60	5.8	6.1	0.01	15	1	2	8.5	1.04	1.31	0.02	0.07	0.59	0.8	3.03	2.3
	S 106 / 80-90	6.0	6.1	0.02	69	1	<1	14.6	0.71	1.02	<0.01	0.05	0.52	0.7	2.30	2.2
Red Kandosol	S 116 / 0-10	5.2	6.0	0.04	102	2	<1	1.6	2.67	1.28	0.09	0.12	0.64	2.1	4.80	2.5
	S 116 / 20-30	5.3	5.9	0.02	72	1	<1	2.6	1.18	0.96	0.02	0.11	0.52	1.2	2.79	3.9
	S 116 / 50-60	5.7	5.9	0.01	58	2	<1	6.9	0.81	1.03	<0.01	0.04	0.45	0.8	2.33	1.7
	S 116 / 70-80	5.8	6.0	0.01	52	1	<1	10.6	0.64	0.96	0.20	0.02	0.50	0.7	2.32	0.9
Red Kandosol	S 139 / 0-10	4.9	5.6	0.02	67	1	<1	1.9	0.03	0.54	0.09	0.05	0.56	0.1	1.27	3.9
	S 139 / 20-30	4.9	5.3	0.01	58	1	<1	<1.0	0.04	0.61	0.06	0.05	0.31	0.1	1.07	4.7
	S 139 / 50-60	5.3	5.3	0.01	54	1	<1	<1.0	0.06	0.73	0.05	0.01	0.19	0.1	1.04	1.0
	S 139 / 70-80	5.6	5.5	0.01	58	1	<1	1.2	0.10	0.84	0.05	0.06	0.21	0.1	1.26	4.8
Red Kandosol	S 166 / 0-10	5.2	6.0	0.01	50	2	<1	1.1	2.32	1.42	0.05	0.04	0.44	1.6	4.27	0.9
	S 166 / 20-30	5.3	5.9	0.01	48	1	<1	3.1	0.85	1.23	0.05	0.06	0.27	0.7	2.46	2.4
	S 166 / 50-60	5.6	5.7	0.01	42	1	<1	9.4	0.50	1.26	0.03	0.03	0.36	0.4	2.18	1.4
	S 166 / 80-90	5.7	5.7	0.01	47	1	<1	12.8	0.45	1.27	0.02	0.02	0.28	0.4	2.04	1.0
	S 166 / 110-120	5.7	5.7	0.01	39	1	<1	8.4	0.39	1.06	0.02	0.01	0.35	<0.1	1.83	0.6

Soil Type	Site ID &	pH	pH	EC	Chloride	Nitrate N	Colwell P	Sulphur - KCl	Ca	Mg	K	Na	Al	Ca:Mg	CEC	ESP
	Depth (cm)	$CaCl_2$	H_2O	dS/m	mg/kg	mg/kg	mg/kg	mg/kg	Exchangeable cations me/100g						me/100g	%
Red	S 122 / 0-10	5.1	5.4	0.03	65	4	<1	4.8	0.22	0.26	0.17	0.06	0.37	0.8	1.08	5.6
Kandosol	S 122 / 20-30	4.9	5.0	0.02	65	3	<1	<1.0	0.06	0.20	0.14	0.04	0.30	0.3	0.74	5.4
(Deep Red)	S 122 / 50-60	5.0	5.1	0.01	53	1	<1	1.5	0.05	0.41	0.12	0.05	0.24	0.1	0.87	5.8
	S 122 / 80-90	4.9	5.0	0.01	50	1	<1	<1.0	0.06	0.31	0.10	<0.01	0.29	0.2	0.76	<0.1
	S 122 / 110-120	5.0	5.1	0.01	52	1	<1	1.0	0.32	0.66	0.10	0.08	0.59	0.5	1.75	4.6
Yellow	S 8 / 0-10	4.8	5.7	0.04	35	3	<1	2.0	2.42	1.85	<0.01	0.23	0.93	1.3	5.43	4.2
Kandosol	S 8 / 20-30	ND	ND	0.02	16	2	ND	15.4	0.83	1.33	<0.01	0.12	0.44	0.6	2.72	4.4
	S 8 / 50-60	5.9	5.6	0.01	16	2	<1	30.7	0.13	1.38	0.30	0.08	0.38	0.1	2.27	3.5
	S 8 / 80-90	5.9	5.6	0.01	14	2	<1	30.4	0.20	1.25	0.22	0.07	0.36	0.2	2.10	3.3
	S 8 / 110-120	5.9	5.6	0.01	14	2	<1	30.4	0.20	1.25	0.22	0.07	0.36	0.2	2.10	3.3

ND = No Data

Table 2: Results of Soil Physical Analyses for 14 Soil Profiles in the South of Embley Project Area

Soil Type	Site ID & Depth (cm)	Zn mg/kg	Cu mg/kg	Fe mg/kg	Mn mg/kg	Extrac B mg/kg	Total N mg/kg	Organic C %	Clay %	Silt %	Fine Sand %	Coarse Sand %	Gravel %
Red Kandosol	S 1 / 0-10	8.7	3.3	17000	840	0.5	1437	3.1	ND	ND	ND	ND	ND
	S 1 / 20-30	7.9	2.4	17000	620	0.5	661	1.7	ND	ND	ND	ND	ND
	S 1 / 50-60	6.5	2.0	18000	460	<0.5	393	1.1	ND	ND	ND	ND	ND
	S 1 / 70-80	6.6	1.4	19000	250	<0.5	287	0.8	ND	ND	ND	ND	ND
Red Kandosol	S 2 / 0-10	7.1	1.9	19000	600	0.6	1552	2.5	ND	ND	ND	ND	ND
	S 2 / 20-30	8.7	1.9	19000	600	0.5	805	2.0	ND	ND	ND	ND	ND
	S 2 / 30-40	11.0	2.4	21000	470	<0.5	464	1.1	ND	ND	ND	ND	ND
	S 2 / 50-60	8.1	1.6	17000	300	<0.5	333	1.0	ND	ND	ND	ND	ND
Red Kandosol	S 3 / 0-10	6.8	1.5	17000	570	<0.5	1319	2.4	21	8	24	17	30
	S 3 / 20-30	7.1	1.3	17000	520	<0.5	871	2.0	27	9	22	14	28
	S 3 / 50-60	6.9	1.4	19000	340	<0.5	731	1.3	29	7	22	12	30
	S 3 / 70-80	6.6	1.1	19000	330	<0.5	443	0.9	29	6	18	15	32
Red Kandosol	S 4 / 0-10	5.9	2.1	14000	600	<0.5	1353	2.6	27	10	28	24	11
	S 4 / 20-30	7.2	2.0	15000	440	<0.5	818	1.9	32	8	28	23	9
	S 4 / 50-60	6.5	1.5	15000	430	<0.5	480	1.0	31	8	29	20	12
	S 4 / 70-80	6.4	1.2	18000	250	<0.5	353	0.6	24	4	19	19	34
Red Kandosol	S 5 / 0-10	4.7	1.2	14000	410	0.6	1471	2.6	20	14	27	27	12
	S 5 / 20-30	4.6	0.9	14000	330	<0.5	861	1.8	28	9	29	22	12
	S 5 / 50-60	5.5	0.7	16000	160	<0.5	432	0.9	23	8	21	18	30
Red Kandosol	S 34 / 0-10	6.8	2.8	28000	530	<0.5	1748	2.6	23	8	24	25	20
	S 34 / 20-30	7.4	2.5	31000	53	<0.5	519	1.7	27	7	23	15	28
	S 34 / 50-60	7.0	1.7	27000	24	<0.5	407	0.9	16	3	14	15	52
Red	S 48 / 0-10	8.6	1.8	46000	450	<0.1	1031	1.4	ND	ND	ND	ND	ND

Soil Type	Site ID & Depth (cm)	Zn mg/kg	Cu mg/kg	Fe mg/kg	Mn mg/kg	Extrac B mg/kg	Total N mg/kg	Organic C %	Clay %	Silt %	Fine Sand %	Coarse Sand %	Gravel %
Kandosol	S 48 / 20-30	9.1	1.8	43000	600	<0.5	635	1.4	ND	ND	ND	ND	ND
	S 48 / 50-60	7.8	1.0	44500	520	<0.1	605	1.1	ND	ND	ND	ND	ND
	S 48 / 80-90	7.4	0.9	46000	310	<0.1	243	0.7	ND	ND	ND	ND	ND
Red Kandosol	S 74 / 0-10	7.0	1.7	34000	490	<0.5	1551	2.0	24	7	25	23	21
	S 74 / 20-30	7.1	1.6	28000	530	<0.5	983	2.0	26	7	25	23	19
	S 74 / 50-60	6.5	1.2	29000	370	<0.1	471	1.0	25	5	25	19	26
	S 74 / 80-90	6.2	1.1	37000	210	<0.1	445	0.7	20	5	18	17	40
Red Kandosol	S 106 / 0-10	3.5	1.2	24000	440	<0.5	1394	2.6	19	10	29	25	17
	S 106 / 20-30	3.7	1.0	21000	430	<0.1	645	1.8	36	8	20	22	14
	S 106 / 50-60	5.0	0.7	24000	340	<0.1	381	0.9	35	4	30	18	13
	S 106 / 80-90	5.0	0.7	34000	180	<0.1	333	0.7	18	0	15	11	56
Red Kandosol	S 116 / 0-10	4.6	1.5	24000	450	<0.1	1373	2.5	26	4	42	22	6
	S 116 / 20-30	4.4	1.3	26000	460	<0.1	646	1.4	36	0	35	17	12
	S 116 / 50-60	4.5	1.0	27000	260	<0.1	314	0.7	41	0	35	14	10
	S 116 / 70-80	5.5	1.0	38000	160	<0.5	252	0.6	22	0	22	10	46
Red Kandosol	S 139 / 0-10	6.5	0.6	22000	68	0.6	1998	2.9	ND	ND	ND	ND	ND
	S 139 / 20-30	3.5	0.4	24000	32	0.6	733	1.8	ND	ND	ND	ND	ND
	S 139 / 50-60	5.3	0.9	32000	53	0.5	238	0.6	ND	ND	ND	ND	ND
	S 139 / 70-80	7.1	1.2	48000	140	<0.5	227	0.5	ND	ND	ND	ND	ND
Red Kandosol	S 166 / 0-10	5.2	1.3	16000	250	<0.5	932	1.6	25	7	40	26	2
	S 166 / 20-30	4.3	0.7	43000	140	<0.5	342	0.9	41	0	39	20	<1
	S 166 / 50-60	3.6	0.4	28000	58	<0.5	171	0.5	46	0	37	17	<1
	S 166 / 80-90	7.3	0.7	31000	46	<0.5	122	0.3	40	0	38	17	5
	S 166 / 110-120	6.3	0.5	49000	42	<0.5	226	0.3	16	0	21	18	45

Environmental Impact Statement

for South of Embley Project

Section 5
Appendix

APPENDIX 5A

GEOMORPHOLOGY

Table 4-2 Study site classification, stability assessment and general geomorphic descriptions

Site Number	Stream	Catchment	Latitude	Longitude	Stream Type	Rosgen Stream Type	Stability Value	Stability Rating	Notes
1a	Norman Tributary	Norman			4	C6	78	Stable	• meandering channel within flat floodplain • downstream of 5a and 7a • much greater flow than upstream sites (groundwater sourced) - introduces dilemmas for seepage from dam site • low longitudinal slope • more incised than upstream sites • minor slumping • undercutting of trees caused by past incision • sandy loam bank • velocities - 0.7-1 m / s
2a	Norman	Norman			2	E5	79.5	Mod. Stable	• high velocity (> 1 m /s in dry season) incised stream with sandy (white) bed with mixed clay • undercut of trees and bauxite in banks • exposed lateritic surface in bed and banks • active moderate bed incision in locations • similar environment to site 11 (Norman Ck tributary) • water sourced from lateritic facies
4	Norman	Norman			3	DA6	49	Stable	• source of Norman Creek
4a	Norman	Norman			4	C6	99	Mod. Unstable	• swamp with minor flow due to low slope drops into a headcutting stream • 20 m downstream of headcut, stream becomes more well-formed • stream D/S of 4a used to be supplied with water from preferential pathways • during a large flow, headcutting pathway has hit a very erodible section of swamp and caused a massive "blowout, causing major bed and bank scour and failure
5a	Norman Tributary	Norman			4	C5	70	Stable	• - moderate incision • similar to site 2A, except not in wetland / swamp • similar creek to that D/S of site 4 • distinct channel • 0.5 - 0.7 m / s flow (several cumecs discharge) • low flow velocity (with very small upstream catchment • meandering channel within flat floodplain

									• sandy loam bank material • easily erodible - hence, consistent (but minor) undercutting, fed by past minor incision • low bed slope
7a	Norman Tributary	Norman			5	B5	82.5	Mod. Unstable	• moderately confined valley with meandering , moderately incised channel • bank composed of sandy loam • bank undercut at bends and obstructions • despite undercut, banks are relatively stable • distinct channel • perennial stream • good flow (30-50cm/s)
9a	Winda Winda	Triluck			4	C5	67	Stable	• distinct channel with obvious low flow, active and bankfull channel demarcation • obvious demarcation between channel and floodplain • bank - dark brown sandy loam (more developed soil horizon) • some groundwater influence - velocities increase downstream of stream crossing • minor bed deposition - inhabited by pioneer grass species • meandering stream • minor undercutting at points (easily erodible soil)
11	Norman Tributary	Norman			1	E6	63.5	Stable	• large depression in landscape where groundwater (in bauxite layer) escapes • incised stream in wetland • appears to be in more erodible material • stream may be forging its way through swamp after an initial knickpoint • high velocity (30-40cm / s) • hydraulic head causing these velocities • despite incision, not much active geomorphic change
14a	Coconut	Coconut			4	C6	70	Stable	• broad dish shaped channel with vegetation on both banks (upper and lower) • no incision (minor in thalweg) • clayey bank • stable • intermittent stream • slower velocity (wide) (50 cm / s) but obviously high discharge • flat irregular meandering stream with no incision • stable

19	??	Triluck			3	DA6	51.5	Stable	• - "flowing swamp" feature similar to U/S of Site 4 • a very unobvious channel - slight depression in a swamp that acts like a channel - fed by groundwater discharge • well vegetated on banks and bed • low slope • clayey silt bed and banks • very stable • noticeable "springs" discharging water from lateritic surface into channel

25a	Coconut	Coconut			4	C5	68	Stable	• moderately incised - bench evidence
									• no apparent current incision
									• stream type - floodplain with incised channel
									• stable rocky banks
									• appears closer to lateritic facies
									  • weathered rock bank
									  • potentially more water discharge into channel
									• velocity > 1m / s (up to ~2m /s)
									• incised straight (slightly sinuous) stream in floodplain
									• similar to stream type 4 but less meandering

26					6	B6	48	Stable	• - chain of ponds within moderately sloped valley • stream type 6 • decent flow in parts (30cm /s) but lots of backwaters • good riparian vegetation • intermittent (although wet for long periods) • stable • clay bed and 'banks' • groundwater fed • no scour anywhere

Table C-1 Stability assessments for the Dam C monitoring study sites

Site Number	1a	5a	7a
Location relative to dam	AW	W/in	U/S
1. Landform Slope	6	6	4
2. Mass wasting	6	6	6
3. Debris Jam Potential	6	4	6
4. Vegetation Protection	3	3	3
5. Channel Capacity	1	1	1
6. Bank rock content	8	8	8
7. Obstructions	4	4	5
8. Cutting	4	4	4
9. Deposition	2	2	4
10. Rock Angularity	4	4	10
11. Brightness	3	3	2
12. Consolidation	3	3	3
13. % Stable Materials	2	2	2.5
14. Scouring / Depositing	8	8	8
15. Aquatic Vegetation	18	12	12
Overall Bank Stability	40	38	41
Overall Bed Stability	38	32	37.5
Overall channel stability	78	70	78.5
Stability Rating	Stable	Stable	Mod. Stable

Note: AW – At proposed dam wall; W/in – within proposed inundation area; U/S – upstream of proposed inundation area; T – unaffected tributary

Appendix 1 Site Assessment Proforma

SITE DETAILS

Site No: [_____] Catchment: [_____] River/Stream: [_____] Date: [_____] Time: [_____]

Recorders Name: [_____] Water level/Flow: [_____] GPS XY: [_____] AMTD: [_____]

Site Description & Landuse:[_____]

PHOTOS

Channel Dimensions	Photo Number 1	Photo Number 2	Photo Number 3	Photo Number 4
Upstream				
Downstream				
Right Bank				
Left Bank				
Feature				

PHYSICAL FORM AND STYLE

Channel Dimensions	Width	Height
Low flow		
Active channel		
Bankfull		

Stream Type (Rosgen 1996)	

Dominant Bed material	No : [____]				
1. Clay (< 2µm)	2. Silt (2µm - 63µm)	3. Sand (63µm – 2mm)	4: Gravel (2mm – 60mm)	5. Boulders (> 60mm)	6. Bedrock

Hydrology	No: [_____]				
Inspection conditions at time of assessment	1. No flow (includes wetlands or intermittent ponds)	2. Low flow (normal base-flow water level)	3. Moderate flow (higher than normal, some terrestrial vegetation submerged)	4. Bankfull	5. Flood
Current Form due to	Drought	Flood	Variable flows		

Upper banks:	Excellent	Good	Fair	Poor
1. Landform Slope	Bank slope gradient <30% **Score: 2**	Bank slope gradient 30-40% **Score: 4**	Bank slope gradient 40-60% **Score: 6**	Bank slope gradient 60%+ **Score: 8**
2. Mass Wasting or Failure (existing or potential)	No evidence of past or any potential for future mass wasting into channel. **Score: 3**	Infrequent and/or very small. Mostly healed over. Low future potential. **Score: 6**	Moderate frequency & size, with some raw spots eroded by water during high flows. **Score: 9**	Frequent or large, causing sediment nearly yearlong OR imminent danger of same. **Score: 12**
3. Debris Jam Potential (floatable objects)	Essentially absent from immediate channel area **Score: 2**	Present but mostly small twigs and limbs. **Score: 4**	Present, volume and size are both increasing. **Score: 6**	Moderate to heavy amounts, predominantly larger sizes. **Score: 8**
4. Vegetative Bank Protection	90% + plant density. Vigour and variety suggest a deep, dense, soil binding, root mass. **Score: 3**	70-90% density. Fewer plant specimens or lower vigour suggests a less dense or deep root mass. **Score: 6**	50-70% density. Lower vigour and still fewer species form a somewhat shallow and discontinuous root mass. **Score: 9**	< 50% density plus fewer species & less vigour indicate poor, discontinuous, and shallow root mass. **Score: 12**
Lower banks:				
5. Channel Capacity	Ample for present plus some increases. Peak flows contained. W/D ratio < 7. **Score: 1**	Adequate. Overbank flows rare. Width to Depth (W/D) ratio 8 to 15. **Score: 2**	Barely contains present peaks. Occasional overbank floods. W/D ratio 15 to 25. **Score: 3**	Inadequate. Overbank flows common. W/D ratio > 25. **Score: 4**
6. Bank Rock Content	65% with large, angular boulders 12"+ numerous. **Score: 2**	40 to 65%, mostly small boulders to cobbles 6-12". **Score: 4**	20 to 40%, with most in the 3-6" diameter class. **Score: 6**	<20% rock fragments of gravel sizes, 1-3" or less. **Score: 8**
7. Obstructions Flow Deflectors Sediment Traps	Rocks and old logs firmly embedded. Flow pattern without cutting or deposition. Pools and riffles stable. **Score: 2**	Some present, causing erosive cross currents and minor pool filling. Obstructions and deflectors newer and less firm. **Score: 4**	Moderately frequent, moderately unstable obstructions & deflectors move with high water causing bank cutting and filling of pools. **Score: 6**	Frequent obstructions and deflectors cause bank erosion yearlong. Sediment traps full, channel migrations occurring **Score: 8**
8. Cutting	Little or none evident. Infrequent raw banks less than 6" high generally. **Score: 4**	Some, intermittently at outcurves and constrictions. Raw banks may be up to 12". **Score: 8**	Significant. Cuts 12"-24" high. Root mat overhangs and sloughing evident. **Score: 12**	Almost continuous cuts, some over 24" high. Failure of overhangs frequent. **Score: 16**
9. Deposition	Little or no enlargement of channel or point bar. **Score: 2**	Some new increase in bar formation, mostly from coarse gravels. **Score: 4**	Moderate deposition of new gravel and coarse sand on old and some new bars. **Score: 6**	Extensive deposits of predominantly fine particles. Accelerated bar development. **Score: 8**
Bottom:				
10. Rock Angularity (if no rocks, Score 4)	Sharp edges and corners, plane surfaces roughened. **Score: 4**	Rounded corners and edges, surfaces smooth and flat. **Score: 8**	Corners & edges well rounded in two dimensions. **Score: 12**	Well rounded in all dimensions, surfaces smooth. **Score: 16**
11. Brightness	Surface dull, darkened, or stained. Generally not "bright". **Score: 1**	Mostly dull, but may have up to 35% bright surfaces. **Score: 2**	Mixture, 50-50% dull and bright, +or- 15% i.e. 35-65%. **Score: 3**	Predominantly bright, 65%+ exposed or scoured surfaces. **Score: 4**
12. Consolidation or Particle Packing	Assorted sizes tightly packed and/or overlapping. **Score: 1**	Moderately packed with some overlapping. **Score: 2**	Mostly a loose assortment with no apparent overlap. **Score: 3**	No packing evident. Loose assortment, easily moved. **Score: 4**
13. Bottom Size Distribution and Percent Stable Materials	No change in sizes evident. Stable materials 80-100%. **Score: 1**	Slight shift in either direction. Stable materials 50-80%. **Score: 2**	Moderate change in sizes, stable materials 20-50%. **Score: 3**	Marked distribution change. Stable materials 0-20%. **Score: 4**
14. Scouring and Depositing	Less than 5% of the bottom affected by scouring and deposition. **Score: 4**	5-30% affected. Scour at constrictions and where grades steepen. Some deposition in pools. **Score: 8**	30-50% affected. Deposits & scour at obstructions, constrictions, and bends. Some filling of pools. **Score: 12**	More than 50% of the bottom in a state of flux or change nearly yearlong. **Score: 16**
15. Clinging Aquatic Vegetation (Measuring Algae)	Abundant. Growth largely moss-like, dark green, perennial. In swift water too. **Score: 6**	Common. Algal forms in low velocity & pool areas. Moss here too and swifter waters. **Score: 12**	Present but spotty, mostly in backwater areas. Seasonal blooms make rocks slick. **Score: 18**	Perennial types scarce or absent. Yellow-green, short term bloom may be present. **Score: 24**
TOTAL				
			SITE TOTAL	

TOTAL TO BE RATED AGAINST STREAM TYPE

Cross Section
Notes

Appendix 2 Site Photographs

Site 1a	
Right Bank	**Left Bank**
Upstream	**Downstream**

Site 2a

Right Bank

Left Bank

Upstream

Downstream

Site 4 and Site 4a	
Site 4	**Site 4a – Upstream**
Upstream	**Site 4a – Downstream**

Site 5a

Right Bank

Floodplain

Upstream

Downstream

Site 7a

Right Bank

Left Bank

Upstream

Downstream

Site 9a	
Right Bank	**Left Bank**
Upstream	**Downstream**

Site 11	
Right Bank	**Bed**
Upstream	**Downstream**

Site 14a	
Right Bank	**Left Bank**
Upstream	**Downstream**

Site 19

Right Bank

Left Bank

Upstream

Downstream

Site 25a

Right Bank

Bed

Upstream / LB

Downstream

Site 26

Right Bank

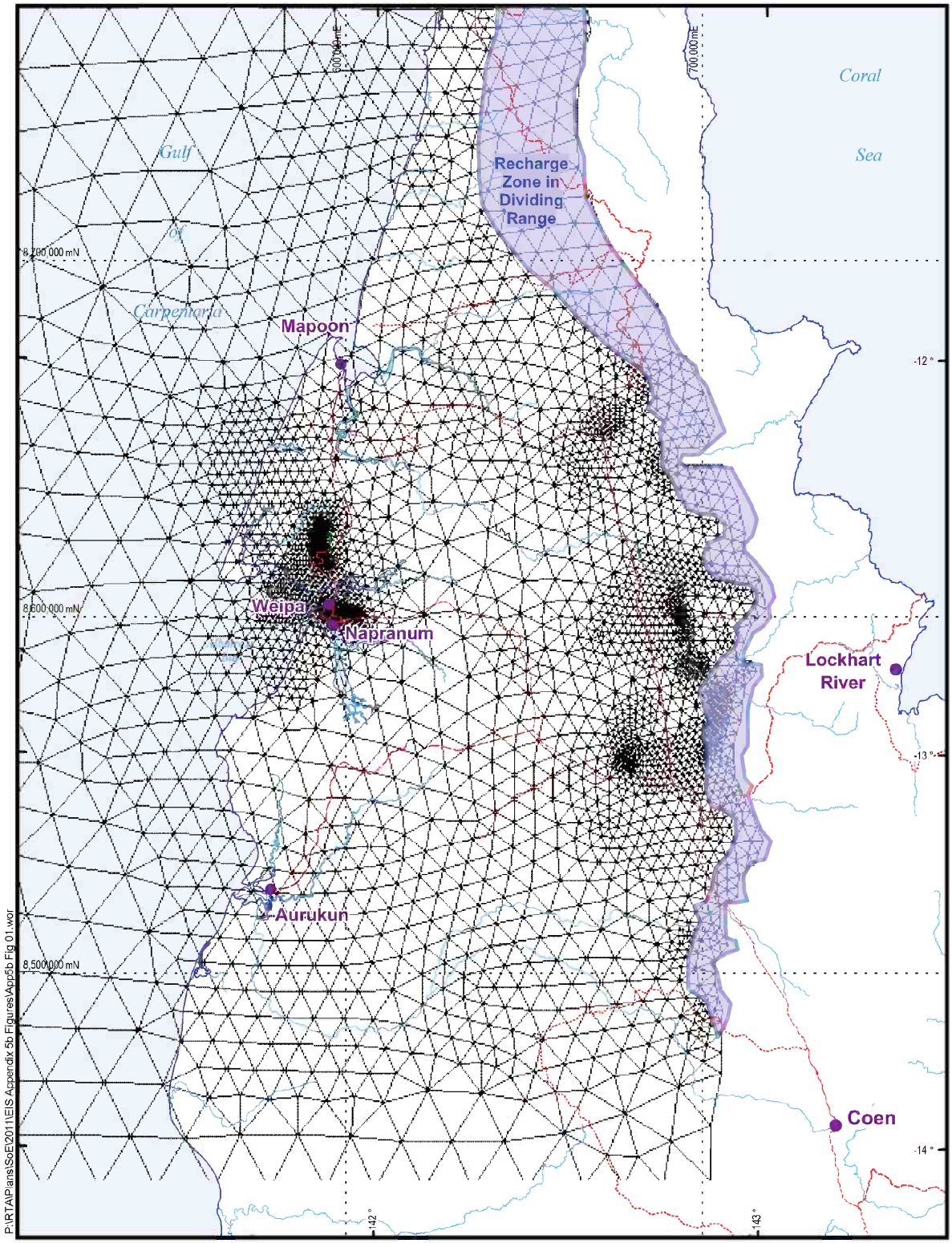
Left Bank

Upstream

Downstream

APPENDIX 5B

ARTESIAN GROUNDWATER



P:\RTAIP\ans\SoE2011\EIS Appendix 5b Figures\App5b Fig 01.wor

Recharge area
Township
River
Road/track

South of Embley Project

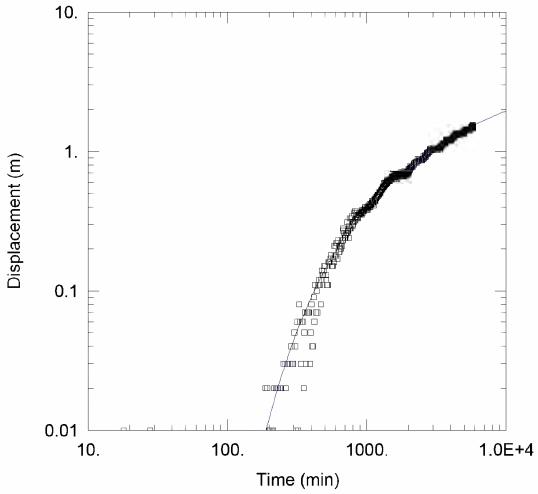
Appendix 5B: Fig. 1

Feflow Model
Finite Element Mesh

N

0 50km

Datum/Projection: GDA94/MGA Zone 54 Date: 05/01/2011



ART10 PUMPING TEST - OBSERVATION WELL ART11

PROJECT INFORMATION

Company: Golder Associates
Client: RTA Weipa
Project: 077636002
Location: ANDOOM ARTESIAN BOREFIELD
Test Well: ART10 - 71.5 L/s (6178 m3/d)
Test Date: 13 - 17 Feb2007

SOLUTION

Aquifer Model: Confined
Solution Method: Theis

T = 588.6 m^2/day
S = 0.0002048
Kz/Kr = 1.
b = 184. m

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
ART10	0	0

Observation Wells

Well Name	X (m)	Y (m)
ART11	0	2160

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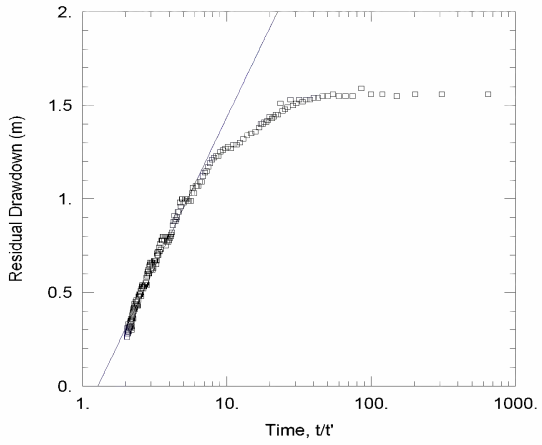
South of Embley Project

Appendix 5B: Fig. 2

ART10 Pumping Test Analysis for Drawdown at ART11

Date: 05/01/2011



ART10 PUMPING TEST -ART11 RECOVERY ANALYSIS

PROJECT INFORMATION

Company: Golder Associates
Client: RTA Weipa
Project: 077636002
Location: Andoom Artesian Borefield
Test Well: ART10
Test Date: 17 Feb 2007

SOLUTION

Aquifer Model: Confined
Solution Method: Theis (Recovery)
T = 704. m^2/day
S/S' = 1.284

AQUIFER DATA

Saturated Thickness: 184. m

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
ART10	0	0

Observation Wells

Well Name	X (m)	Y (m)
ART11	2160	0

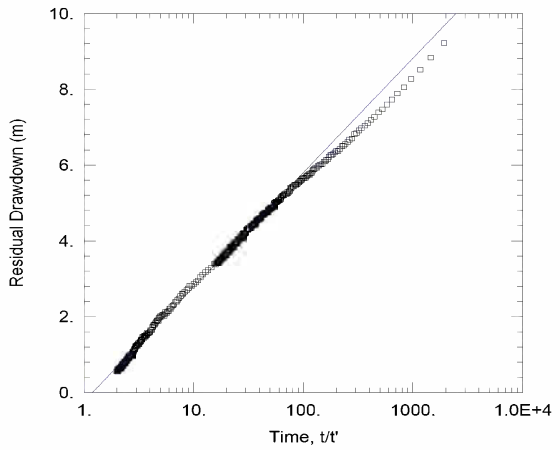
RioTintoAlcan

South of Embley Project

Appendix 5B: Fig. 3

ART10 Pumping Test Analysis for Drawdown at ART11

Date: 05/01/2011



ART10 PUMPING TEST RECOVERY ANALYSIS

PROJECT INFORMATION

Company: Golder Associates
Client: RTA Weipa
Project: 077636002
Location: Andoom Artesian Borefield
Test Well: ART10
Test Date: 17 Feb 2007

SOLUTION

Aquifer Model: Confined
Solution Method: Theis (Recovery)

T = 375.3 m^2/day
S/S' = 1.2

AQUIFER DATA

Saturated Thickness: 170. m

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
art10	0	0

Observation Wells

Well Name	X (m)	Y (m)
art10	0.1	0

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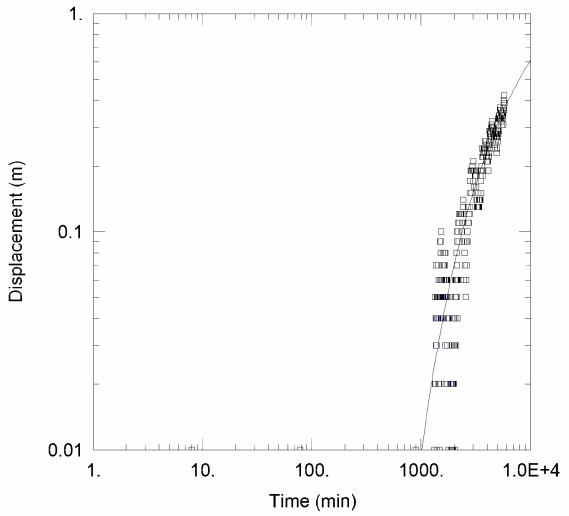
South of Embley Project

Appendix 5B: Fig. 4

ART10 Pumping Test Analysis for Drawdown at ART10

Date: 05/01/2011



ART10 PUMPING TEST - OBSERVATION WELL ART12

PROJECT INFORMATION

Company: Golder Associates
Client: RTA Weipa
Project: 077636002
Location: ANDOOM ARTESIAN BOREFIELD
Test Well: ART10
Test Date: 13 - 17 Feb2007

SOLUTION

Aquifer Model: Confined
Solution Method: Theis

T = 748.5 m^2/day
S = 0.0003429
Kz/Kr = 1.
b = 170. m

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
ART10	0	0

Observation Wells

Well Name	X (m)	Y (m)
ART12	0	4210

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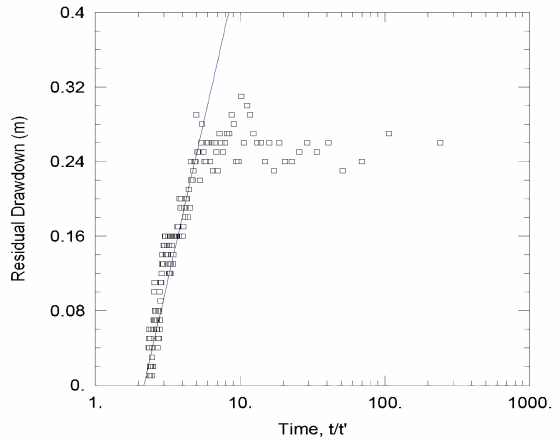
South of Embley Project

Appendix 5B: Fig. 5

ART10 Pumping Test Analysis for Drawdown at ART12

Date: 05/01/2011



ART12 PUMPING TEST - ART10 RECOVERY ANALYSIS

PROJECT INFORMATION

Company: Golder Associates
Client: RTA Weipa
Project: 077636002
Location: Andoom Artesian Borefield
Test Well: ART12
Test Date: 28 Feb 2007

SOLUTION

Aquifer Model: Confined
Solution Method: Theis (Recovery)
T = 1829. m^2/day
S/S' = 2.179

AQUIFER DATA

Saturated Thickness: 114. m
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells			Observation Wells		
Well Name	X (m)	Y (m)	Well Name	X (m)	Y (m)
ART12	0	0	ART10	4210	0

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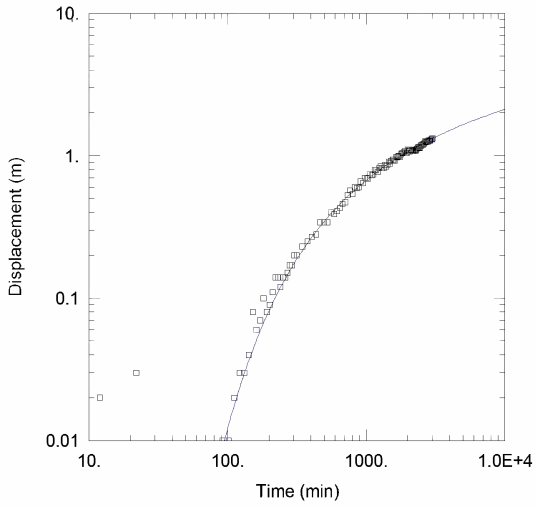
South of Embley Project

Appendix 5B: Fig. 6

ART12 Pumping Test Analysis for Drawdown at ART10

Date: 05/01/2011



ART12 PUMPING TEST - OBSERVATION WELL ART11

PROJECT INFORMATION

Company: Golder Associates
Client: RTA Weipa
Project: 077636002
Location: ANDOOM ARTESIAN BOREFIELD
Test Well: ART12 - 79 L/s (6178 m3/d)
Test Date: 21 - 23 Feb2007

SOLUTION

Aquifer Model: Confined
Solution Method: Theis

T = 779. m^2/day
S = 0.0001421
Kz/Kr = 1.
b = 184. m

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
ART12	0	0

Observation Wells

Well Name	X (m)	Y (m)
ART11	0	2060

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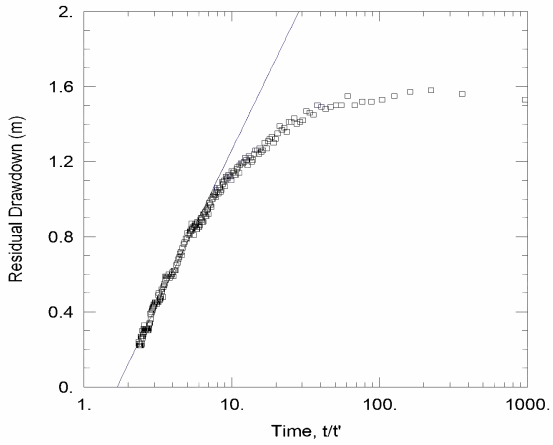
South of Embley Project
Appendix 5B: Fig. 7

ART12 Pumping Test Analysis for Drawdown at ART11

Date: 05/01/2011



ART12 PUMPING TEST - ART11 RECOVERY ANALYSIS

PROJECT INFORMATION

Company: Golder Associates
Client: RTA Weipa
Project: 077636002
Location: Andoom Artesian Borefield
Test Well: ART12
Test Date: 28 Feb 2007

SOLUTION

Aquifer Model: Confined
Solution Method: Theis (Recovery)
T = 769.5 m^2/day
S/S' = 1.679

AQUIFER DATA

Saturated Thickness: 184. m

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells			Observation Wells		
Well Name	X (m)	Y (m)	Well Name	X (m)	Y (m)
ART12	0	0	ART11	2060	0

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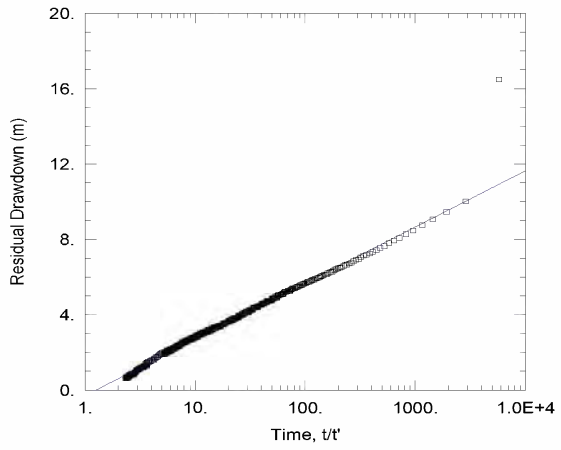
South of Embley Project

Appendix 5B: Fig. 8

ART12 Pumping Test Analysis for Recovery at ART11

Date: 05/01/2011



ART12 PUMPING TEST RECOVERY ANALYSIS

PROJECT INFORMATION

Company: Golder Associates
Client: RTA Weipa
Project: 077636002
Location: Andoom Artesian Borefield
Test Well: ART12
Test Date: 28 Feb 2007

SOLUTION

Aquifer Model: Confined
Solution Method: Theis (Recovery)

T = 419.3 m^2/day
S/S' = 1.259

AQUIFER DATA

Saturated Thickness: 133. m

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
art12	0	0

Observation Wells

Well Name	X (m)	Y (m)
art12	0.1	0

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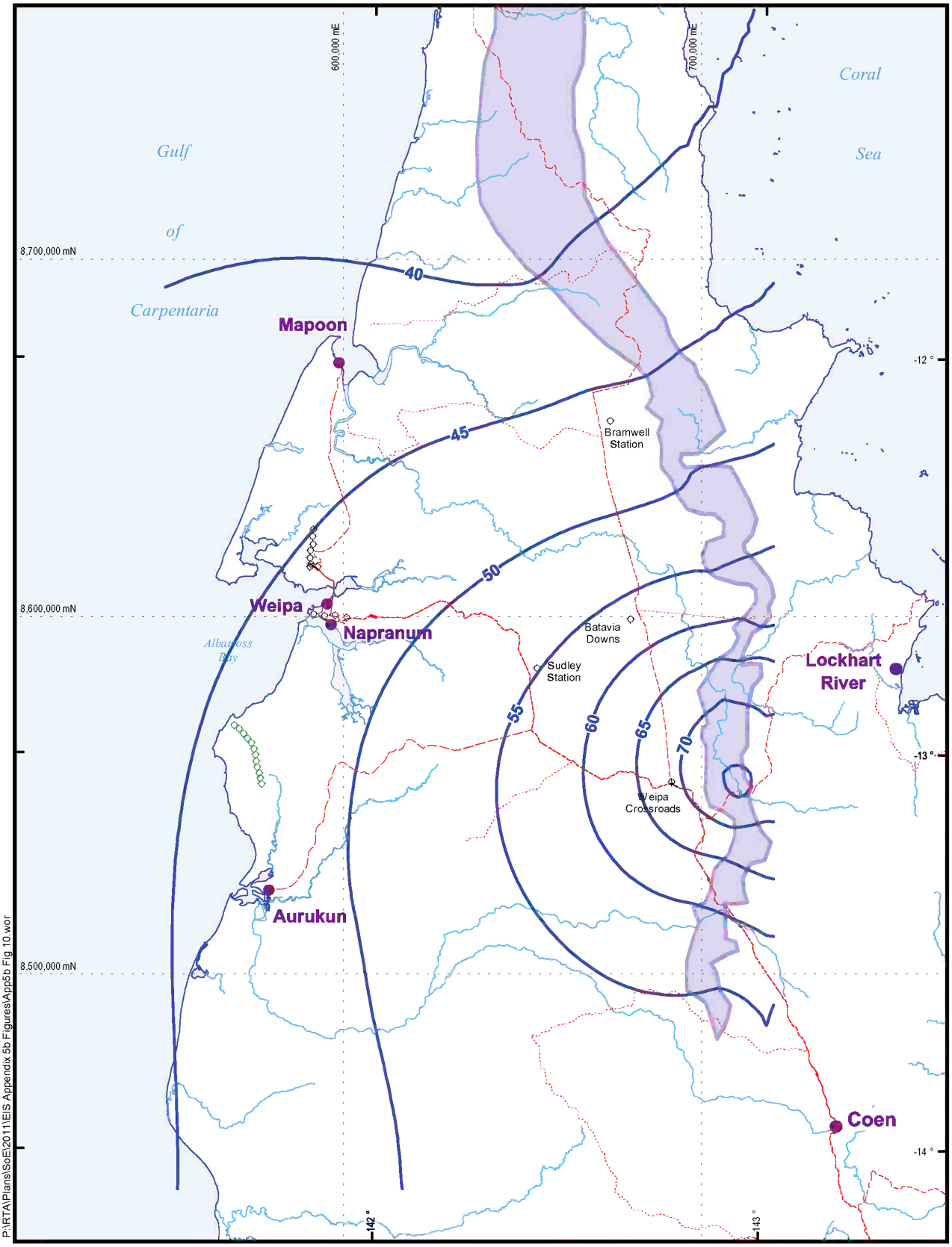
South of Embley Project

Appendix 5B: Fig. 9

ART12 Pumping Test Analysis for Recovery at ART12

Date: 05/01/2011



P:\RTA\Plans\SoE\2011\EIS Appendix 5b Figures\App5b Fig 10.wor

Recharge area
Township
River
Road/track
Existing Borehole
Proposed Borehole

Rio Tinto Alcan

South of Embley Project

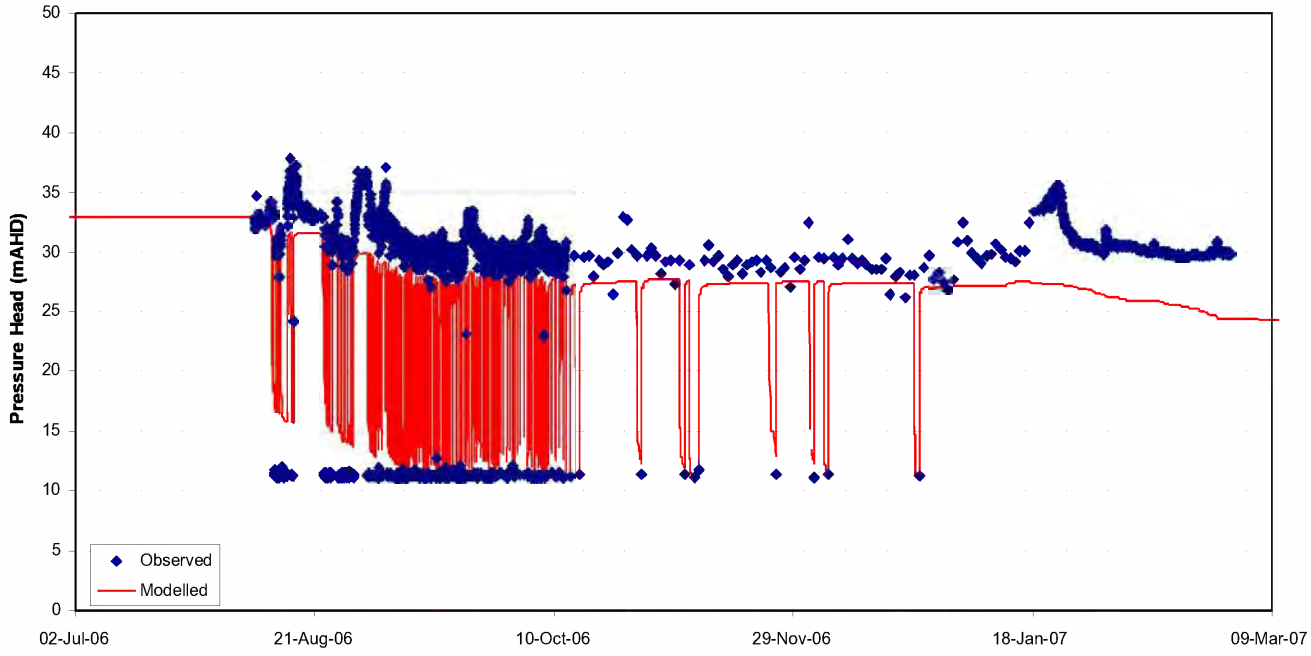
Appendix 5B: Fig. 10

Contoured Head (m AHD) Calibration for 1971

N

0 50km

Datum/Projection: GDA94/MGA Zone 54 Date: 05/01/2011



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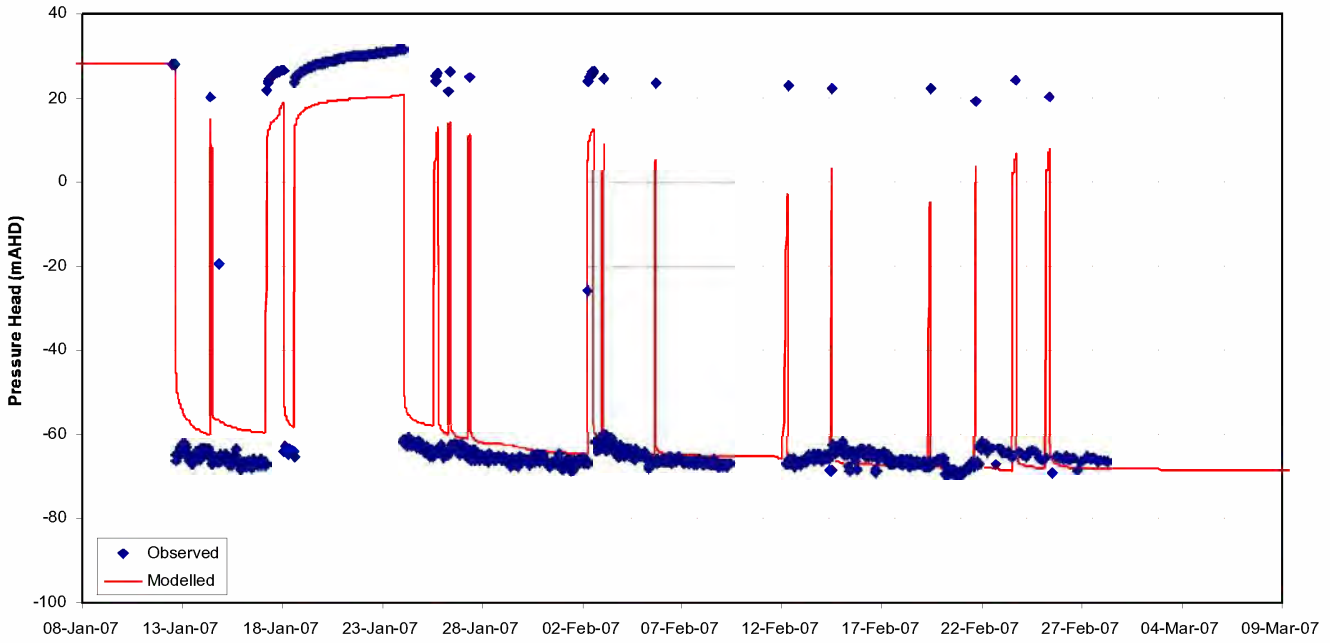
Appendix 5B: Fig. 11

ART5 Transient Calibration Plot

Date: 05/01/2011



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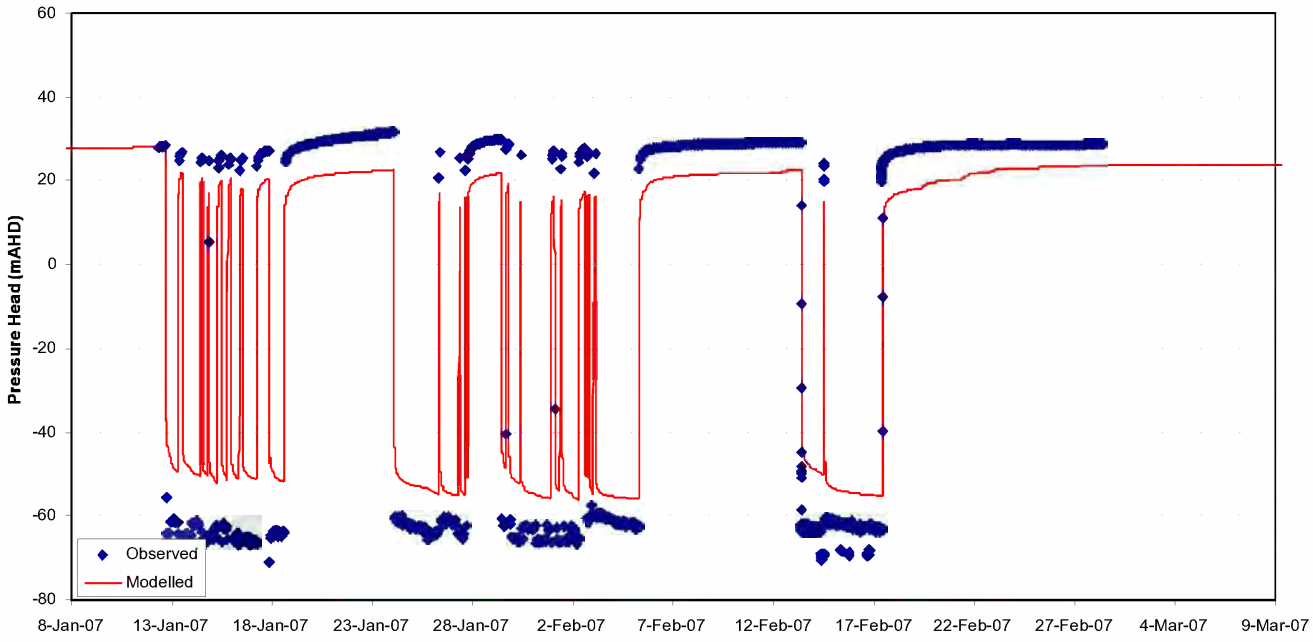
South of Embley Project

Appendix 5B: Fig. 12

ART9 Calibration Plot for February 2007 Pumping Test

Date: 05/01/2011



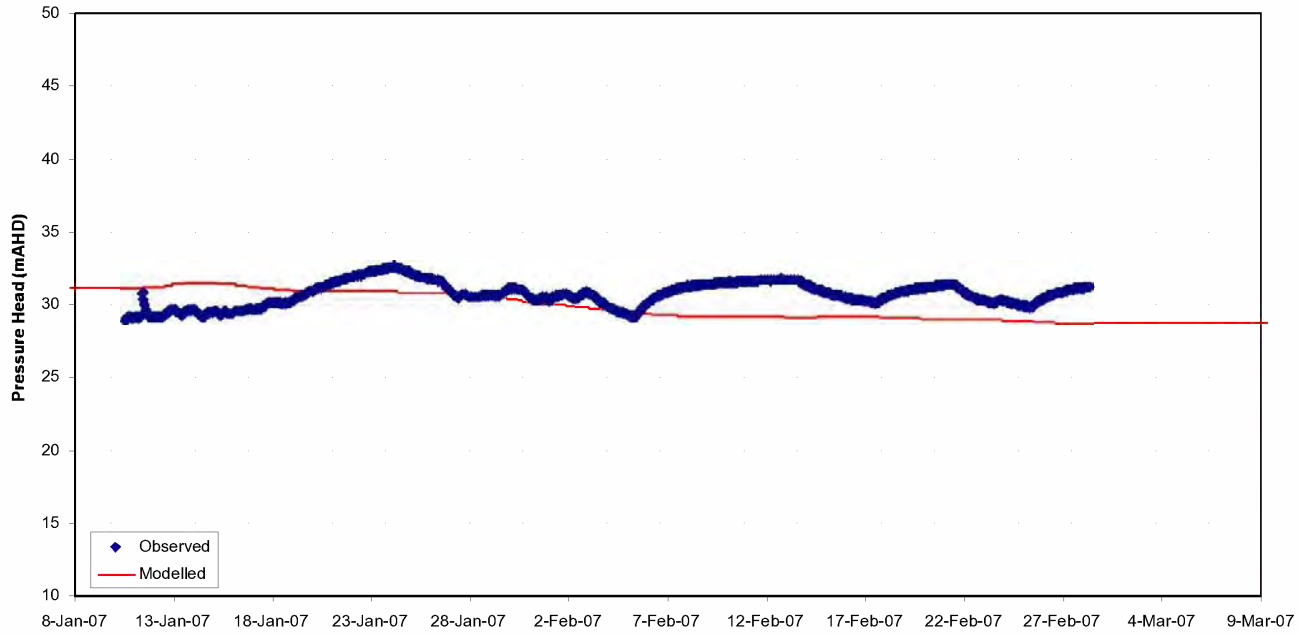
RioTintoAlcan

South of Embley Project

Appendix 5B: Fig. 13

ART10 Calibration Plot for February 2007 Pumping Test

Date: 05/01/2011



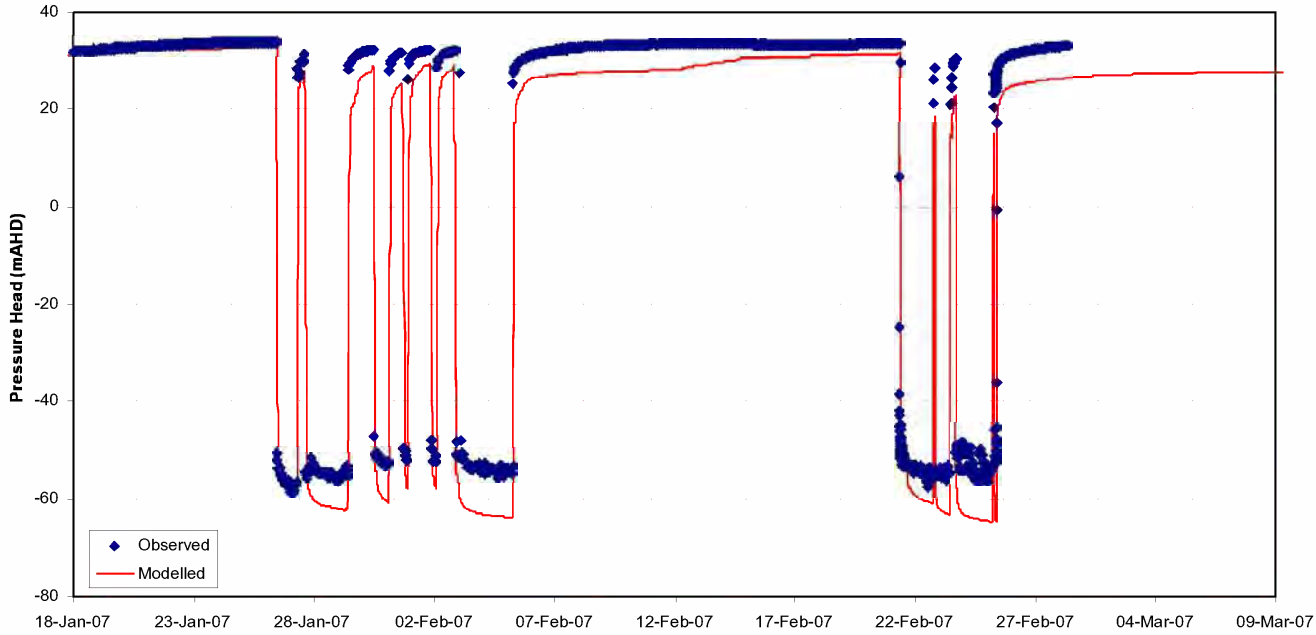
RioTintoAlcan

South of Embley Project

Appendix 5B: Fig. 14

ART11 Calibration Plot for February 2007 Pumping Test

Date: 05/01/2011



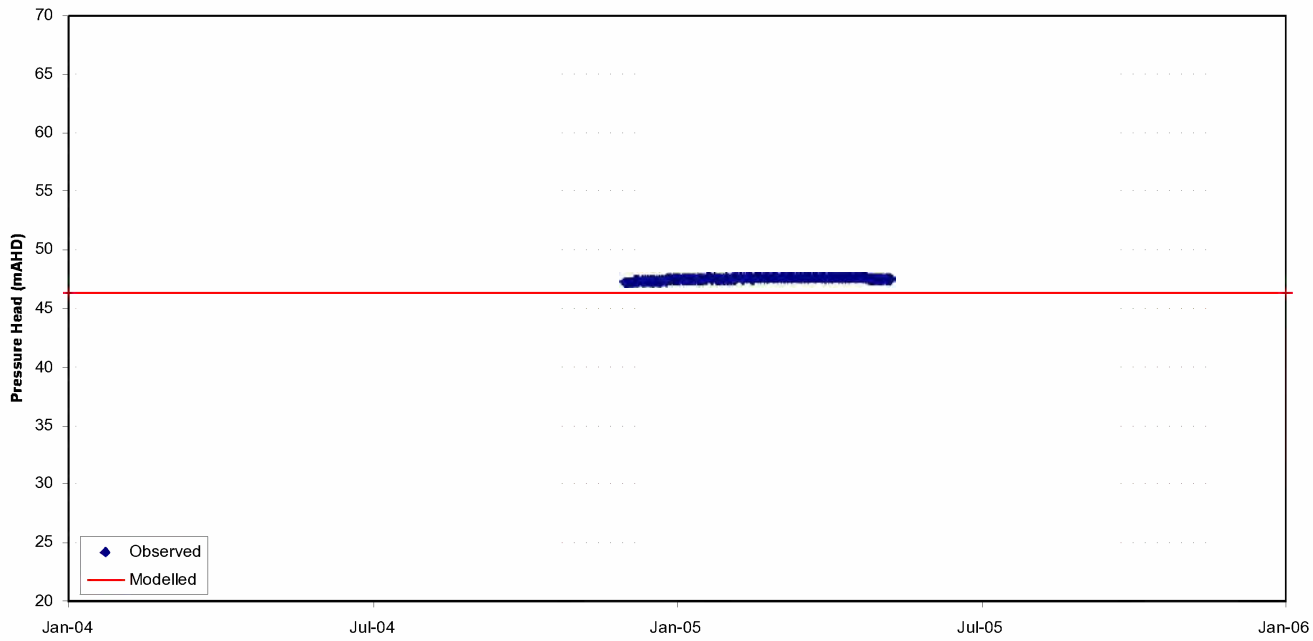
RioTintoAlcan

South of Embley Project

Appendix 5B: Fig. 15

ART12 Calibration Plot for February 2007 Pumping Test

Date: 05/01/2011



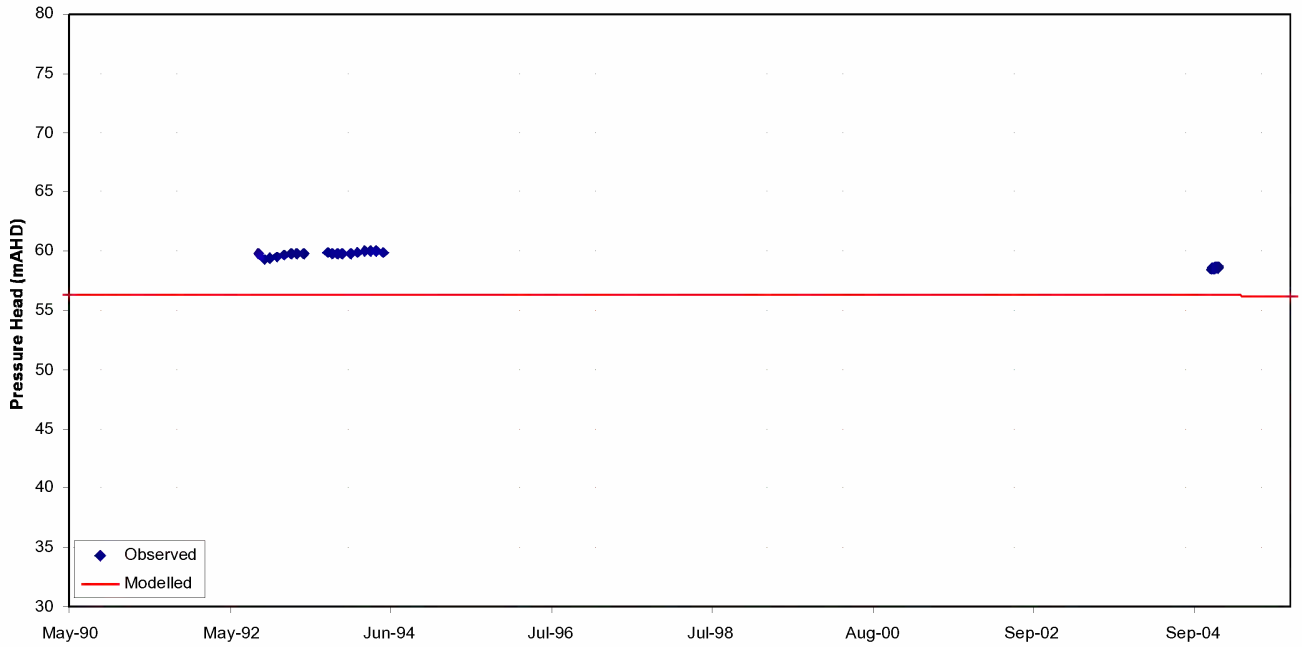
RioTintoAlcan

South of Embley Project

Appendix 5B: Fig. 16

Transient Calibration Plot
Bramwell Station Bore

Date: 05/01/2011



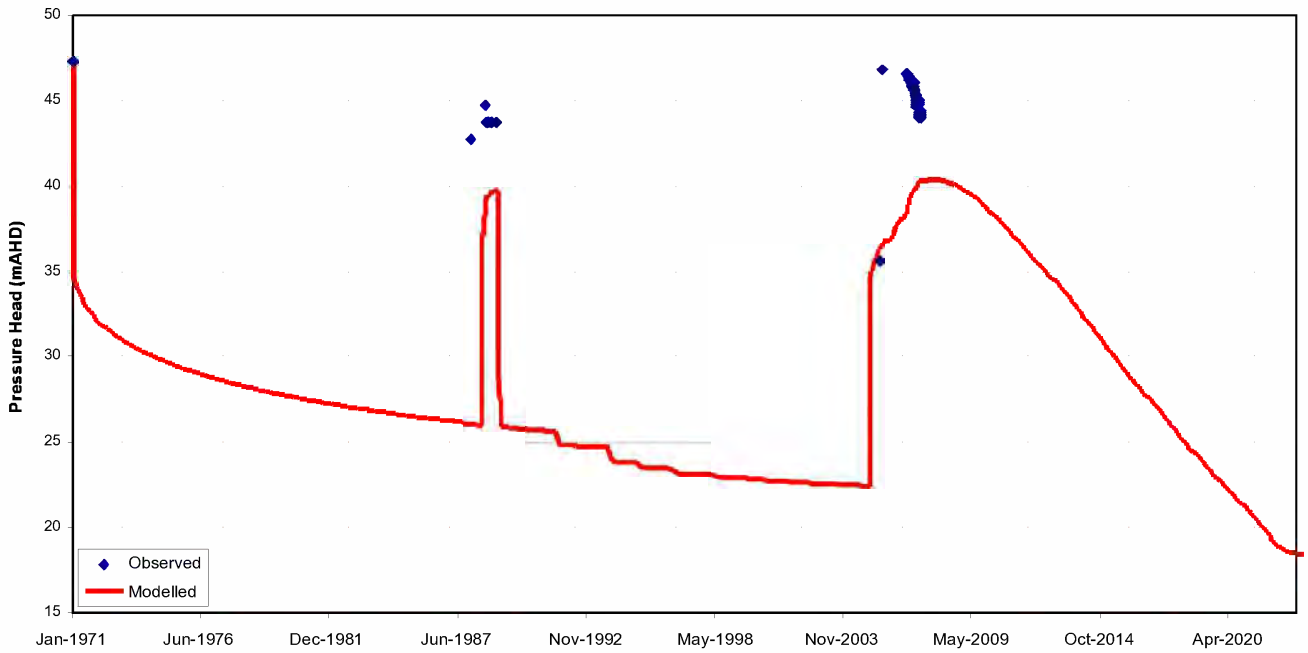
RioTintoAlcan

South of Embley Project

Appendix 5B: Fig. 17

Transient Calibration Plot
Batavia Downs Station Bore

Date: 05/01/2011



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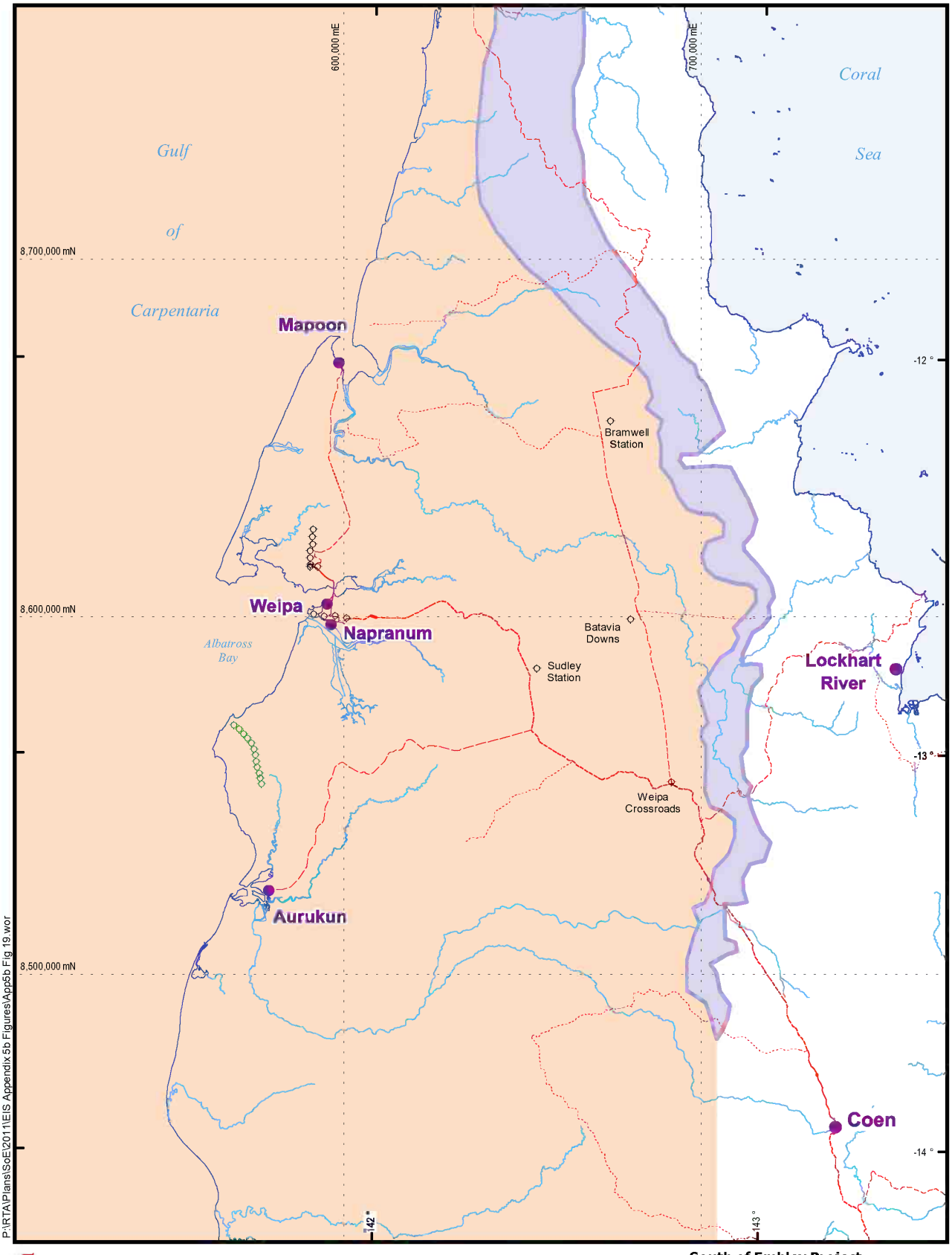
Appendix 5B: Fig. 18

ART4 Transient Calibration 1971

Date: 05/01/2011



P:\RTA\Plans\SoE\2011\EIS Appendix 5b Figures\App5b Fig 19.wor

Recharge area
Township
River
Road/track
Existing Borehole
Proposed Borehole
1.6 m/d
1.0 m/d

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South of Embley Project

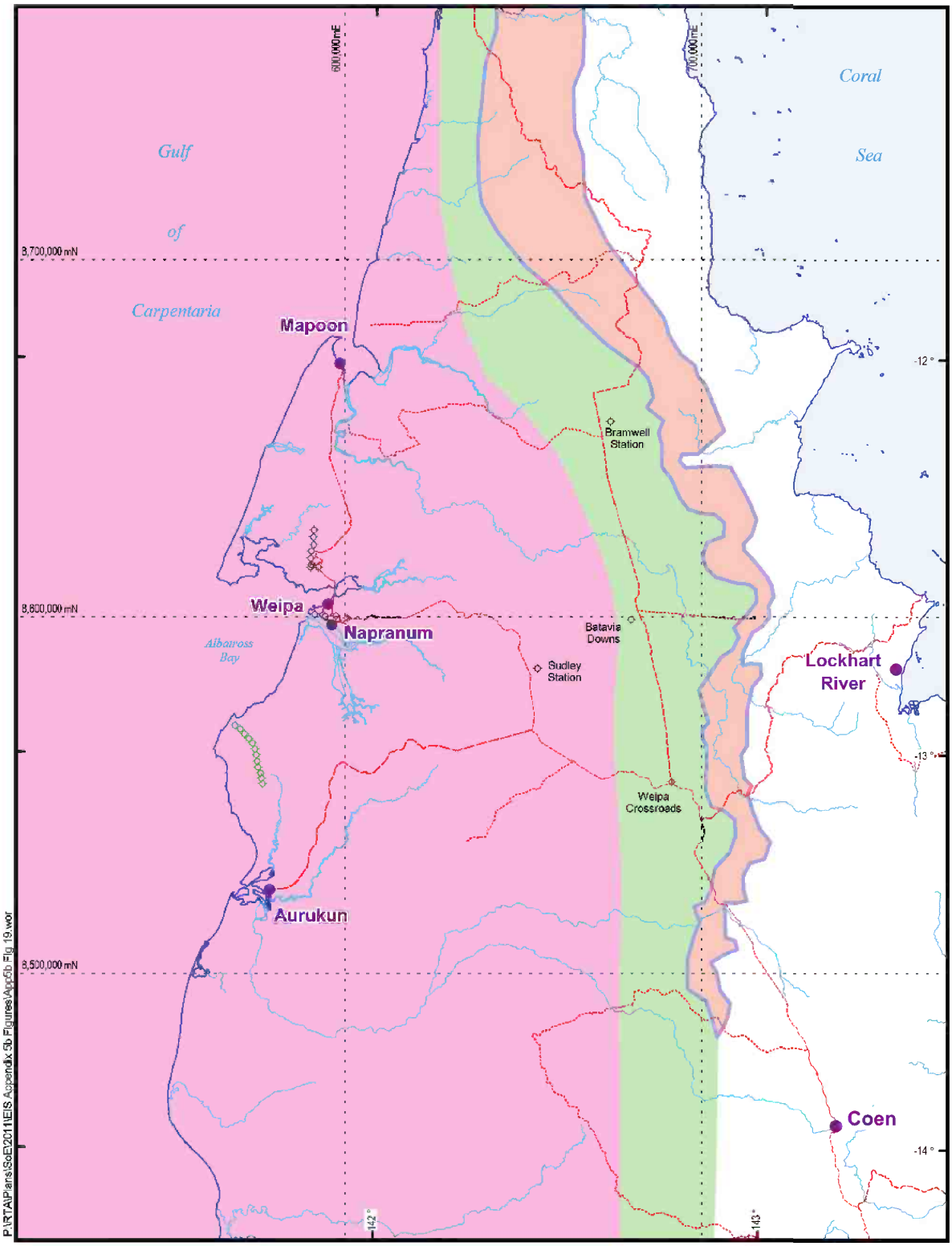
Appendix 5B: Fig. 19

Feflow Model Hydraulic Conductivity Distribution

N

0 50km

Datum/Projection: GDA94/MGA Zone 54 Date: 05/01/2011



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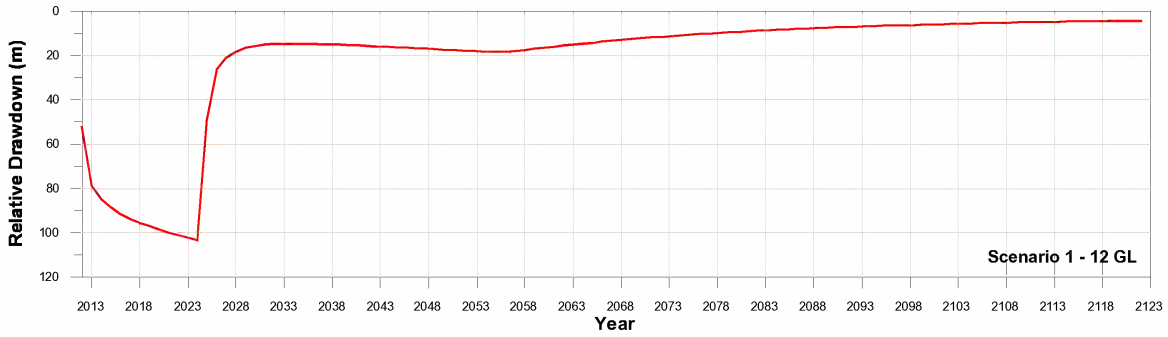
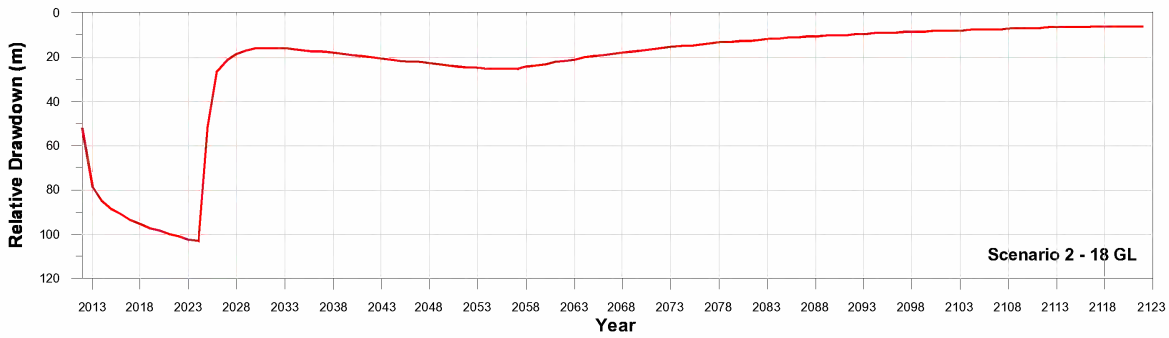
Appendix 5B: Fig. 20

Feflow Model Specific Yield Distrubution





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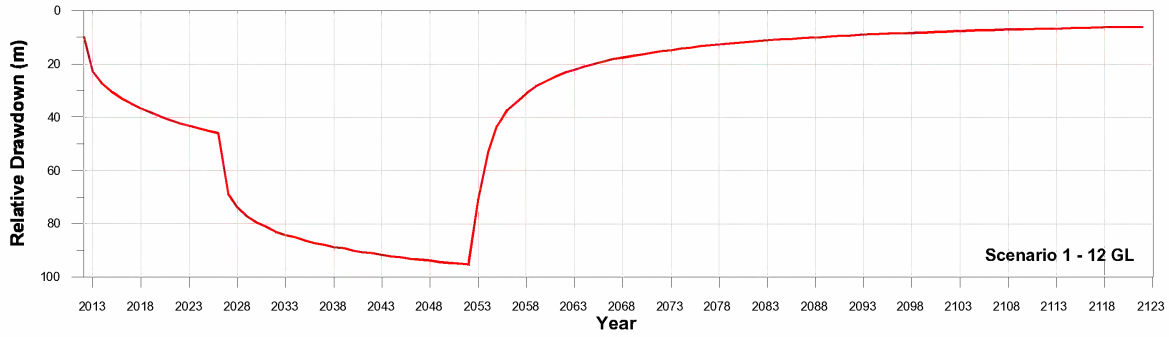
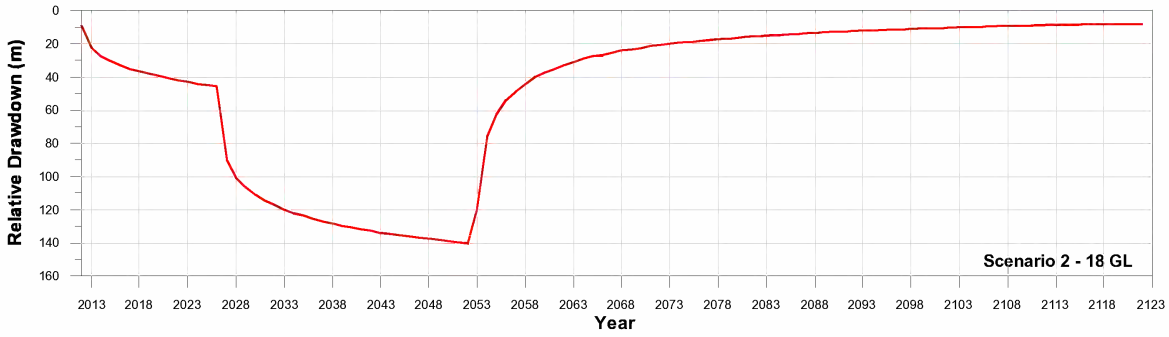
Appendix 5B: Fig. 21

Drawdown Hydrograph - ART8
(Representative Andoom Bore)

Date: 05/01/2011





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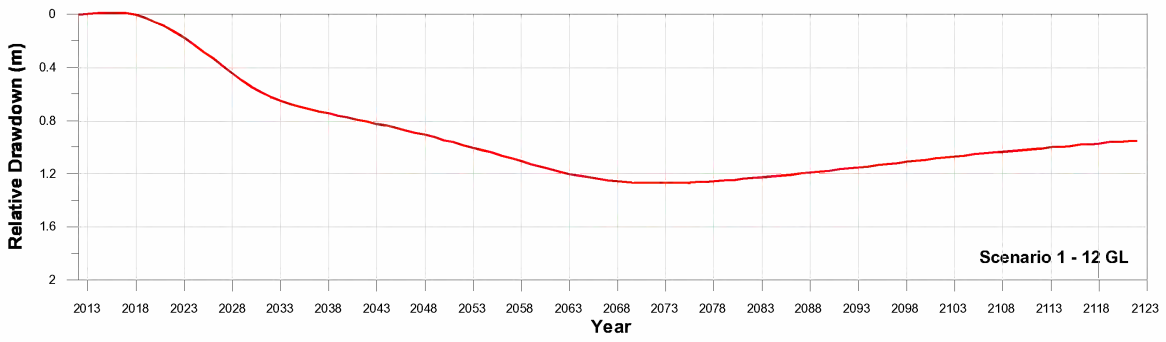
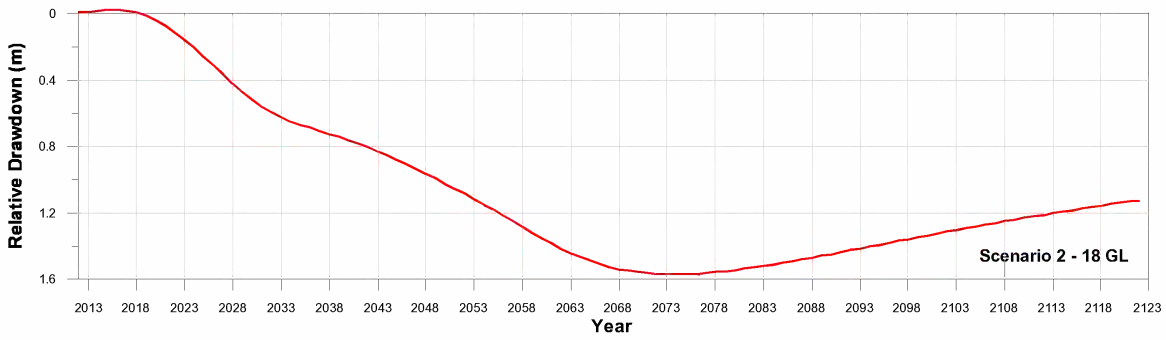
South of Embley Project

Appendix 5B: Fig. 22

Drawdown Hydrograph - ART15
(Representative SoE Bore)

Date: 05/01/2011





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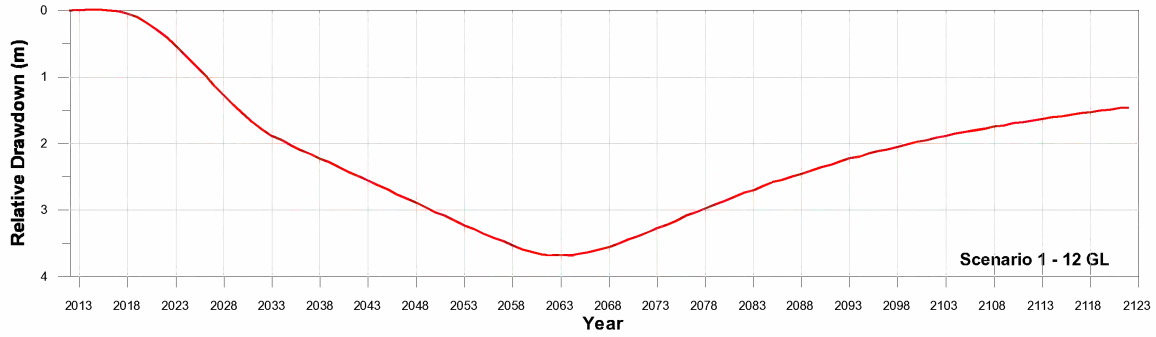
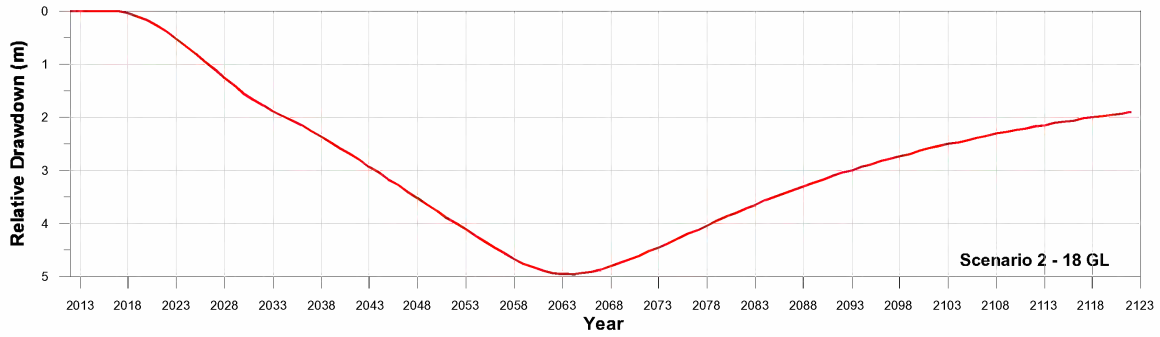
Appendix 5B: Fig. 23

Drawdown Hydrograph
Bramwell Station

Date: 05/01/2011





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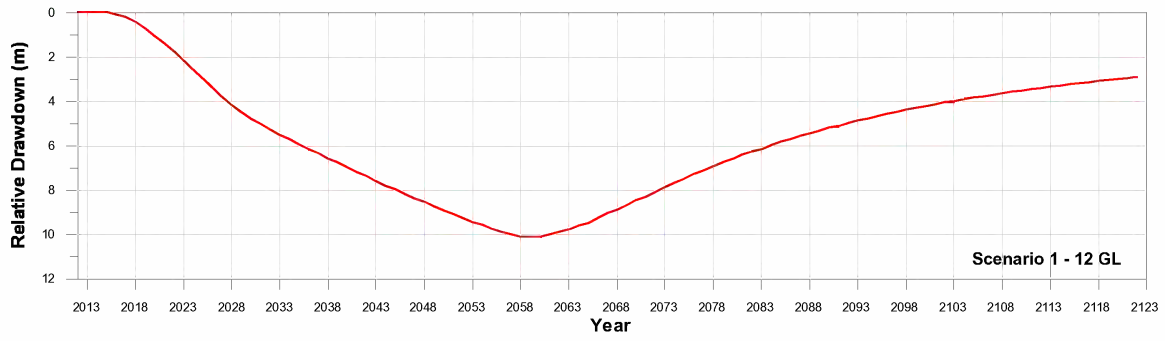
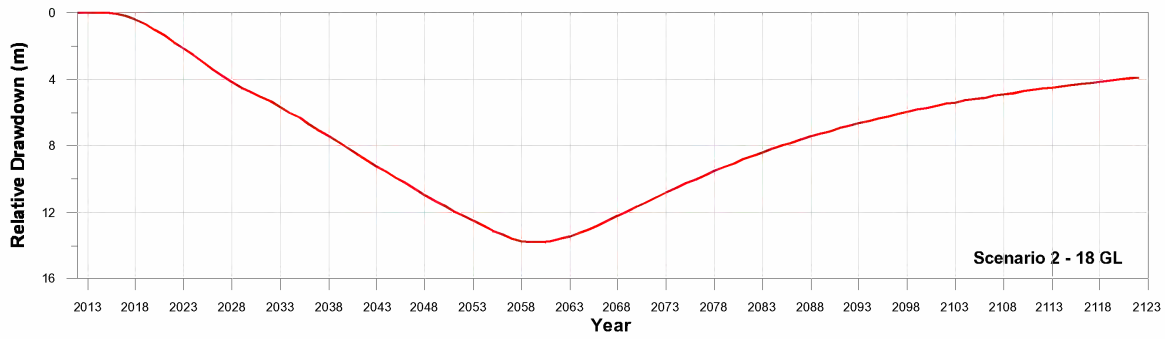
Appendix 5B: Fig. 24

Drawdown Hydrograph
Batavia Downs

Date: 05/01/2011





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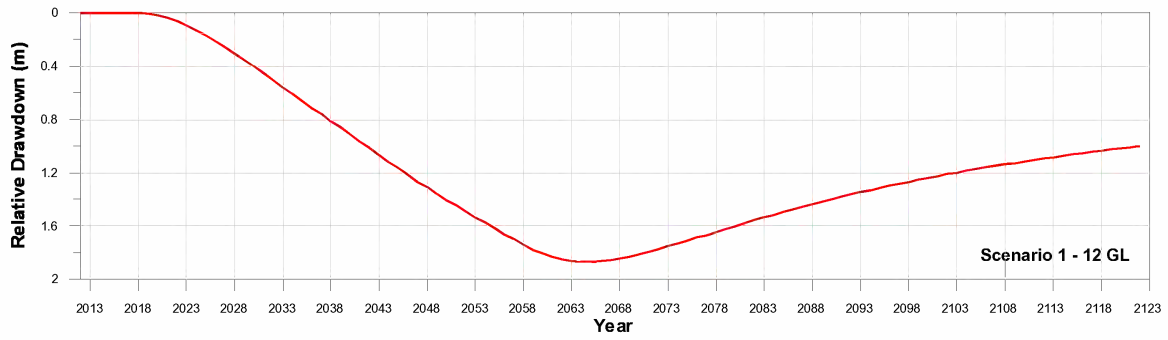
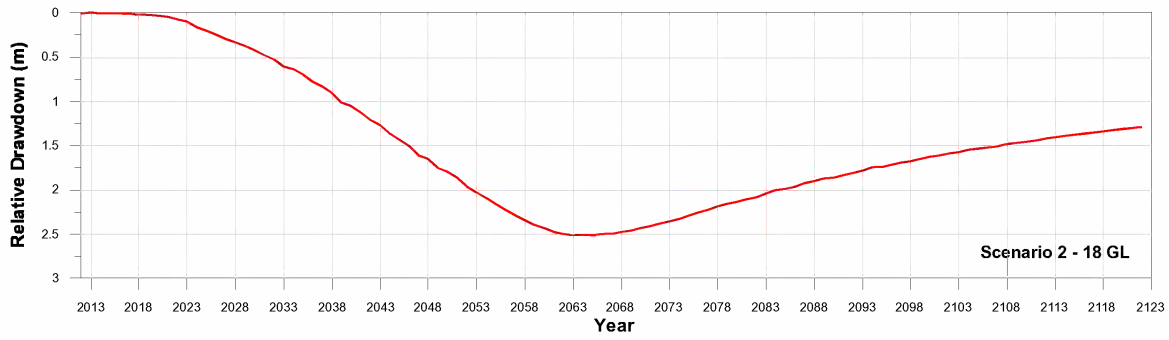
Appendix 5B: Fig. 25

Drawdown Hydrograph
Sudley Station

Date: 05/01/2011





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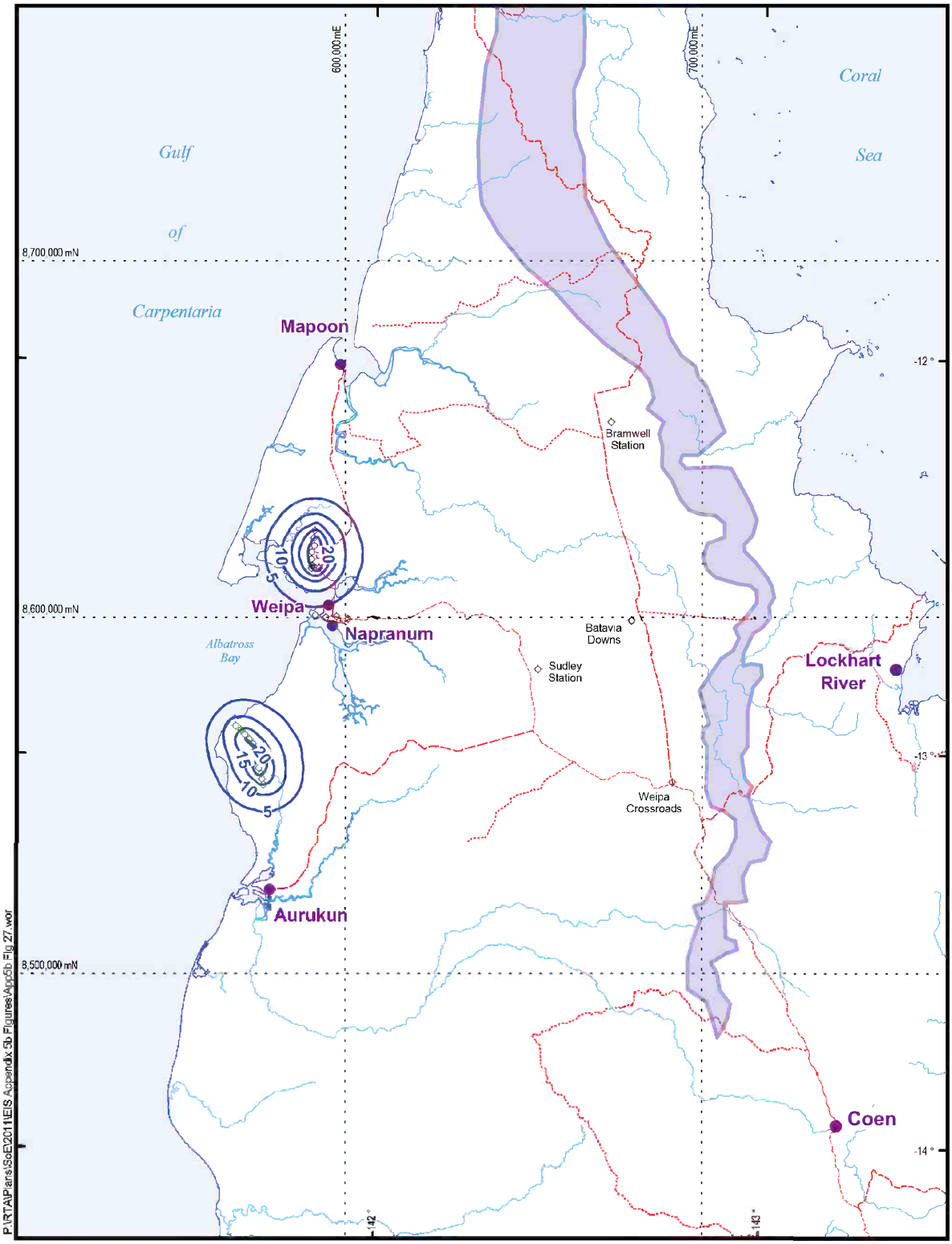
Appendix 5B: Fig. 26

Drawdown Hydrograph
Weipa Crossroads

Date: 05/01/2011


600,000 mE
700,000 mE
Gulf
of
Carpentaria
Coral
Sea
8,700,000 mN
8,600,000 mN
8,500,000 mN
-12 °
-13 °
-14 °
142
143
Mapoon
Weipa
Napranum
Albatross
Bay
Bramwell
Station
Batavia
Downs
Sudley
Station
Weipa
Crossroads
Lockhart
River
Aurukun
Coen
10
5
20
15
10
5
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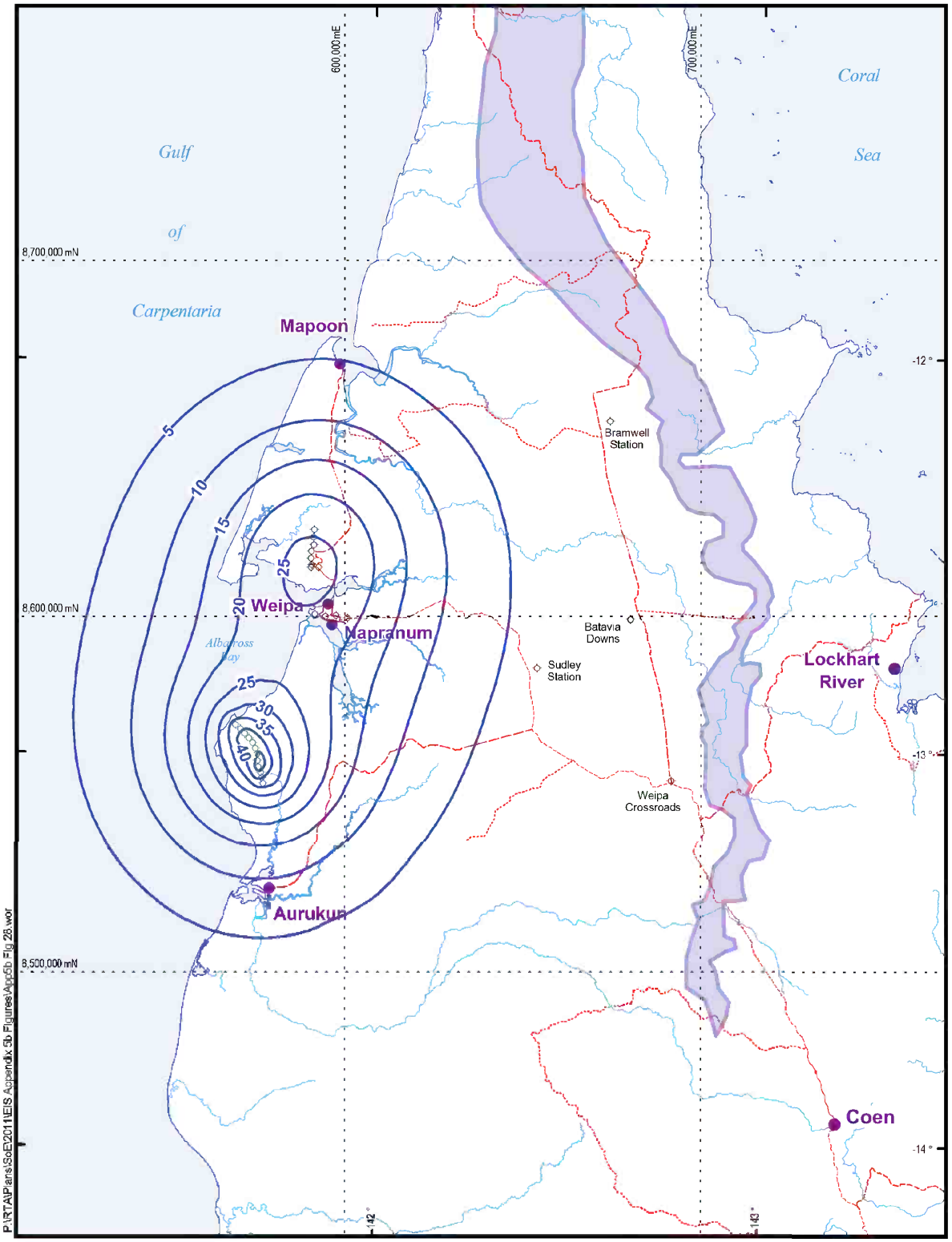
Recharge area
Township
River
Road/track
Existing Borehole
Proposed Borehole
Rio Tinto Alcan
South of Embley Project
Appendix 5B: Fig. 27
Predicted Drawdown Contours
Scenario 1 (12 GL) - 2013 (Yr 1)
N
0
50km
Datum/Projection: GDA94/MGA Zone 54
Date: 05/01/2011



Recharge area
Township
River
Road/track
Existing Borehole
Proposed Borehole

Rio Tinto Alcan

South of Embley Project

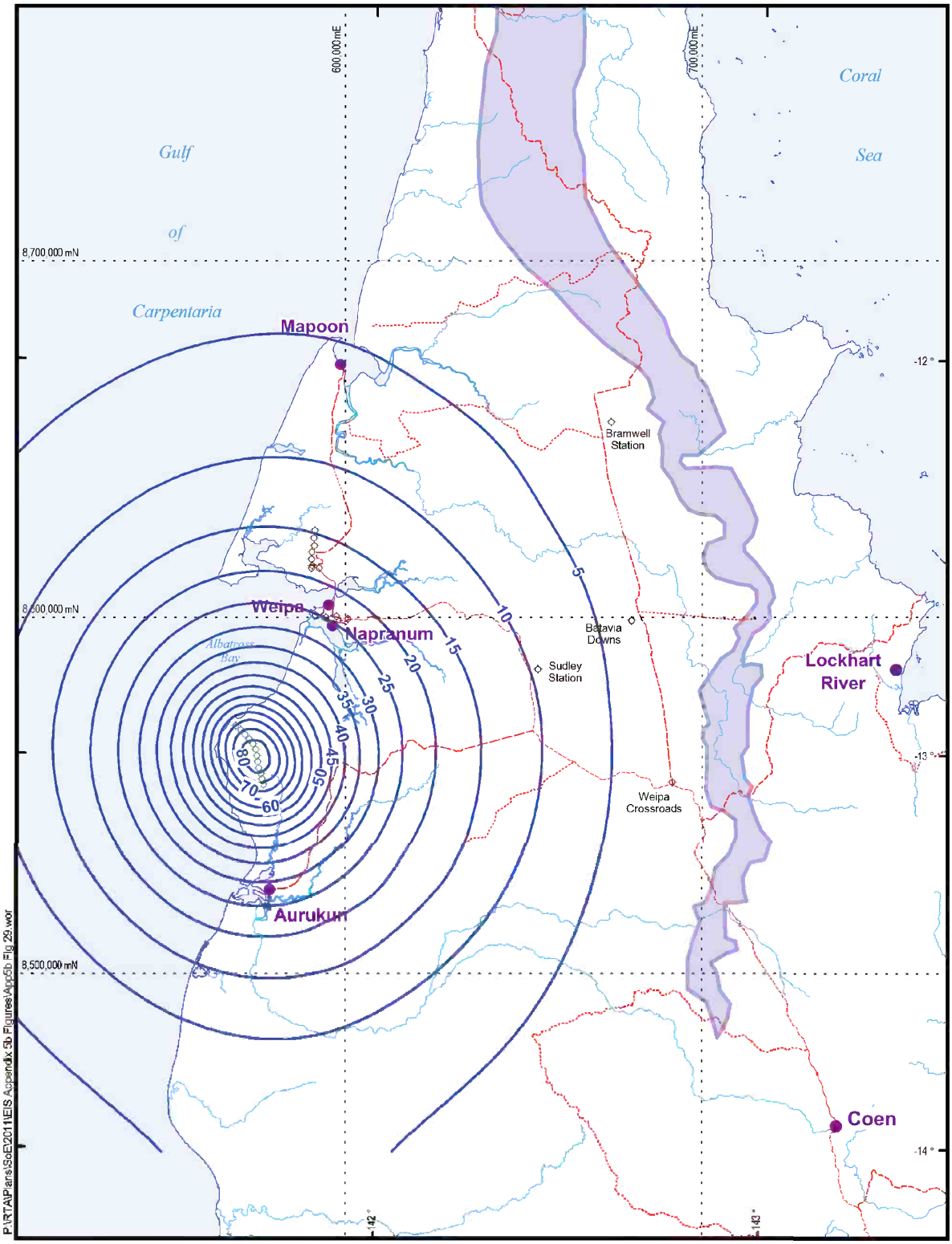
Appendix 5B: Fig. 28

Predicted Drawdown Contours
Scenario 1 (12 GL) - 2026 (Yr 13)

N

0 50km

Datum/Projection: GDA94/MGA Zone 54 Date: 05/01/2011



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Rio Tinto Alcan

- Recharge area
- Township
- River
- Road/track
- Existing Borehole
- Proposed Borehole

South of Embley Project

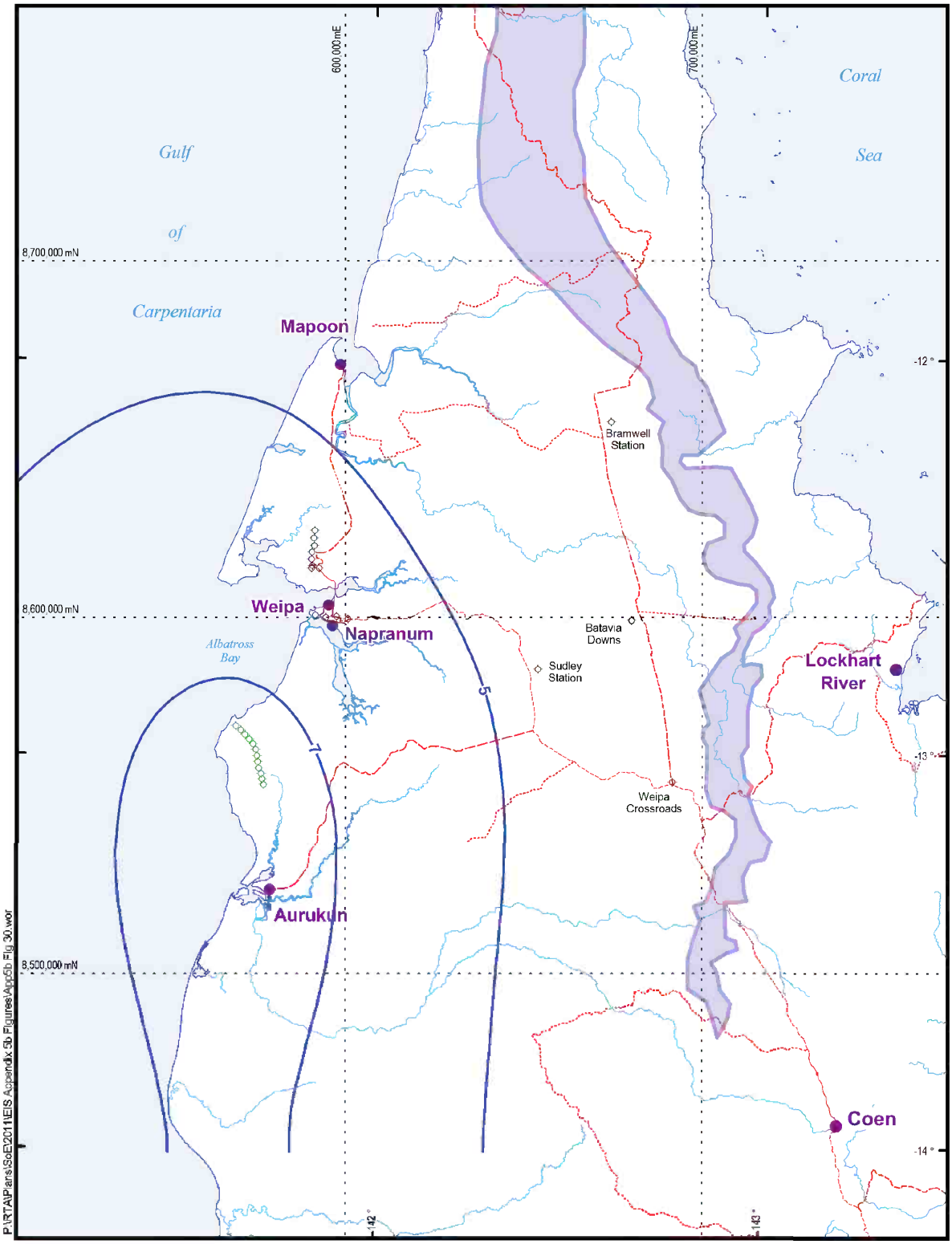
Appendix 5B: Fig. 29

Predicted Drawdown Contours Scenario 1 (12 GL) - 2053 (Yr 40)

N

0 50km

Datum/Projection: GDA94/MGA Zone 54 Date: 05/01/2011



Recharge area
Township
River
Road/track
Existing Borehole
Proposed Borehole

Rio Tinto Alcan

South of Embley Project

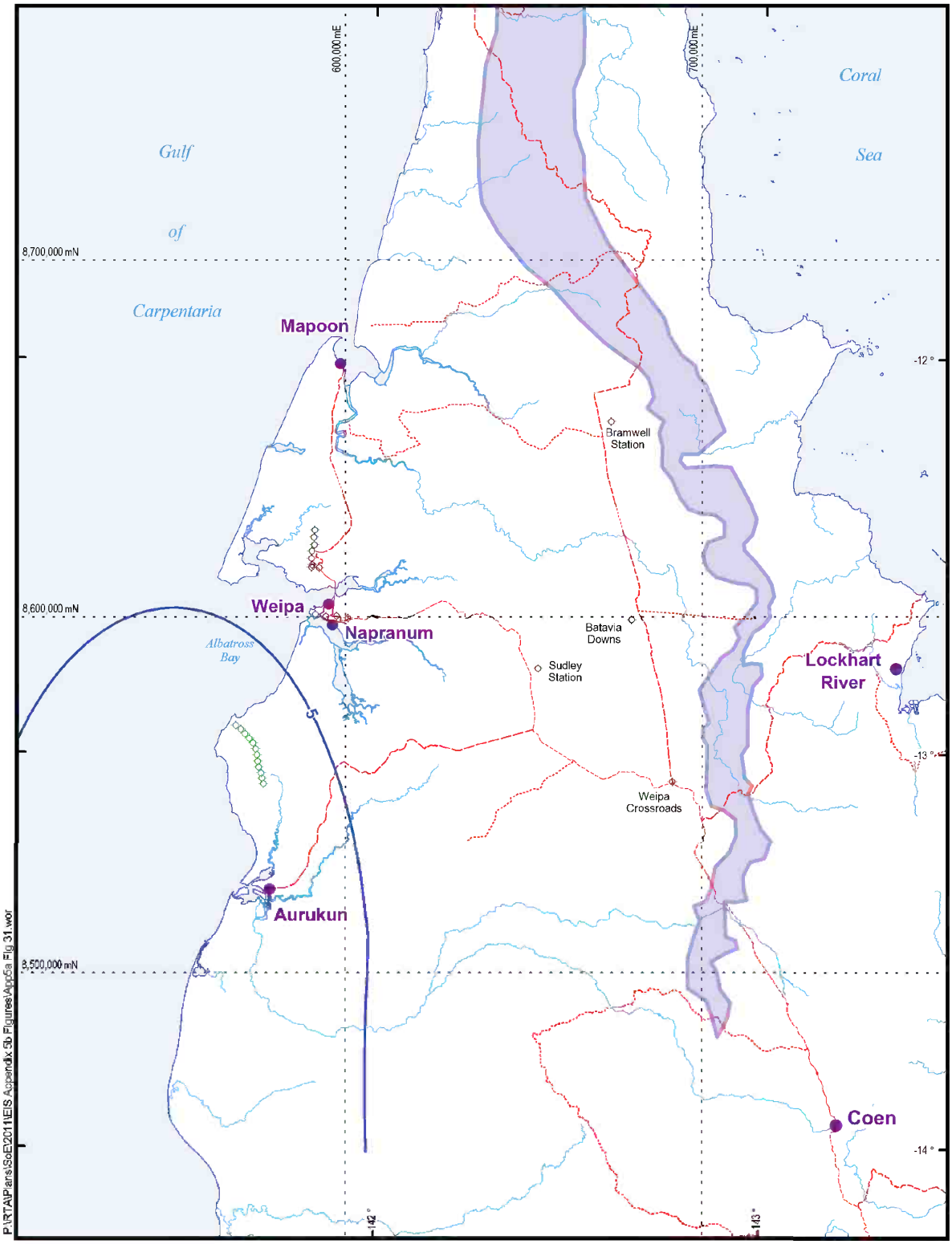
Appendix 5B: Fig. 30

Predicted Drawdown Contours Scenario 1 (12 GL) - 2103 (Yr 90)

N

0 50km

Datum/Projection: GDA94/MGA Zone 54 Date: 05/01/2011



Recharge area
Township
River
Road/track
Existing Borehole
Proposed Borehole

Rio Tinto Alcan

South of Embley Project

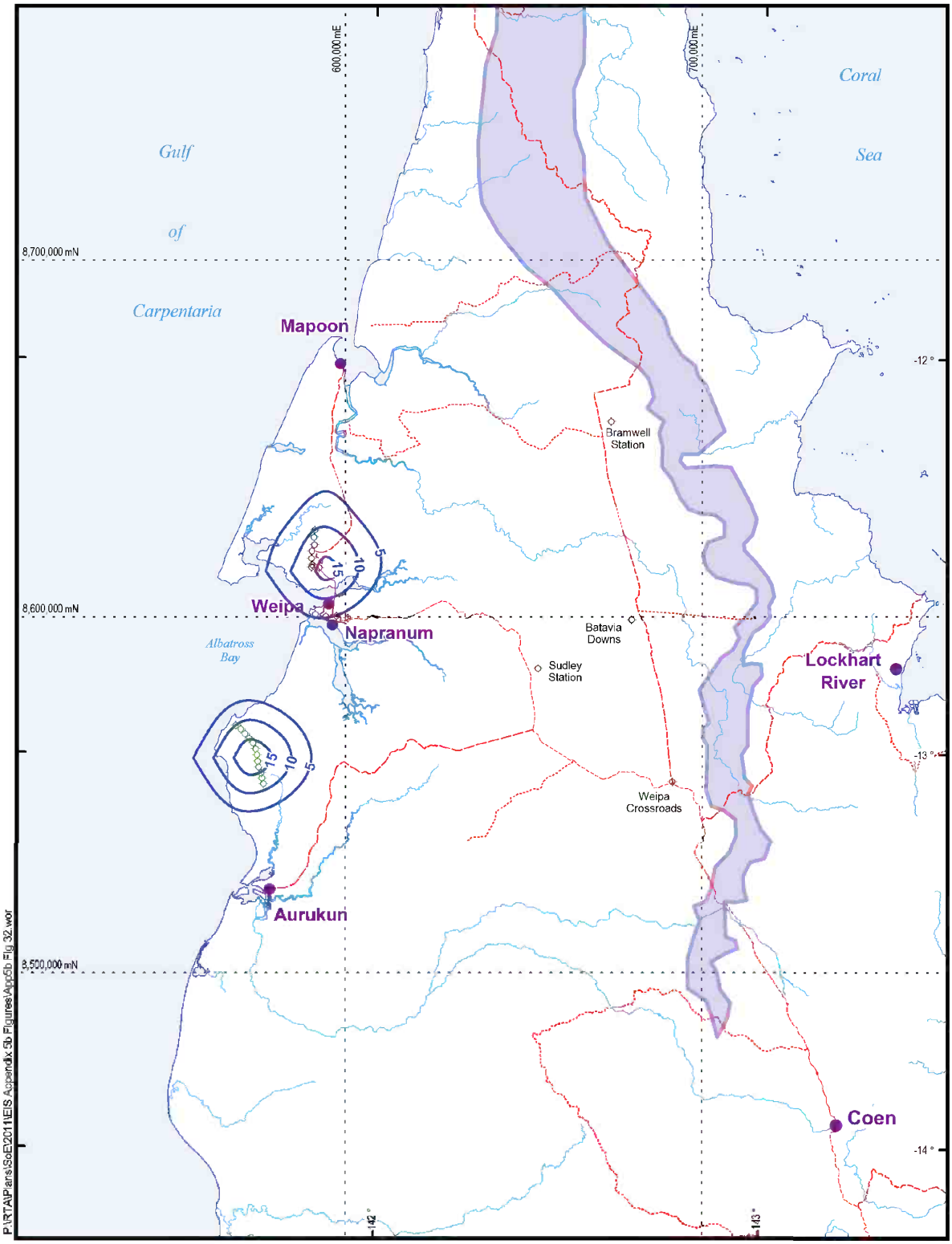
Appendix 5B: Fig. 31

Predicted Drawdown Contours Scenario 1 (12 GL) - 2123 (Yr 110)

N

0 50km

Datum/Projection: GDA94/MGA Zone 54 Date: 05/01/2011



Recharge area
Township
River
Road/track
Existing Borehole
Proposed Borehole

Rio Tinto Alcan

South of Embley Project

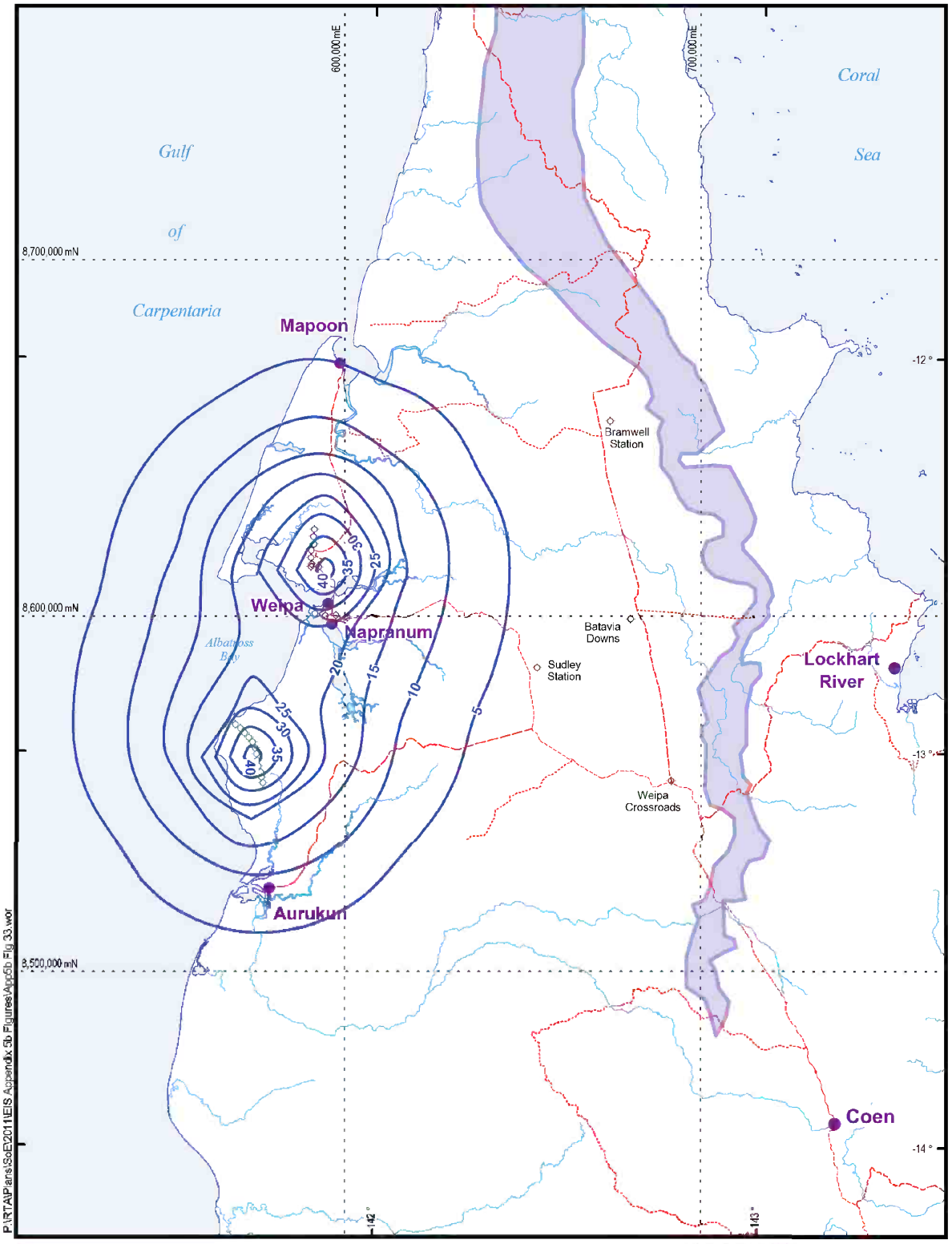
Appendix 5B: Fig. 32

Predicted Drawdown Contours Scenario 2 (18 GL) - 2013 (Yr 1)

N

0 50km

Datum/Projection: GDA94/MGA Zone 54 Date: 05/01/2011



Recharge area
Township
River
Road/track
Existing Borehole
Proposed Borehole

Rio Tinto Alcan

South of Embley Project

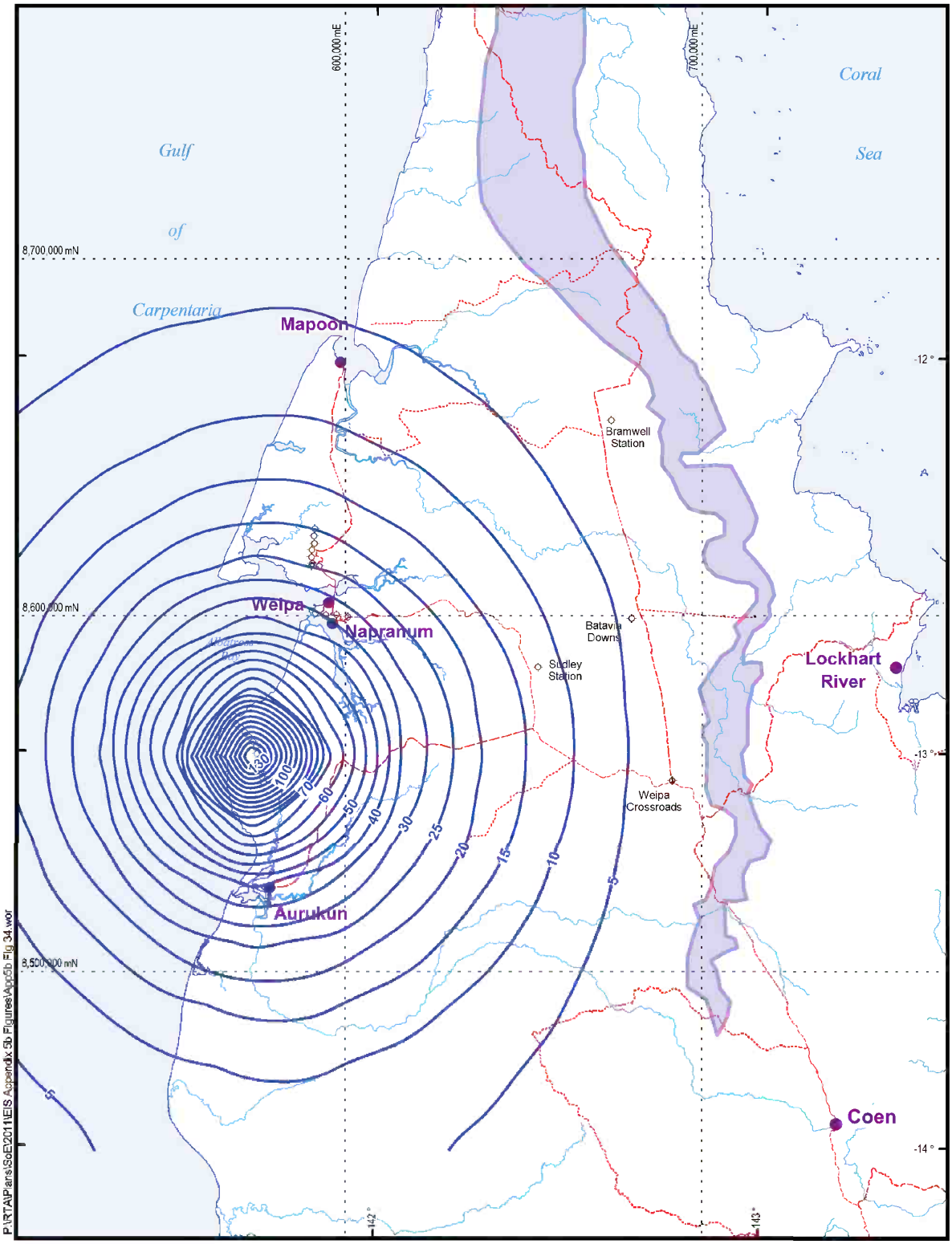
Appendix 5B: Fig. 33

Predicted Drawdown Contours Scenario 2 (18 GL) - 2026 (Yr 13)

N

0 50km

Datum/Projection: GDA94/MGA Zone 54 Date: 05/01/2011



Recharge area
Township
River
Road/track
Existing Borehole
Proposed Borehole

Rio Tinto Alcan

South of Embley Project

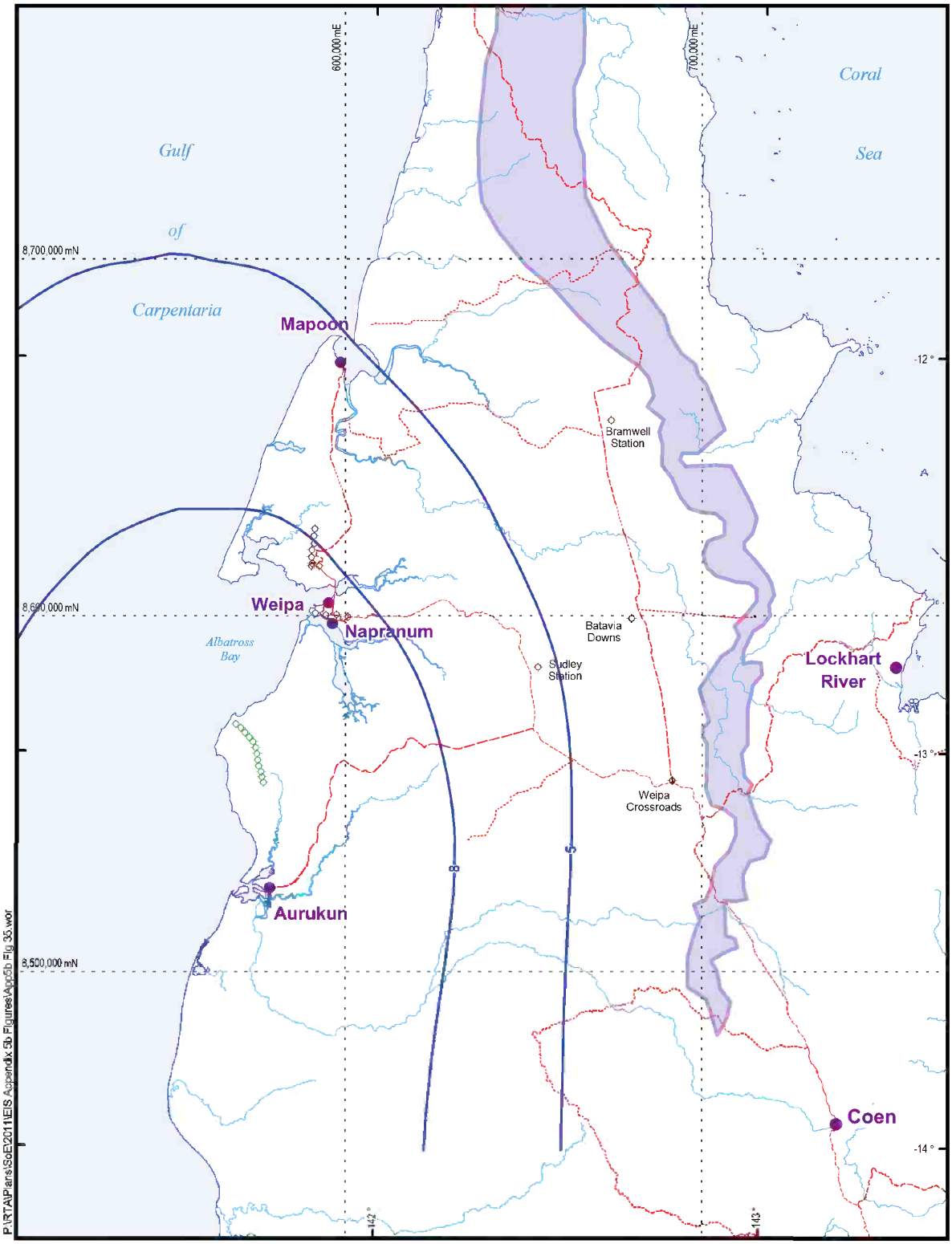
Appendix 5B: Fig. 34

Predicted Drawdown Contours Scenario 2 (18 GL) - 2053 (Yr 40)

N

0 50km

Datum/Projection: GDA94/MGA Zone 54 Date: 05/01/2011



Recharge area
Township
River
Road/track
Existing Borehole
Proposed Borehole

Rio Tinto Alcan

South of Embley Project

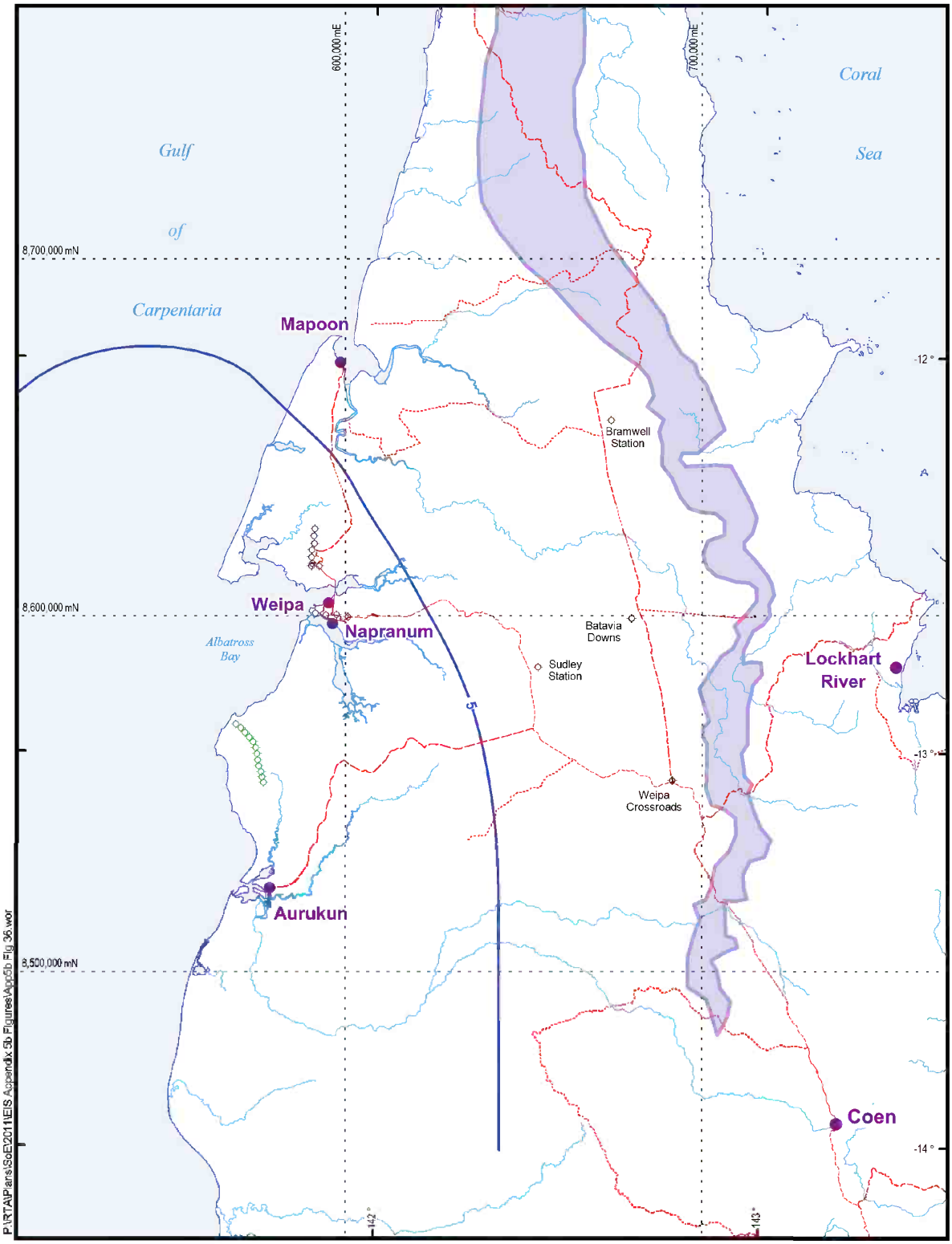
Appendix 5B: Fig. 35

Predicted Drawdown Contours Scenario 2 (18 GL) - 2103 (Yr 90)

N

0 50km

Datum/Projection: GDA94/MGA Zone 54 Date: 05/01/2011



Recharge area
Township
River
Road/track
Existing Borehole
Proposed Borehole

Rio Tinto Alcan

South of Embley Project

Appendix 5B: Fig. 36

Predicted Drawdown Contours
Scenario 2 (18 GL) - 2123 (Yr 110)

N

0 50km

Datum/Projection: GDA94/MGA Zone 54 Date: 05/01/2011

Environmental Impact Statement

for South of Embley Project

Section 6
Appendix

APPENDIX 6A

ASSEMBLAGES IN ESTUARINE AND SHALLOW COASTAL WATERS OF ALBATROSS BAY

Modified from Blaber *et al.* (1990)

Family Name, Scientific Name and Common Name		**Depth Strata within Albatross Bay**	
		7–10 m	**11–20 m**
ORECTOLOBIDAE			
Nebrius ferrugineus (tawny nurse shark)		✓	
CARCHARHINIDAE			
Carcharhinus amblyrhynchos (Grey Reef Shark)		✓	✓
Carcharhinus cautus (Nervous Shark)		✓	✓
Carcharhinus dussumieri (Whitecheek Shark)		✓	✓
Carcharhinus fitzroyensis (Creek Whaler)			✓
Carcharhinus macloti (Hardnose Shark)			✓
Carcharhinus melanopterus (Blacktip Reef Shark)			✓
Carcharhinus sorrah (Spottail Shark)			✓
Hemigaleus microstoma (Sicklefin Weasel Shark)			✓
Hemipristis elongatus (Snaggletooth Shark)		✓	✓
Negaprion acutidens (Sicklefin Lemon Shark)			✓
Rhizoprionodon acutus (Milk Shark)		✓	✓
Rhizoprionodon taylori (Australian Sharpnose Shark)			✓
SPHYRNIDAE			
Sphyrna lewini (Tiger Shark)			✓
PRISTIDAE			
Anoxypristis cuspidata (Narrow Sawfish)			✓
Pristis pristis (Common Sawfish)			✓
RHINOBATIDAE			
Rhynchobatis djiddensis (Shovelnose Shark)		✓	✓
DASYATIDIDAE			
Dasyatis annotatus (Plain Mask Ray)		✓	✓
Dasyatis kuhlii (Bluespotted Stingray)			✓
Dasyatis leylandi (Painted Mask Ray)			✓
Dasyatis thetidis (Thorntail Stingray)			✓

Family Name, Scientific Name and Common Name		Depth Strata within Albatross Bay	
		7–10 m	11–20 m
Himantura granulata (Mangrove Whipray)		✓	
Himantura toshi (Black-Spotted Whipray)		✓	✓
GYMNURIDAE			
Gymnura australis (Australian Butterfly Ray)		✓	✓
MYLIOBATIDAE			
Aetobatus narinari (Spotted Eagle Ray)			✓
Aetomyleus nichofii (Banded Eagle Ray)		✓	✓
RHINOPTERIDAE			
Rhinoptera sp. cf *adspersa* (Cownose Ray)		✓	✓
ELOPIDAE			
Elops machnata (Giant Herring)			✓
MURAENESOCIDAE			
Muraenesox cinereus (Daggertooth Pike Conger Eel)			✓
CLUPEIDAE			
Anodontostoma chacunda (Chacunda Gizzard Shad)		✓	✓
Dussumieria acuta (Rainbow Sardine)		✓	✓
Herklotsichthys koningsbergeri (Koningsberger's Herring)		✓	✓
Herklotsichthys lippa (Australian Spotted Herring)		✓	
Hyperlophus vittatus (Sandy Sprat)			✓
Nematalosa come (Bony Bream)		✓	✓
Pellona ditchela (Indian Pellona)		✓	✓
Sardinella albella (White Sardinella)		✓	✓
Sardinella gibbosa (Goldstripe Sardinella)			✓
ENGRAULIDAE			
Stolephorus carpentariae (Gulf of Carpentaria Anchovy)		✓	✓
Stolephorus indicus (Indian Anchovy)		✓	✓
Thryssa hamiltoni (Hamilton Anchovy)		✓	✓
Thryssa setirostris (Longjaw Thryssa)		✓	✓

Family Name, Scientific Name and Common Name		Depth Strata within Albatross Bay	
		7–10 m	11–20 m
CHIROCENTRIDAE			
Chirocentris dorab (Wolf Herring)		✓	✓
SYNODONTIDAE			
Saurida longimanus (Long Finned Grinner)			✓
Saurida micropectoralis (Short Finned Grinner)			✓
Saurida undosquamis (Large Scaled Grinner)		✓	✓
ARIIDAE			
Arius bilineatus (Bronze Catfish)			✓
Arius macrocephalus (Longsnouted Catfish)			✓
Arius thalassinus (Giant Seacatfish)		✓	✓
PLOTOSIDAE			
Euristhmus nudiceps (Naked-headed Catfish)			✓
Plotosus lineatus (Striped Catfish)			✓
BELONIDAE			
Ablennes hians (Longtom)		✓	
FISTULARIDAE			
Fistularia commersonii (Blue-spotted Cornetfish)			✓
Fistularia petimba (Red Cornetfish)		✓	✓
CENTRISCIDAE			
Centriscus scutatus (Grooved Razorfish)			✓
SCORPAENIDAE			
Pterois volitans (Red Lionfish)			✓
PLATYCEPHALIDAE			
Elates ransonetti (Dwarf Flathead)			✓
Platycephalus arenarius (Northern Sand Flathead)			✓
Platycephalus endrachtensis (Bar-tailed Flathead)			✓
Platycephalus indicus (Bar-tailed Flathead)			✓
Suggrundus japonicus (Japanese Flathead)			✓

Family Name, Scientific Name and Common Name		Depth Strata within Albatross Bay	
		7–10 m	11–20 m
SERRANIDAE			
Epinephelus malabaricus (Estuary Cod)		✓	✓
Epinephelus sexfasciatus (Sixbar Cod)			✓
TERAPONIDAE			
Pelates quadrilineatus (Four-Lined Trumpeter)		✓	✓
Pelates sexlineatus (Six-lined Trumpeter)		✓	✓
Terapon jarbua (Jarbua Terapon)		✓	✓
Terapon puta (Small-scaled Terapon)		✓	✓
Terapon theraps (Large-scaled Terapon)		✓	✓
PRIACANTHIDAE			
Priacanthus tayenus (Purple-spotted Bigeye)		✓	✓
APOGONIDAE			
Apogon ellioti (Flag-fin Cardinal Fish)			✓
Apogon poecilopterus (Pearly Finned Cardinal Fish)		✓	
Apogon robustus (Cook's Cardinal Fish)		✓	✓
PERCICHTHYIDAE			
Acropoma japonicum (Glowbelly)			✓
SILLAGINIDAE			
Sillago maculata (Diver Whiting)		✓	✓
Sillago sihama (Northern Whiting)		✓	✓
Sillago lutea (Mud Whiting)		✓	✓
LACTARIDAE			
Lactarius lactarius (False Trevally)		✓	✓
ECHENEIDIDAE			
Echeneis naucrates (Remora)		✓	✓
CARANGIDAE			
Absalom radiatus (Fringe-finned Trevally)		✓	✓
Alectis indicus (Diamond Trevally)		✓	✓

Family Name, Scientific Name and Common Name		Depth Strata within Albatross Bay	
		7–10 m	11–20 m
Carangoides caeruleopinnatus (Coastal Trevally)		✓	✓
Carangoides chrysophyrus (Long-nosed Trevally)		✓	✓
Carangoides humerosus (Duskyshoulder Trevally)		✓	✓
Carangoides malabaricus (Malabar Trevally)		✓	✓
Carangoides talamparoides (Imposter Trevally)		✓	✓
Caranx bucculentus (Bluespotted Trevally)		✓	✓
Caranx papuensis (Papuan Trevally)		✓	✓
Caranx para (Razorbelly Scad)		✓	✓
Decapturus russelli (Indian Trevally)			✓
Gnathanodon speciosus (Golden Trevally)		✓	✓
Scomberoides commersonianus (Talang Queenfish)		✓	✓
Scomberoides tala (Barred Queenfish)		✓	✓
Scomberoides tol (Needlescaled Queenfish)		✓	✓
Selar boops (Oxeye Scad)		✓	✓
Selar crumenophthalmus (Bigeye Scad)		✓	
Selaroides leptolepis (Yellowstripe Scad)		✓	✓
Seriolina nigrofasciata (Black Banded Trevally)			✓
FORMIONIDAE			
Apolectus niger (Black Pomfret)		✓	✓
MENIDAE			
Mene maculata (Moonfish)			✓
LEIOGNATHIDAE			
Gazza minuta (Toothed Ponyfish)		✓	✓
Leiognathus bindus (Orange Fin Ponyfish)		✓	✓
Leiognathus decorus (Decorated Ponyfish)		✓	✓
Leiognathis leuciscus (Whipfin Ponyfish)		✓	✓
Leiognathus moretoniensis (Moreton Bay Ponyfish)		✓	✓
Leiognathus smithurtsti (Longspine Ponyfish)		✓	✓

Family Name, Scientific Name and Common Name		Depth Strata within Albatross Bay	
		7–10 m	11–20 m
Leiognathus splendens (Splendid Ponyfish)		✓	✓
Secutor insidiator (Pugnose Ponyfish)		✓	✓
Secutor ruconius (Deep Pugnose Ponyfish)		✓	✓
LUTJANIDAE			
Lutjanus argentimaculatus (Mangrove Jack)		✓	
Lutjanus carponatatus (Stripey)		✓	
Lutjanus erythropterus (Small-mouth Nannygai)		✓	✓
Lutjanus lutjanus (Bigeye Snapper)		✓	
Lutjanus malabaricus (Large-mouth Nannygai)		✓	
Lutjanus russelli (Moses Perch)		✓	✓
Lutjanus sebae (Red Emperor)		✓	✓
Lutjanus vitta (Brown Striped Red Snapper)			✓
NEMIPTERIDAE			
Nemipterus furcosus (Fork-tailed Threadfin Bream)			✓
Nemipterus hexodon (Ornate Threadfin Bream)		✓	✓
Nemipterus peronii (Notched Fin Threadfin)		✓	✓
Pentapodus porosus (North West Australian Whiptail)		✓	✓
Scolopsis taeniopterus (Lattice Monocle Bream)			✓
GERREIDAE			
Gerres filamentosus (Whipfin Silverbiddy)		✓	✓
Gerres oyena (Common Silverbiddy)		✓	✓
Gerres subfasciatus (Common Silverbiddy)		✓	✓
Pentaprion longimanus (Longfin Mojarra)		✓	✓
HAEMULIDAE			
Gaterin sordidus (Sordid Sweetlip)		✓	
Pomadasys kaakan (Javelin Fish)		✓	✓
Pomadasys maculatus (Saddle Tailed Grunter)		✓	✓
Pomadasys trifaciatus (Black Eared Javelin Fish)		✓	✓

Family Name, Scientific Name and Common Name		Depth Strata within Albatross Bay	
		7–10 m	11–20 m
LETHRINIDAE			
Lethrinus lentjan (Pink Ear Emperor)		✓	✓
SCIAENIDAE			
Austronibea oedogenys (Yellowtail Croaker)		✓	✓
Johniops vogleri (Little Jewfish)		✓	✓
Johnius amblycephalus (Bearded Croaker)		✓	✓
Otolithes ruber (Silver Teraglin)		✓	✓
Protonibea diacanthus (Black Jewfish)			✓
MULLIDAE			
Parupeneus pleurospilus (Cinnabar Goatfish)			✓
Upeneus asymmetricus (Asymmetrical Goatfish)			✓
Upeneus luzonius (Dark-barred Goatfish)		✓	
Upeneus sulphureus (Sulphur Goatfish)		✓	✓
Upeneus sundaicus (Ochre-banded Goatfish)		✓	✓
EPHIPPIDIDAE			
Drepane punctata (Spotted Sicklefish)		✓	✓
Platax teira (Batfish)			✓
Zabidius novaemaculatus (Ninespine Batfish)			✓
SCATOPHAGIDAE			
Selenotoca multifasciatus (Southern Butterfish)		✓	✓
CHAETODONTIDAE			
Chelmon mulleri (Blackfin Coralfish)			✓
Parachaetodon ocellatus (Sixspine Butterfly Fish)		✓	
POMACENTRIDAE			
Pristotis jerdoni (Gulf Damselfish)			✓
MUGILIDAE			
Valamugil cunnesius (Long Finned Mullet)		✓	✓
SPHYRAENIDAE			

Family Name, Scientific Name and Common Name		Depth Strata within Albatross Bay	
		7–10 m	11–20 m
Sphyraena forsteri (Bigeye Barracuda)			✓
Sphyraena jello (Pickhandle Barracuda)			✓
Sphyraena obtusata (Striped Seapike or Barracuda)		✓	✓
Sphyraena putnamiae (Chevron Barracuda)		✓	✓
POLYMENIDAE			
Polynemus multiradiatus (Puttynose Perch)		✓	✓
Polynemus sheridani (King Threadfin)			✓
LABRIDAE			
Choerodon monostigma (Dark Spot Tuskfish)			✓
SIGANIDAE			
Siganus canaliculatus (White Spotted Spinefoot)		✓	✓
TRICHIURIDAE			
Trichiurus lepturus (Hairtail)		✓	✓
SCOMBRIDAE			
Cybiosarda elegans (Leaping Bonito)			✓
Rastrelliger kanagurta (Indian Mackerel)		✓	✓
Scomberomorus commerson (Spanish Mackerel)		✓	✓
Scomberomorus munroi (Spotted Mackerel)		✓	✓
Scomberomorus queenslandicus (School Mackerel)			✓
Scomberomorus semifasciatus (Grey Mackerel)		✓	✓
PSETTODIDAE			
Psettodes erumei (Australian Halibut)		✓	✓
BOTHIDAE			
Engyprosopon grandisquama (Large Scaled Flounder)			✓
Pseudorhombus arsius (Large Toothed Flounder)		✓	✓
Pseudorhombus elevatus (Deep Flounder)			✓
Pseudorhombus spinosis (Spiny Flounder)			✓

Family Name, Scientific Name and Common Name		Depth Strata within Albatross Bay	
		7–10 m	11–20 m
CYNOGLOSSIDAE			
Cynoglossus bilineatus (Four Lined Tongue Sole)			✓
TRIACANTHODIDAE			
Triacanthus biaculeatus (Black Tailed Tripod Fish)		✓	
Trixiphichthys weberi (Black Tipped Tripod Fish)		✓	✓
BALISTIDAE			
Abalistes stellaris (Starry Triggerfish)			✓
MONACANTHIDAE			
Monacanthus chinensis (Fan-bellied Leatherjacket)			✓
Paramonacanthus japonicus (Hair-finned Leatherjacket)			✓
OSTRACIIDAE			
Rhynchostracion nasus (Long-nosed Boxfish)		✓	✓
TETRADONTIDAE			
Arothron stellatus (Starry Pufferfish)		✓	
Chelonodon patoca (Milk-spotted Toadfish)		✓	✓
Lagocephalus lunaris (Rough Golden Pufferfish)		✓	✓
Lagocephalus sceleratus (Silver Pufferfish)		✓	✓
Lagocephalus spadiceus (Brown Backed Toadfish)		✓	✓
Torquigener hicksi (Hick's Toadfish)			✓
Torquigener whitleyi (Whitely's Toadfish)		✓	✓

Note: Blue text indicates common recreational fishing species.

Environmental Impact Statement

for South of Embley Project

Section 7
Appendix

APPENDIX 7A

FLORA METHODOLOGY

Vegetation Communities

Three main survey methods were used to survey and assess the vegetation communities within the Project area comprising:

- Secondary level vegetation survey plots based on the methodology of the Queensland Herbarium (Neldner *et al.* 2005) and providing relatively detailed information on the structural and floristic composition of the vegetation of each site;
- Vegetation mapping reference sites based on the Tertiary level vegetation survey plots of the Queensland Herbarium (Neldner *et al.* 2005) and providing relatively detailed information on the structural and floristic composition of the vegetation of each site;
- Quaternary level vegetation survey points comprising qualitative descriptions of the vegetation community and landscape characteristics occurring at and often adjacent to the sites, and used predominantly to capture variability in the structural composition of certain vegetation types and to provide ground reference points at vegetation boundaries to be used in vegetation mapping.

Secondary Survey Sites

A total of 134 Secondary survey sites were surveyed (refer to **Figure 7-3** for locations). Secondary flora survey sites were recorded to obtain quantitative floristic and structural data for each vegetation type present. Secondary sites were conducted using a 20m x 50m transect as per Neldner *et al.* (2005). The following information was recorded for each secondary survey site:

- Community description data;
- Vegetation density and height data;
- Flora in each stratum;
- Plant collection for species identification;
- General observations of physical site characteristics (fire history, disturbance, weed infestation etc); and,
- Site photos.

Field survey data was collated on standard flora survey recording sheets.

Classification of vegetation type followed the established format of Walker and Hopkins (1990). This classification uses the floristic composition and structural features of each community, primarily using growth form, density and height descriptors in the classification. The field survey involved identification of the major taxa contributing to any distinct strata or layers within the vertical profile of the community.

Following recognition of each strata layer throughout the vegetation profile at each site, height estimates of the major taxa contributing to each stratum were made. Consistent with established methodologies (Neldner *et al.* 2005; Walker and Hopkins 1990), the structure and composition of the dominant strata was used to assign vegetation type.

Crown Separation Ratio (CSR) was used to determine the density of each stratum, visually estimated from the centre of each transect. The CSR represents the ratio of crown width to crown separation, defined by averaging field-determined dimensions. This procedure was used for each of the upper layers at each survey site, while Percentage Foliage Cover (PFC) was used for the ground layer (% ground plant cover, % litter cover, % bare). Field data was used to assign the vegetation at each site to a structural type such as open forest, woodland, with qualifiers of height and dominant taxa also added.

Bitterlich sweeps were undertaken from the centre of each quadrat to determine densities of each plant taxa within each of the upper strata layers. This methodology utilises a standardised but rapid measure of stem density, used to consistently compare the relative densities of dominant taxa at each site, and can be further utilised to determine volumes of standing timber. Relative densities of each taxa were also collected for each taxa in each of the lower plant strata utilising a standard measure of abundance, with the coding for this measure indicated on the bottom of the data sheet shown in **Figure A-1**.

All plant species within each survey site were identified where possible. Initial plant collections were made within each defined community, and specimens of all plant taxa which could not be positively identified in the field were collected, pressed and dried for later identification. A number of specimens were consigned to the Queensland Herbarium for identification. Fruiting and/or flowering specimens were collected wherever possible. Species lists were compiled from field identifications and specimens identified following field work.

Tertiary Survey Sites

A total of six tertiary sites were surveyed, all during the May 2009 field trip. These sites were undertaken to provide structural and floristic data to the Queensland Herbarium for vegetation types occurring within the Project area that did not adequately correlate with existing REs for the bioregion. Data collected at these sites comprised:

- site number;
- GPS derived position;
- general location;
- landscape position/land zone;
- vegetation unit types present;
- structural composition including the height and density of different strata;
- dominant flora in all strata;
- qualitative description of community structure; and
- site photos.

Quaternary Survey Sites

A total of 847 quaternary survey sites were surveyed. In contrast to secondary survey sites, which were used as the basis for describing the mapping units and vegetation communities present, these quaternary sites were rapid on-ground site records taken primarily to ground-truth vegetation typing and to confirm the location of vegetation map unit boundaries across the Project area. Minimum data collected at these sites comprised:

- Site number
- GPS derived position;
- general location;
- land zone;
- vegetation unit types present;
- dominant flora in canopy; and,
- qualitative description of community structure.

Vegetation Mapping and Refinement

During the preliminary survey events (July 2006 and May 2007) mapping of vegetation focussed on the areas of *Eucalyptus tetrodonta* dominated vegetation within the Project area. In order to effectively indicate the boundary of the *E. tetrodonta* community, the mapping exercise also had to establish the extent and boundary of the riparian and coastal vegetation. Prior to the availability of colour imagery, the 1:50,000 topographic maps provided the most accurate and suitable basis for the delineation of broad vegetation types (i.e. mangroves, riparian vegetation on alluvia) adjacent to *Eucalyptus tetrodonta* community. Consequently, preliminary vegetation mapping was undertaken using the topographic mapping as a base layer. The vegetation unit classification and descriptions of Godwin (1985) and Gunness *et al.* (1987) were used as the basic vegetation map units.

Using the MapInfo 7.5 GIS package, field survey site locations were overlain on the topographic layer to delineate and refine vegetation map unit boundaries. To a large extent this involved the refinement of existing 1:50,000 vegetation patterns indicated on topographic mapping, to conform to the vegetation unit classification of, and the observed boundaries for these units as recorded during fieldwork.

During the May 2008, December 2008 and May 2009 surveys, secondary, tertiary and quaternary data was gathered on the riparian, wetland, vine forest and beach vegetation of the Project area to enable the preliminary mapping to be refined and in particular to provide more accurate delineation of the boundaries of different vegetation units. The preliminary mapping layer and all field survey sites were then overlain on high resolution rectified colour aerial imagery of the Project area and the final vegetation map produced by adjusting preliminary vegetation boundaries based on vegetation boundaries apparent on the imagery, and subsequently using site data to assign vegetation unit types to the derived polygons. Wherever possible, individual vegetation units were mapped out as individual polygons. In some cases, complex vegetation mosaics were mapped as combined polygons as per the approach of RE mapping. Mapping was produced at an approximate scale of 1:10,000.

Individual vegetation unit polygons were subsequently assigned to a RE type to enable production of both vegetation unit and RE maps of the Project area. In most cases, vegetation units could be attributed to an equivalent RE; however, because vegetation units were originally defined primarily on the basis of structural composition, some of the vegetation units could be mapped for multiple land zones used in the RE classification and therefore could be attributed to multiple REs. Consequently following the completion of delineation of vegetation units within the Project area the entire mapping coverage was reviewed and individual polygons of problematic vegetation units were assigned to the correct RE for the land zone within which they were situated.

Following the release of Version 6 RE mapping by DERM in late 2009, the revised RE mapping layer was reviewed and a number of polygons re-classified to reflect new RE variants (e.g. RE 3.2.6a, RE 3.2.5a) established for Version 6 mapping.

Floristics

Identification of the flora within the Project area occurred concurrently with the Secondary survey sites, with additional floristic records made incidentally whilst on site. The siting of Secondary survey sites in representative examples of all of the major vegetation unit types within the Project area ensured broad coverage of the flora of the Project area. Unidentified plant specimens and their collection details were sent to the Queensland Herbarium for further identification where possible. Species identified by the Queensland Herbarium are indicated in **Appendix 7D**.

Seasonal conditions limited the identification of some plant species during the dry season survey in 2006, particularly some species within the ground layer that appeared to be seasonal or were otherwise in poor condition. The subsequent, late wet season survey at selected sites in May 2007, and the main late wet season survey in May 2008 enabled the positive identification of some previously unidentifiable plant species, and identification of certain flora in non *Eucalyptus tetrodonta* communities within the Project area.

Targeted Threatened Flora traverses

During the May 2008, December 2008 and May 2009 survey events targeted surveys were undertaken to determine the presence and distribution of threatened (endangered, vulnerable and rare) plants within the Project area (refer **Section 7.6.1**). The sampling effort and approach to these surveys was based on the outcomes of an assessment of the threatened plant species potentially occurring in the Project area and the habitats in which they may occur. The surveys comprised foot based traverses of likely habitat while undertaking visual observations for the species. Traverses consisted of differing lengths and durations depending on the prevailing habitat types, the area of habitat being surveyed and the ability to manoeuvre through the understorey vegetation. The focus of the traverses was to maximise the possibility of locating threatened species so the approach consisted of mainly short transverses throughout a diversity of locations. Traverses were conducted by a Botanist and Field Assistant.

Overall survey effort was divided between all vegetation types with the majority of survey effort in non *Eucalyptus– tetrodonta* vegetation types. This was due to the majority of potential threatened species having their preferred habitat within the riparian, wetland, vine forest and mangrove vegetation types.

Available Literature and Vegetation Mapping

A search of literature and online resources was undertaken to locate existing descriptions and mapping of the vegetation of the Project area. Key resources thus identified include the vegetation unit classification and descriptions of Godwin (1985) and Gunness *et al.* (1987) which provide a property scale delineation of commonly encountered vegetation units of the western Cape York Peninsula bauxite plateau based on physical terrain units and dominant vegetation structure and floristics. Essentially these vegetation units conform with the RE approach to vegetation mapping used by the Queensland Herbarium but provide more detailed breakdown of vegetation communities.

The Version 5 RE mapping for the Cape York Bioregion produced by the Queensland Herbarium (EPA) provided the currently accepted vegetation mapping for the Project area under VMA. The Version 6 RE mapping was released by the EPA following fieldwork but during the preparation of the Draft EIS.

Flora Records

The DERM Wildlife Online database and Queensland Herbarium HERBRECS database were searched for records of flora within and immediately adjacent to the Project area. The search areas are provided in **Table A-1** below.

Table 7A-1 Wildlife Online and Herbrecs Search Area Coordinates

Corner Point	Latitude (Decimal degrees)	Longitude (Decimal degrees)
North west	-12.62	141.55
North east	-12.62	142.00
South west	-13.40	141.55
South east	-13.40	142.00

Figure 7A-1 Secondary Survey Site Proforma

VEGETATION MAPPING RECORDING FORM	Project: Sth Embley	Site BB02

Detail	■	3*	Date 20/07/2006	Recorders JS

Datum	EASTING	NORTHING	RE 3.5.2
WSG84	574841	8568912	Veg Type 2b(2)

Structural Summary CSR = 1:3-5+ >>>> WOODLAND

Stratum	Av. Top Height	Height Range	Key Species	Abundance	Bitterlich (1cm)
Tree 1	26m	22-30m	Eucalyptus tetrodonta	6	IIIII I
			Corymbia nesophila	5	IIIII
			Erythrophleum chlorostachys	3	III
			Parinari nonda	+	
Tree 2		10-18m	Eucalyptus tetrodonta		
		CSR1: 5-10	Corymbia nesophila		
		SPARSE	Parinari nonda	1	I
			Erythrophleum chlorostachys	+	
			Acacia rothii		

Shrub 1	**Height: 3-8m**		**CSR 1: 3-10 SPARSE**	**Abund**
Grevillea glauca		3	Parinari nonda	1
Grevillea parellela		3	Erythrophleum chlorostachys	1
Syzygium suborbiculare		3	Planchonia careyi	2
Shrub 2	**Height: 1-2m**		**CSR 1:1-3 MID-DENSE**	
Eucalyptus/Corymbia spp.		5	Grevillea parellela	3
Ficus opposita		3	Pouteria pohlmaniana	3

Acacia rothii	4	Xylomelum schottianum	3
Planchonia careyi	2	Maytenus cunninghamii	2
Clerodendrum costata	2		
Ground **Height: 0.5-2m**		**FPC = 30-50%; Litter = 30%; Bare = 10%**	
Heteropogon triticeus	6	Drymophila moorei	3
Sorghum plumosum	5	Schelhammera multiflora	
Bothriochloa erianthoides	5	Marsdenia cymulosa	2
Buchnera tetragona	2		
Buchnera linearis	4	Microstachys chamaelea	5
Spermacoce brachystema	5	Grewia retusifolia	5
Erythroxylum australe	4	Crotalaria medicaginea	4
Cayratia trifolia	1	Rhynchosa minima	2
Coelospermum reticulatum	3	Flemingia parviflora	5
Cyanthilium cinereum	3	Striga curviflora	3
		Galactia muellerii	5
Lomandra multiflora	2	Evolvulus alsinoides	3
Desmodium heterocarpon	4	Panicum seminudum var cairnsianum	3
Euphorbia vachellii	3	Polymeria ambigua	2
Smilax australis	2	Hibbertia dealbata	2

Comments: This site corresponds with Fauna Site 2. Fire less conspicuous in this location, higher forb diversity and grass growth, possible edge of bauxite plateau and more moisture evident.

Abundance ratings (per 400m^2 plot):
1= Present (1 individual); 2 = Occasional (2-3 individuals); 3 = Uncommon (3-5 individuals); 4 = Uncommon-Common (5-9 individuals); 5 = Common (10-25 individuals); 6 = Common-Abundant (26-50 individuals); 7 = Abundant (50+ individuals)

APPENDIX 7B

DETAILED DESCRIPTIONS OF THE VEGETATION OF THE PROJECT AREA

RE 3.1.1a Closed forest of Red Mangrove (*Rhizophora stylosa*) ± Large-fruited Orange Mangrove (*Bruguiera gymnorhiza*) occurring as Outer Mangroves.

Description: This community is characterized by a closed to low closed forest dominated by Red Mangrove (*Rhizophora stylosa*) at the outer margins, while Large-fruited Orange Mangrove (*Bruguiera gymnorhiza*) is also typically present. The arching prop roots of the Red Mangrove form a dense, inter-meshed network at the stream bank margins. Other mangrove tree species, including Grey Mangrove (*Avicennia marina*) are often present, particularly in areas inland from the seaward edge.

A sparse shrub or sub-canopy layer of Club Mangrove (*Aegialitis annulata*), Myrtle Mangrove (*Osbornia octodonta*) and River Mangrove (*Aegiceras corniculatum*) is sometimes present from 2 to 10m in height. Apart from a dense patches of Mangrove Fern (*Acrostichum speciosum*) in some locations, the ground layer is bare of herbaceous plants.

Occurrence in the Study Area: Occurs on unconsolidated mud and forms the outer mangrove zone where the mangrove forest is extensive, most notably the middle to lower reaches of the Ward River, and upstream of the main estuary of Norman Creek.

Corresponding Land Unit (after Gunness 1984): Direct correlation, incorporating both Land Unit 3d (Mangroves – *Rhizophora* Zone); and Land Unit 6b (Mangroves – *Bruguiera* Zone)

Additional Information from REDD Database V6b

Vegetation Management Act Status (November 2009): Least concern

Biodiversity Status: No concern at present

Subregion: .

Estimated Extent:

Extent in Reserves: Medium

Wetland: Estuarine wetlands (e.g. mangroves).

Structure Category: Dense

Protected Areas:

Fire Management Guidelines: STRATEGY: No fire management required. ISSUES: Non-flammable vegetation.

C**omments:** Wenlock, Ducie, Pascoe and McIvor Rivers. Lines tidal rivers.

RE 3.1.1c Closed forest of Cajuput Tree (*Melaleuca cajuputi*) behind Red Mangrove (*Rhizophora stylosa*) fringe – Upper Freshwater Margins of Tidal Systems.

Description: Closed forest Cajuput Tree (*Melaleuca cajuputi*) forming dense large stands from 6 to 18m in height, typically located at the outer or upper margins of marine tidal systems. May include other paperbark trees (*M. leucadendra, M. acacioides*) in lower numbers, but generally occurs as mono-specific stands, interspersed with low clumps of Mangrove Fern (*Acrostichum speciosum*) or sedges (*Leptocarpus* species). Typically this vegetation fringes a main watercourse channel, which is lined with a thin layer of mangroves that can include Red Mangrove (*Rhizophora stylosa*) and Looking Glass Mangrove (*Heritiera littoralis*).

Occurrence in the Study Area: This community was located at the upstream tidal influence of the Ward River as small flooded swamps fringing the main river channel, usually on the inside bend of the river. This community was also located on the northern bank of Norman Creek in low swampy areas just landward of tidal estuaries (adjoining RE 3.3.60a), on outflow areas below Swamp Box (*Lophostemon suaveolens*) woodland and mixed paperbark forest communities (RE 3.3.9).

Corresponding Land Unit (after Gunness 1984): Land Unit 3d (Mangroves – *Rhizophora* Zone); Land Unit 7d (Melaleuca along footslopes or outer margins of drainage lines). The floristic composition of this community was most closely correlated with RE3.1.1c, and occurs at the interface of alluvial and marine plains (land zones 1 and 3).

Additional Information from REDD Database V6b.

Vegetation Management Act Status (November 2009): Least concern

Biodiversity status: No concern at present

Subregion: .

Estimated Extent:

Extent in Reserves: Medium

Wetland: Estuarine wetlands (e.g. mangroves).

Structure Category: Dense

Protected Areas:

Fire Management Guidelines: STRATEGY: No fire management required. ISSUES: Non-flammable vegetation.

C**omments:** Wenlock, Ducie, Pascoe and McIvor Rivers. Lines tidal rivers. Vegetation communities 3.1.1b and 3.1.1c only occur in small areas throughout the bioregion.

RE 3.1.3 Closed to low closed forest of Yellow Mangrove (*Ceriops tagal*) ± Grey Mangrove (*Avicennia marina*).

Description: This community is characterized by a dense closed to low closed mangrove forest from 3 to 16m in height and dominated by Yellow Mangrove (*Ceriops tagal*). While the dark buttressed trunks of Yellow Mangrove frequently form almost pure stands, other species present include Grey Mangrove (*Avicennia marina*), Black Mangrove (*Lumnitzera* species), and the emergent Cannonball Mangrove (*Xylocarpus granatum*). Vascular plants are generally absent from the ground layer, characterized by deep mud.

Occurrence in the Study Area: This vegetation community occurs as the inner or more landward mangrove zone in more extensive bands of mangrove, typically around the middle to upper reaches of the Ward River and Norman Creek. This community also incorporates highly saline mangrove areas dominated by low sparse to dense shrub layers comprised of Club Mangrove (*Aegialitis annulata*), River Mangrove (*Aegiceras corniculatum*) and/or Blind-your-eye Mangrove (*Excoecaria agallocha*) up to 3m in height.

Corresponding Land Unit (after Gunness 1984): Direct correlation with Land Unit 6c (Mangroves – *Ceriops* Zone); also incorporates with Land Unit 9a (Highly saline mangrove zone)

Additional Information from REDD Database V6b

Vegetation Management Act Status (November 2009): Least concern

Biodiversity status: No concern at present

Subregion: 1, 2, 4, 6, 7, 9, Great Barrier Reef

Estimated Extent:

Extent in Reserves: Medium

Wetland: Estuarine wetlands (e.g. mangroves).

Structure Category: Dense

Protected Areas:

Fire Management Guidelines: STRATEGY: Protection relies on broad-scale management of surrounding country with numerous small fires throughout the year so that wildfires will be very limited in extent. ISSUES: Fire sensitive vegetation.

RE 3.1.6 Sparse Herbland or Bare Saltpans on Saline Flats

Description: Considerable areas of bare saline mudflats or saltpans. Some large areas and many small patches of samphire or herbfield are also present on these saline flats, and support a variety of samphire species (*Halosarcia* species), generally below 30cm in height . Marine grasses, including both Saltwater Couch (*Sporobolus virginicus*) and the grass *Xerochloa imberbis* are present, generally in small patches or interspersed with other samphire species.

Occurrence in the Study Area: This vegetation community occurs on marine plains associated with the estuaries and lower reaches of majot watercourses within the study area. Considerable expanses of this community occur on the marine plains of the Ward River and Norman Creek.

Corresponding Land Unit (after Gunness 1984): Directly correlates with Land Unit 12e (Saltpan – sparse herbfield).

Additional Information from REDD Database V6b

Vegetation Management Act Status (November 2009): Least concern

Biodiversity status: No concern at present

Subregion:

Estimated Extent:

Extent in Reserves High

Wetland: Estuarine wetlands (e.g. mangroves).

Structure Category: Very sparse

Protected Areas: P .

Fire Management Guidelines: STRATEGY: No fire management required. ISSUES: Non-flammable vegetation. Low fuel loads and sparse vegetation limits fire spread.

RE 3.2.2 Semi-Deciduous Vine Thicket on Coastal Dunes and Beach Ridges

Description: This community is characterised by a diverse assemblage of vine forest vines and mesic canopy trees forming an uneven but dense closed canopy from 6 to 12m in height.

The canopy layer is diverse, but is generally dominated by a mixture of deciduous and evergreen species which include *Terminalia sericocarpa, T. muelleri, Pongamia pinnata, Ficus virens, Cupaniopsis anacardioides, Sterculia quadrifida, Canarium australianum,* as the principal deciduous species, sometimes forming emergents up to 25m in height. Evergreen tree species present include *Drypetes deplanchea, Buchanania arbroescens, Maranthes corymbosa, Beilschmiedia obtusifolia, Parinari nondia, Gyrocarpus americanus, Malottus discolor, Bridelia tomentosa, Ganophyllum falcatum, Aidia racemosa, Celtis philippensis, Polyalthia nitidissima* and *Mimusops elengi*.

A mid-dense sub-canopy or shrub layer from 2 to 8m high supports a variety of other species, most commonly including *Eugenia reinwardtiana, Psychotria poliostemma, Aglaia elaeagnoidea, Pouteria sericea, Gossia floribunda, Diospyros calycantha, Atractocarpus sessilis,* and *Strychnos lucida*. Vines are common and dense in places, including *Flagellaria indica, Smilax australis, Abrus precatorius, Parsonisa velutina, Cayratia cardiophylla, Clematis pickeringii* and *Jasminum didymum*. The ground layer is very sparse, and mainly composed of graminoids such as *Oplismeus aemulus* and *Panicum tricoides*.

Occurrence in the Study Area: This vegetation community forms small to large patches of varying structural development and floristic diversity on sandy soils fronting the western coastal margins of the mining lease, including a small patch at Boyd Point and a large strip between Thud Point and the northern mouth of Norman Creek.

Corresponding Land Unit (after Gunness 1984): Directly correlates with Land Unit 3a (Semi-Evergreen Notophyll Vine Forest or Thicket on Coastal Dunes).

Additional Information from REDD Database V6b

Vegetation Management Act Status (November 2009): Least concern

Biodiversity status: Of concern

Subregion: 4, 7, 9.

Estimated Extent:

Extent in Reserves: Low

Structure Category: Dense

Protected Areas:

Fire Management Guidelines: STRATEGY: Protection relies on broad-scale management of surrounding country with numerous small fires throughout the year so that wildfires will be very limited in extent. ISSUES: Fire sensitive vegetation.

Comments: West coast of bioregion. Areas near settlements and road access are degraded by weeds such as Rubber Vine (*Cryptostegia grandiflora*) and Calotropis (*Calotropis* sp).

RE 3.2.3 Grey Paperbark (*Melaleuca dealbata*) Open Forest on Dune Swales

Description: This community typically forms a narrow band of open forest dominated by Grey Paperbark (*Melaleuca dealbata*) up to 25m in height in sandy swales adjacent to frontal dunes, or fringing watercourses on sandy soils near the coast. Other canopy species are limited and may include Weeping Paperbark (*Melaleuca leucadendra*).

The sub-canopy is also generally sparse but a number of wattle species (*Acacia crassicarpa* and *A. leptocarpa*) are frequent shrub or even sub-canopy trees within this community.

The ground layer is generally very sparse, and is often dominated by the grass *Vetiveria elongata*, or in lower areas tall sedges (*Leptocarpus* species) up to 2m in height. Although not recorded in the current survey, the exotic sub-shrub or vine *Cryptostegia grandiflora* is reported as a common pest species within this community type.

Occurrence in the Study Area: This vegetation community occurs as a narrow band of grassy open forest dominated by Grey Paperbark (*Melaleuca dealbata*) up to 25m in height in sandy swales adjacent to frontal dunes or fringing minor drainage areas near the coast, including the area fringing the small coastal lagoon around Pera Head.

Corresponding Land Unit (after Gunness 1984): Directly correlates with Land Unit 5d (Paperbark Fringe on Sandy Swales).

Additional Information from REDD Database V6b

Vegetation Management Act Status (November 2009): Of concern

Biodiversity status: Of concern

Subregion:

Estimated Extent:

Extent in Reserves: Low

Wetland: Palustrine wetland (e.g. vegetated swamp).

Structure Category: Mid -dense

Protected Areas:

Fire Management Guidelines: SEASON: Early to mid-dry season. INTENSITY: Light to moderate. Burn only under mild conditions. INTERVAL: 3-5 years. STRATEGY: Burn less than 10% in any year. Protection relies on broad-scale management of surrounding country with numerous small fires throughout the year so that wildfires will be very limited in extent. ISSUES: Restrict extent and intensity of fires, because intense and extensive fires degrade vegetation structure and destroy animal habitats.

Comments: West coast of the bioregion.

RE 3.2.5a Mixed Shrubby Woodland (*Acacia crassicarpa* ± *Syzygium suborbiculare* ± *Parinari nonda*) on Beach Ridges

Description: This community type consists of a mixed shrubby woodland on beach ridges forming a sparse and discontinuous canopy from 6 to 20m in height. Spoon Tree (*Acacia crassicarpa*) is a characterisitic and usually the dominant component of this canopy layer, together with Northern Lancewood (*Acacia torulosa*) in most areas. Other frequent canopy trees include Lady Apple (*Syzygium suborbiculare*), Nonda Plum (*Parinari nonda*), Beach Pandan (*Pandanus spiralis*), Damson (*Terminalia muelleri*) and the wattle (*Acacia platycarpa*).

Trees are often well spaced, and the intervening area supports a very sparse shrub layer up to 2m in height, while the sandy open areas are dominated by a variety of grasses including *Vetiveria elongata, Panicum* species and *Perotis rara*.

Occurrence in the Study Area: This is the dominant vegetation of the narrow sandy strip fringing the western coastline of the mining lease.

Corresponding Land Unit (after Gunness 1984): Directly correlates with Land Unit 7a (Mixed Shrubby Woodland (sclerophyll vine woodland) on dunefield).

Additional Information from REDD Database V6b.

Vegetation Management Act Status (November 2009): Least concern

Biodiversity status: No concern at present

Subregion:

Estimated Extent:

Extent in Reserves: Low

Structure Category: Sparse

Protected Areas:

Fire Management Guidelines: SEASON: Early to mid-dry season. INTENSITY: Light to moderate. Burn only under mild conditions. INTERVAL: 3-5 years. STRATEGY: Burn less than 30% in any year. No fire management required. ISSUES: Restrict extent and intensity of fires, because intense and extensive fires degrade vegetation structure and destroy animal habitats.

Comments: Most extensive on the west coast. 3.2.5a (vegetation unit 54A) is a Carbeen (*Corymbia tessellaris*) dominated shrubby woodland. Veiny Paperbark (*Melaleuca nervosa*) is usually present as a subdominant tree and Damson (*Terminalia muelleri*) occurs frequently in the canopy. The sparse to mid-dense shrub layer is composed of similar species as 3.2.5. It occurs on the coastal dunes adjoining Princess Charlotte Bay.

RE 3.2.6a Beach She-Oak (*Casuarina equisetifolia*) Woodland on Foredunes

Description: This beach strand community occurs on the primary coastal dune in the colonization zone above high tide. It is characterised by a sparse or vary sparse open canopy of Beach She-Oak (*Casuarina equisetifolia*) from 5 to 15m in height, and may incude small patches of other species including Beach Almond (*Terminalia catappa*). A very sparse shrub layer up to 2m high may be present, including Beach Alyxia (*Alyxia spicata*) and Beach Mallow (*Thespesia populnea*). The ground layer is sparse and short, typically comprising patches of Beach bean (*Canavalia rosea*) and the grasses *Dactyloctenium* species, *Thuarea involuta* and *Spinifex hirsuta*.

Occurrence in the Study Area: This community forms a discontinuous narrow strip along the coastal margins of the mining lease, including around the camping area at False Pera Head. Where present this community is generally limited to a narrow band up to 30m wide fringing the shoreline at high tide.

Corresponding Land Unit (after Gunness 1984): Directly correlates with Land Unit 7a (Mixed Shrubby Woodland (sclerophyll vine woodland) on dunefield).

Additional Information from REDD Database V6b

Vegetation Management Act Status (November 2009): Of concern

Biodiversity Status: Of concern

Subregion:

Estimated Extent:

Extent in Reserves: Low

Structure Category: Sparse

Protected Areas:

Fire Management Guidelines: STRATEGY: No fire management required. Protection relies on broad-scale management of surrounding country with numerous small fires throughout the year so that wildfires will be very limited in extent. ISSUES: Fire sensitive vegetation community. Avoid burning from the strand line with a wind. Burning into wind can be safe.

Comments: Widely distributed type. Also occurs in other coastal bioregions.

RE 3.2.10c Darwin Stringybark (*Eucalyptus tetrodonta*) ± Clarkson's Bloodwood (*Corymbia clarksoniana*) on Stabilised Dunes

NO IMAGE AVAILABLE

Description: Woodland to open forest comprising a canopy of Darwin Stringybark (*Eucalyptus tetrodonta*), Clarkson's Bloodwood (*Corymbia clarksoniana*) and sometimes Molloy Red Box (*Eucalyptus leptophleba*) ranging from 9 to 22m in height on more stabilized coastal dunes and deep sandy soils.

Sub-canopy and shrub species typically include Northern Lancewood (*Acacia torulosa*), Bushman's Clothes Pegs (*Grevillea glauca*) and Lady Apple (*Syzygium suborbiculare*), sometimes in dense clumps. The ground layer is dominated by grasses, such as Plumed Sorghum (*Sorghum plumosum*), Native Panic (*Panicum mindaenense*) and Cockatoo Grass (*Alloteropsis semialata*).

Occurrence in the Study Area: This vegetation community was inaccessible and not examined in the current survey. It has been mapped and described for the coastal area around the mouth of Winda Winda Creek (Gunness 1984). This community appears to correspond with stabilized coastal sands in north-eastern part of the mining lease.

Corresponding Land Unit (after Gunness 1984): Correlates with Land Unit 2a (Tall Woodland on Massive Sandy Loam Soils).

Additional Information from REDD Database V6b.

Vegetation Management Act Status (November 2009): Least concern

Biodiversity status: Of concern

Subregion:

Estimated Extent:

Extent in Reserves: High

Structure Category: Sparse

Protected Areas:

Fire Management Guidelines: SEASON: Dry season. INTENSITY: Various. INTERVAL: 2-5 years. STRATEGY: Begin burning early in the fire season, followed by progressive patch fires burnt through the year. Burn less than 30% in any year. ISSUES: Management of this inherently stable, and fire tolerant vegetation type should be based on maintaining animal habitats and preventing extensive wildfire. Maintaining a fire mosaic will ensure protection of animal habitats and mitigate against wildfires.

RE 3.2.25 Sparse Herbland on Foredunes and Beach Ridges

Description: This community is characterized by a open grassland or herbfield which supports a variety of forbs and graminoids within a very sparse ground layer and typically only reaching 20-50cm in height. Common plant species within this ground layer include the herbs *Tribilus solandri, Evolvulus alsinoides,Crotalaria medicaginea, Indigofera colutea, I. hirsutus, Boerhavia hirsuta, Polycarpaea* species*, Achyranthes aspera, Cleome tetrandra* and the grasses *Spinifex hirsuta, Panicum tricoides, Perotis rara* and the sedge *Bulbostylis barbata*.

Occurrence in the Study Area: This community is recorded along the beach strand and beach ridge areas of the western coastline of the mining lease, and is differentiated from similar communities on these areas (i.e. RE 3.2.5 and Re3.2.6) by a general absence of tree or shrubs and a dominant grassy or mixed herb ground cover. *Grevilleas* (*G. parallela* and *G glauca*) are often the most frequent trees or shrubs in this community, although isolated individuals or patches of

Spoon Tree (*Acacia crassicarpa*), Northern Lancewood (*Acacia torulosa*), Lady Apple (*Syzygium suborbiculare*), Beach Pandan (*Pandanus spiralis*) or Damson (*Terminalia muelleri*) occur.

Corresponding Land Unit (after Gunness 1984): Directly correlates with Land Unit 12c (Grassland / Herbland on dunefield).

Additional Information from REDD Database V6b

Vegetation Management Act Status (November 2009): Of concern

Biodiversity status: Of concern

Subregion:

Estimated Extent:

Extent in Reserves: High

Structure Category: Very sparse

Protected Areas:

Fire Management Guidelines: STRATEGY: Protection relies on broad-scale management of surrounding country with numerous small fires throughout the year so that wildfires will be very limited in extent. ISSUES: Burning of this ecosystem may lead to dune instability.

Comments: The naturalised grasses *Chloris inflata** and *Dactyloctenium aegyptium** can sometimes be dominant in the ground layer.

RE 3.3.5 Evergreen Notophyll Vine Forest on Alluvial Streamlines

Description: This community forms a fringing riverine notophyll vine forest community on the most sheltered and well watered margins of major watercourses in the mining lease, with a canopy of 12 to 20m in height.

Common canopy species include L*ophostemon suaveolens, Buchanania arborescens, Syzygium forte subsp. potamophilum* and *Blepharocarya involucrigera*.

A sparse to dense sub-canopy or shrub layer is also often present. Other characteristic tree or shrub species present include *Melaleuca leucadendra, Carallia brachiata, Mallotus polyadenos, Dillenia alata, Endiandra glauca, Atractocarpus sessilis, Chionanthus ramiflora, Pongama pinnata, Memecylon pauciflorum, Cleistanthus apodus* and *Myrsine porosa.* Vine species present include *Flagellaria indica, Austrosteenisia blackii, Lygodium flexuosum, Smilax australis, Eustrephus latifolius, Hypserpa decumbens* and *Abrus precatorius.*

Occurrence in the Study Area: This vegetation community occurs in small fringing patches along the most sheltered and well watered margins of Norman Creek and the Ward River.

Corresponding Land Unit (after Gunness 1984): Correlates with Land Unit 4a2 (Riparian gallery Forest), which occurs as a gallery vine forest along the most sheltered and well watered margins of Norman Creek and the Ward River.

Additional Information from REDD Database V6b

Vegetation Management Act Status (November 2009): Least concern

Biodiversity status: No concern at present

Subregion:

Estimated Extent:

Extent in Reserves: High

Wetland: Riverine wetland or fringing riverine wetland.

Structure Category: Dense

Protected Areas:

Fire Management Guidelines: STRATEGY: Protection relies on broad-scale management of surrounding country with numerous small fires throughout the year so that wildfires will be very limited in extent. ISSUES: Fire sensitive vegetation type.

Comments: High usage by cattle, and hence frequently weed-infested. Local disturbance by human camping activities. Stream bank species such as Satinash (*Syzygium tierneyanum*), River She-Oak (*Casuarina cunninghamiana*), Forest Red Gum (*Eucalyptus tereticornis*) and Weeping Teatree (*Melaleuca leucadendra*) are frequently present.

RE 3.3.9 Swamp Mahogany (*Lophostemon suaveolens*) Open Forest on Streamlines, Swamps and Alluvial Terraces

Description: This is the dominant vegetation community fringing the upper margins of watercourses, and is characterized by a canopy layer in which Swamp Mahogany (*Lophostemon suaveolens*) and/or Weeping Teatree (*Melaleuca leucadendra*) are the dominant components. This community has three distinct variants within the mining lease area.

Occurrence in the Study Area: Within the upstream tributaries of both the Ward River and Norman Creek (variant LU4a1), Swamp Mahogany (*Lophostemon suaveolens*) is typically the dominant canopy species, ranging from 8 to 18m in height, and most commonly occurs within a narrow fringing band up to 40m in width. Other frequent canopy species within this community type include Cape York Red Gum (*Eucalyptus brassiana*), Weeping Teatree (*Melaleuca leucadendra*) and Pale Satinash (*Syzygium eucalyptoides*). Other less common canopy or sub-canopy species include Deplancea (*Deplanchea tetraphylla*) and Golden Guinea Tree (*Dillenia alata*). The outer margins of this community often form a lower, more open canopy or sub-canopy from 3 to 10m in height, in which Broad-leaved Teatree (*Melaleuca viridiflora*) and Toothed Banksia (*Banksia dentata*) are prominent components. The ground layer is sparse to mid-dense and composed of a variety of sedges, graminoids and ferns.

Within the lower freshwater sections of both the Ward River and Norman Creek (variant LU4a3), Weeping Teatree (*Melaleuca leucadendra*) becomes the more dominant canopy species up to 25 meteres in height, and may form more extensive stands fringing the main watercourse. Swamp Mahogany (*Lophostemon suaveolens*) is often also present on the outer

margins, together with Broad-leaved Teatree (*Melaleuca viridiflora*) and Toothed Banksia (*Banksia dentata*). The shrub layer also often becomes more mesic and well developed on levy banks and the outer margins, with Carallia (*Carallia brachiata*) and Short-fruited Canthium (*Cyclophyllum brevipes*) being prominent components.

This community also forms a tall open forest dominated by Swamp Mahogany (*Lophostemon suaveolens*) on the north-western bank of Norman Creek (variant 7b), forming a canopy to 22m in height with Cabbage Palm (*Livistona muelleri*) and Deplanchea (*Deplanchea tetraphylla*) and co-dominant species in the sub-canopy layer. This variant of his community is a well-developed example of Swamp Mahogany open forest within the mining lease area.

Corresponding Land Unit (after Gunness 1984): Correlates with Land Unit 7b (*Melaleuca*/ Swamp Mahogany on the outer margins of drainage depressions). Also correlates with Land Unit 4a1/4a3 (riparian gallery forest), which occurs as a gallery forest along the upper margins of permanent and semi-permanent watercourses which is often dominated by Swamp Mahogany.

Additional Information from REDD Database V6b

Vegetation Management Act Status (November 2009): Least concern

Biodiversity status: No concern at present**Subregion:**

Estimated Extent:

Extent in Reserves: High

Wetland: Riverine wetland or fringing riverine wetland.

Structure Category: Mid-dense

Protected Areas:

Fire Management Guidelines: SEASON: Early to mid-dry season. INTENSITY: Light to moderate. Burn only under mild conditions. INTERVAL: 3-5 years. STRATEGY: Burn less than 30% in any year. Protection relies on broad-scale management of surrounding country with numerous small fires throughout the year so that wildfires will be very limited in extent. ISSUES: Restrict extent and intensity of fires. Intense and extensive fires degrade vegetation structure and destroy animal habitats.

RE 3.3.14a Hard-barked Teatree (*Melaleuca clarksoniana*) Woodland of Drainage Depressions

Description: This community is characterized by an open woodland of Hard-barked Teatree (*Melaleuca clarksoniana*), Broad-leaved Paperbark (*Melaleuca viridiflora*) and Swamp Mahogany (*Lophostemon suaveolens*) from 10 to 18m in height on the broader outer margins, with Weeping Teatree (*Melaleuca leucadendra*)the dominant canopy species in more heavily inundated areas. The sub-canopy and shrub layer is very sparse to absent, although Asteromyrtus (*Asteromyrtus symphyocarpa*) and False Casuarina (*Calycopeplus casuarinoides*) may be abundant within a narrow band.

The sub-shrub layer is characteristically absent, while the ground cover layer is stratified in relation to inundation level. Above the more permanent inundation line, this layer is characterized by a low diversity grassland dominated by the Wanderie Grass (*Eiachne triseta*) to 50cm in height. Below this inundaton line, the ground cover is characterized by swampy species generally below 10cm in height, including *Drosera petiolaris, Urticularia chrysantha* and *Fimbristylis* species.

Occurrence in the Study Area: This RE occurs throughout the Project area in association with drainage lines and wetlands.

Corresponding Land Unit (after Gunness 1984): Correlates with Land Units 3b and 7b in part (*Melaleuca* swamp – zone at most consistent water level; and *Melaleuca*/ Swamp Mahogany on the outer margins of drainage depressions). These land units are generic to *Melaleuca* swamps and do not differentiate between species.

Additional Information from REDD Database V6b

Vegetation Management Act Status (November 2009): Least concern

Biodiversity status: No concern at present

Subregion:

Estimated Extent:

Extent in Reserves: High

Wetland: Palustrine wetland (e.g. vegetated swamp).

Structure Category: Sparse

Protected Areas:

Fire Management Guidelines: SEASON: Early to mid-dry season. INTENSITY: Light to moderate. Burn only under mild conditions. INTERVAL: 3-5 years. STRATEGY: Burn less than 30% in any year. Protection relies on broad-scale management of surrounding country with numerous small fires throughout the year so that wildfires will be very limited in extent. ISSUES: Restrict extent and intensity of fires, because intense and extensive fires degrade vegetation structure and destroy animal habitats.

Comments: This vegetation community often occurs in patches too small to be mapped.

RE 3.3.21 Clarkson's Bloodwood (*Corymbia clarksoniana*) ± Satinash (*Syzygium eucalyptoides*) Woodland in Drainage Depressions.

Description: This community is characterized by a canopy in which Clarkson's Bloodwood (*Corymbia clarksoniana*) and Satinash (*Syzygium eucalyptoides subsp. eucalyptoides*) are co-dominant trees from 8 to 18m in height. This community typically forms a topographic band 30 to 100m wide in drainage depressions, and as an outer fringing zone where watercourses develop.

The outer margins of this community often support a sub-canopy to shrub layer of Broad-leaved Teatree (*Melaleuca viridiflora*), Fibre-barked Teatree (*Melaleuca stenostachya*), Toothed Banksia (*Banksia dentata*), Lineament Tree (*Asteromyrtus symphyocarpa*) up to 6m in height. The sub-shrub layer varies with topography, while the ground cover layer is stratified in relation to inundation level. Above the more permanent inundation line, this layer is characterized by a low diversity grassland dominated by the Wanderie Grass (*Eiachne triseta*) to 50cm in height. Below this inundaton line, the swampy species including *Drosera petiolaris, Eriocaulon* species, *Urticularia chrysantha* and *Fimbristylis* species are dominant.

Occurrence in the Study Area: This vegetation community occurs in drainage depressions and extends well into the outer zone of riparian corridors where the stream channel becomes more distinct. This RE appear to occur consistently on the middle to upper reaches of both Norman Creek and the Ward River, including areas previously mapped as RE3.3.54. The floristic composition of this community closely matches the corresponding RE description, although this

community appears to cover the margins of both Land Zone 3 and 5 in the middle reaches of Norman Creek and the Ward River.

Corresponding Land Unit (after Gunness 1984): Correlates with Land Unit 5j in part (Upper parts of broad drainage basins, Bloodwood/Banksia).

Additional Information from REDD Database V6b

Vegetation Management Act Status (November 2009): Least concern

Biodiversity status: No concern at present

Subregion:

Estimated Extent

Extent in Reserves: Low

Wetland: Floodplain (other than floodplain wetlands).

Structure Category: Sparse

Protected Areas: Mungkan Kandju NP

Fire Management Guidelines: SEASON: Dry season. INTENSITY: Various. INTERVAL: 1-5 years. STRATEGY: Begin burning early in the fire season, followed by progressive patch fires burnt through the year. Burn less than 30% in any year. Protection relies on broad-scale management of surrounding country with numerous small fires throughout the year so that wi ISSUES: Management of this inherently stable, and fire tolerant vegetation type should be based on maintaining animal habitats and preventing extensive wildfire. Maintaining a fire mosaic will ensure protection of animal habitats and mitigate against wildfires.

Comments: Dissected Holroyd plain, south of Aurukun.

RE 3.3.49b Broad-leaved Teatree (Melaleuca viridiflora) Open Woodland on Low Plains

Description: This community is characterized by a low open woodland from 4 to 10m in height. Broad-leaved Teatree (*Melaleuca viridiflora*) is the dominant and defining tree species, with emergent Clarkson's Bloodwood (*Corymbia clarksoniana*) and Fibre-barked Teatree (*Melaleuca stenostachya*) locally prominent.

The sub-canopy and shrub layer is mostly very sparse to absent, and usually comprising a layer of recruiting Broad-leaved Teatree (*Melaleuca viridiflora*) where present. The ground cover layer

is characterized by a dense low diversity grassland with extensive patches of Panadanus (*Pandanus spiralis*) common.

Occurrence in the Study Area: This RE occurs as a peripheral band along streamlines and seasonal drainage depressions throughout the Project area. In contrast to the wetlands of RE 3.3.50a this RE experiences shorter inundation during the wet season, from surface run-off or groundwater discharge at the edge of the alluvial/colluvial zone.

Corresponding Land Unit (after Gunness 1984): Correlates with Land Unit 5j2.

Additional Information from REDD Database V6b

Vegetation Management Act Status (November 2009): Least concern

Biodiversity status: No concern at present

Subregion:

Estimated Extent:

Extent in Reserves: High

Structure Category: Very sparse

Protected Areas: Iron Range NP, Jardine River NP, Lakefield NP, Mungkan Kandju NP

Fire Management Guidelines: SEASON: Early to mid-dry season. INTENSITY: Light to moderate. INTERVAL: 1-5 years. STRATEGY: Burn less than 30% in any year. Protection relies on broad-scale management of surrounding country with numerous small fires throughout the year so that wildfires will be very limited in extent. Burn only under mild conditions. ISSUES: Restrict extent and intensity of fires. Intense and extensive fires degrade vegetation structure and destroy animal habitats.

Comments: One of the most extensive REs in the bioregion.

RE 3.3.50a Broad-leaved Teatree (*Melaleuca viridiflora*) Open Woodland on Low Plains (Paperbark wetland)

Description: This community is characterized by a low woodland to open woodland from 4 to 10m in height. Broad-leaved Teatree (*Melaleuca viridiflora*) is the dominant and defining tree species, and often occurs in dense, single species stands. The outer margins of this community

typically support a more open zone in which Clarkson's Bloodwood (*Corymbia clarksoniana*) and Fibre-barked Teatree (*Melaleuca stenostachya*) are prominent.

The sub-canopy and shrub layer mostly very sparse to absent, although Asteromyrtus (*Asteromyrtus symphyocarpa*) and False Casuarina (*Calycopeplus casuarinoides*) may be abundant within a narrow band. The ground cover layer is stratified in relation to inundation level. Above the more permanent inundation line, this layer is characterized by a low diversity grassland dominated by the grass *eriachne triseta* to 50cm in height. Below this inundation line, the ground cover is characterized by swampy species generally below 10cm in height, including *Drosera petiolaris, Urticularia chrysantha* and *Fimbristylis* species.

Occurrence in the Study Area: This RE occurs as a seasonal wetland community on streamlines and seasonal drainage depressions throughout the Project area.

Corresponding Land Unit (after Gunness 1984): Correlates with Land Units 3b and 7b in part (*Melaleuca* swamp – zone at most consistent water level; and *Melaleuca*/ Swamp Mahogany on the outer margins of drainage depressions). These land units are generic to *Melaleuca* swamps and do not differentiate between species.

Additional Information from REDD Database V6b

Vegetation Management Act Status (November 2009): Least concern

Biodiversity status: No concern at present

Subregion:

Estimated Extent:

Extent in Reserves: High

Wetland: Contains palustrine wetland (e.g. in swales).

Structure Category: Very sparse

Protected Areas:

Fire Management Guidelines: SEASON: Early to mid-dry season. INTENSITY: Light to moderate. INTERVAL: 1-5 years. STRATEGY: Burn less than 30% in any year. Protection relies on broad-scale management of surrounding country with numerous small fires throughout the year so that wildfires will be very limited in extent. Burn only under mild conditions. ISSUES: Restrict extent and intensity of fires. Intense and extensive fires degrade vegetation structure and destroy animal habitats.

Comments: One of the most extensive REs in the bioregion.

RE 3.3.60 Closed Tussock Grassland (*Vetiveria elongata*) on Alluvial / Marine Plains

Description: This community consists of a closed tussock grassland around 1m in height on marine influenced alluvial plains in the downstream sections of major watercourses. The main grass species was *Vetiveria elongata*, and was likely to include a varity of other native grass species (such as *Panicum* species, *Smithia conferta*, *Dichanthium sericeum*, *Capillipedium parviflorum*, *Themeda arguens*) and native sedges (such as *Scleria novae-hollandiae*, *Fimbristylis* species), although the composition of these grasslands was difficult to determine as they were dead and largely broken down when accessible for survey. A sparse open canopy of shrubs or small trees was also sometimes present, typically compromised of Broad-leaved Teatree (*Melaleuca viridiflora*) to 6m in height.

Occurrence in the Study Area: These grasslands were found on marine-influenced alluvial plains on the middle to downstream stretches of Norman Creek and the Ward River within the mining lease area, often adjacent to the main waterway channel and elevated above mudflats or saltpans.

Corresponding Land Unit (after Gunness 1984): Correlates with Land Unit 12d (Grasslands on low level terraces).

Additional Information from REDD Database V6b

Vegetation Management Act Status (November 2009): Least concern

Biodiversity status: No concern at present

Subregion:

Estimated Extent:

Extent in Reserves: High

Wetland: Floodplain (other than floodplain wetlands).

Structure Category: Very sparse

Protected Areas:

Fire Management Guidelines: SEASON: Progressive early to mid-dry season, followed by storm time. INTENSITY: Moderate to hot. INTERVAL: 1-5 years. STRATEGY: Burn up to 50% in any year. A combination of early to mid-dry season fires and storm-burns would assist in

maintaining a mosaic of fire ages. ISSUES: Burn when fires will carry, which is generally Sep to Oct. Reduction in cattle grazing may be required to produce adequate fire intensity. Fire exclusion and/or mild early dry season fires will benefit woody species at the expense of ground layer species, causing vegetation thickening. Late dry season fires and storm-burn help to restore the dominance of grasses.

Comments: East and west coast.

RE 3.3.61 Native Tussock Grassland (*Panicum, Fimbristylis*) on Alluvial / Marine Plains

Description: This community consists of a sedgeland or tussock grassland up to 1m in height on marine influenced alluvial plains in the downstream sections of major watercourses. The main graminiods species present are typically large congregations of fine native sedges (*Fimbristylis* species) interspersed with clumps of Native Panic (*Panicum trachyrhachis*). These areas differ from similar *Vetiveria elongata* dominated grasslands (RE3.3.60) by being more sparse and occurring in more salt-influenced areas further downstream.

Occurrence in the Study Area: These grasslands were found on marine-influenced alluvial plains on downstream stretches of Norman Creek and the Ward River within the mining lease area, often adjacent to the main waterway channel and elevated above mudflats or saltpans.

Corresponding Land Unit (after Gunness 1984): Correlates with Land Unit 12d (Grasslands on low level terraces). Similar grasslands which support scattered low trees such as Ghost Gum (*Corymbia dallachiana*) have been mapped on coastal terraces in the broader area (Land Unit 5i (Ghostgum grassy woodland on young coastal terraces) and would comprise a variant of this community type, although none were recorded in the current survey.

Additional Information from REDD Database V6b

Vegetation Management Act Status (November 2009): Least concern

Biodiversity status: No concern at present

Subregion:

Estimated Extent:

Extent in Reserves: Low

Wetland: Floodplain (other than floodplain wetlands).

Structure Category: Very sparse

Protected Areas: Lakefield NP

Fire Management Guidelines: SEASON: Early to mid-dry season. INTENSITY: Light to moderate. INTERVAL: 3-5 years. STRATEGY: Burn less than 30% in any year. Protection relies on broad-scale management of surrounding country with numerous small fires throughout the year so that wildfires will be very limited in extent. ISSUES: Can be burnt when water level is deep enough to protect bases of sedges. Sedges are disadvantaged by repeated hot fires. Mild fires help to maintain open structure. Mosaic helps protect animal habitat and food.

Comments: Especially in the south-west of bioregion. 3.3.61a Differentiated from 3.3.61b by being on coastal cracking clay plains (mostly Qac geology).

RE 3.3.63 Closed Sedgeland dominated by Bulkuru (*Eleocharis dulcis*)

Description: This vegetation community is characterized by closed sedgelands in which Bulkaru (*Eleocharis* species, particularly *Eleocharis dulcis*) dominate as a dense sward from 30cm to 1m in height. Water Chestnut (*Eleocharis dulcis*) is frequently the dominant species, whereas *E. spiralis* is abundant in some areas of shallower water. While other sedges (*Fimbristylis* species) may be common in some areas, other herbs typically only occur in low densities.

Occurrence in the Study Area: These communities are typically dense in the wet season when inundated with freshwater, and gradually deteriorate as they dry out or become increasingly salt-influenced in more saline areas.

Two variants of this community occur within the mining lease area, those that occur in marine or saline influenced areas along the main watercourse channels, particularly as fringing bands along their margins where freshwater seepage occurs (variant LU12f), and those that occur as more expansive freshwater swamps further upstream on alluvial depressions (variant LU12b). These more alluvial areas in particular are subject to heavy damage by feral pigs, and may appear as barren mud-holes during the late dry season.

Corresponding Land Unit (after, Gunness 1984): Correlates with Land Unit 12f (Bulkuru wetlands on seasonally flooded saline marine plains) in marine influenced areas, and with Land Unit 12b (Sedgeland in basins of seasonally flooded swamps and drainage depressions) in alluvial areas upstream.

Additional Information from REDD Database V6b

Vegetation Management Act Status (November 2009): Least concern

Biodiversity status: No concern at present

Subregion:

Estimated Extent:

Extent in Reserves: No representation

Wetland: Palustrine wetland (e.g. vegetated swamp).

Structure Category: Very sparse

Protected Areas: No representation.

Fire Management Guidelines: SEASON: Early to mid-dry season. INTENSITY: Light to moderate. INTERVAL: 3-5 years. STRATEGY: Burn less than 30% in any year. Protection relies on broad-scale management of surrounding country with numerous small fires throughout the year so that wildfires will be very limited in extent. ISSUES: Can be burnt when water level is deep enough to protect bases of sedges. Sedges are disadvantaged by repeated hot fires. Mild fires help to maintain open structure. Mosaic helps protect animal habitat and food.

Comments: Along west coast. Heavily dug up by feral pigs.

RE 3.3.64 Open Sedgeland (*Baloskion tetraphyllum*) in Drainage Swamps

Description: This vegetation community is characterized by sedgelands dominated by the rush *Baloskion tetraphyllum subsp meiostachyum*. These areas form a vegetated swamp (palustrine wetland) of dense rushes and sedges, typically to around 1m in height. Other rushes and sedges present may include *Tricostularia undulata, Dapsilanthus* species, *Isachne confusa,*

Schoenus sparteus and *Fimbristylis* species. Swampy forbs such as *Nepenthes mirabilis* and *Eriocaulon/Utricularia/Drosera/Selaginella* species may be present, particularly on outer margins. Scattered shrubs may be present, including Teatrees (*Meleleuca* species, especially *M. nervosa* and *M. acacioides*) and Lineament Tree (*Asteromyrtus lysicephala*).

Occurrence in the Study Area: This vegetation community occurs over some large areas, including the swamp draining into the middle portion of the Ward River from the north-west. Many smaller areas, including fringing strips of this community occur throughout the drainage areas of the mining lease, some of which are too small to map or forma mosaic with other wetland vegetation communities.

Corresponding Land Unit (after, Gunness 1984): Correlates with Land Unit 12a (Sedgeland in drainage lines of permanent running swamps).

Additional Information from REDD Database V6b

Vegetation Management Act Status (November 2009): Least concern

Biodiversity status: No concern at present

Subregion:

Estimated Extent:

Extent in Reserves: High

Wetland: Palustrine wetland (e.g. vegetated swamp).

Structure Category: Very sparse

Protected Areas:

Fire Management Guidelines: SEASON: Combination of early to mid-dry season and storm time. INTENSITY: Moderate to hot. INTERVAL: 15-20 years. STRATEGY: Burn less than 10% in any year. Protection relies on broad-scale management of surrounding country with numerous small fires throughout the year so that wildfires will be very limited in extent. ISSUES: Fires should be lit when the conditions are hot enough to ensure germination of hard-seeded plants, but when fire spread will be restricted. A combination of early to mid-dry season fires and storm-burns would assist in maintaining a mosaic of fire ages. Heath floristic diversity is greatest in the first few years after fire. Structural diversity (e.g., of epiphytes) and animal habitats require long inter-fire intervals. A mosaic of fire ages ensures both habitat diversity and restricts fire spread.

Comments: Most extensive in the Jardine Swamps in the north.

RE 3.3.65 Lakes and Lagoons on Alluvial Plains and Depressions

Description: This vegetation community is characterized by open bodies of freshwater such as lakes or lagoons, in which the floristic composition and dominance varies with locality, based upon water depth and frequency and duration of flooding. Floating plants such Marshworts (*Nymphoides* species) dominate in some areas while the bottom-rooted plants including Water Lily (*Nymphaea* species) and Water Primrose (*Ludwigia perennis*) dominate other areas. Tall graminoids including Bulkaru (*Eleocharis* species) are frequently present and dominate in some areas. Large areas of the outer margin of these lakes and lagoons are ephemeral and progressively dry out in dry season, when a variety of swampy forbs (*Eriocaulon/Urticularia/Stylidium* species) occupy the margins of exposed wet soil.

Occurrence in the Study Area: This vegetation community occurs as small areas at the lowest points within drainage lines within the mining lease, including the central parts of sinkhole swamps.

Corresponding Land Unit (after, Gunness 1984): Correlates with Land Unit 12b (Sedgeland in basins of seasonally flooded swamps and drainage depressions).

Additional Information from REDD Database V6b

Vegetation Management Act Status (November 2009): Least concern

Biodiversity status: No concern at present

Subregion:

Estimated Extent:

Extent in Reserves: High

Wetland: Palustrine wetland (e.g. vegetated swamp).

Structure Category: Very sparse

Protected Areas:

Fire Management Guidelines: SEASON: Early to mid-dry season. INTENSITY: Light to moderate. INTERVAL: 3-5 years. STRATEGY: Burn less than 30% in any year. Protection relies on broad-scale management of surrounding country with numerous small fires throughout the year so that wildfires will be very limited in extent. ISSUES: Can be burnt when water level is

deep enough to protect bases of sedges. Sedges are disadvantaged by repeated hot fires. Mild fires help to maintain open structure. Mosaic helps protect animal habitat and food.

Comments: Potentially threatened by spread of exotic ponded pasture species. Heavily damaged by feral pigs.

RE 3.5.2 Darwin Stringybark (*Eucalyptus tetrodonta*), Melville Island Bloodwood (*Corymbia nesophila*) Tall Woodland on Deeply Weathered Plateaus and Remnants

Description: This community is characterized by a tall woodland to open forest in which Darwin Stringybark (*Eucalyptus tetrodonta*) and Melville Island Bloodwood (*Corymbia nesophila*) are co-dominant canopy species from 20 to 32m in height. Other common canopy or sub-canopy tree species include Cooktown Ironwood (*Erythrophleum chlorostachys*), Variable Bloodwood (*Corymbia stockeri*) and Nonda (*Parinari nonda*).

The lower sub-canopy and shrub layers are highly variable with location and fire history, and may be sparse to absent where fire has been prominent in the landscape. Alternatively these layers may be mid-dense and reach up to 8m in height. Common small tree and shrub species include Roth's Wattle (*Acacia rothii*), Woody Pear (*Xylomelum scottianum*), Yellow Boxwood (*Pouteria pohlmaniana*), White Currant (*Flueggea virosa subsp. melanthesoides*), Cocky Apple (*Planchonia careya*), Dwarf Cabbage palm (*Livistona muelleri*) and juvenile *Eucalyptus* saplings.

The ground layer is typically mid-dense and dominated by tall grasses, notably including Giant Speargrass (*Heteropogon triticeus*), Plumed Sorghum (*Sarga plumosum*), Northern Canegrass (*Mnesithea rottboelloides*) and Silky Browntop (*Eulalia mackinlayi*). A wide variety of forbs and vines are often interspersed within the ground cover, including *Ampelocissus acetosa, Cissus opaca, Cayratia clematidea, Coelospermum reticulatum, Chaemesayce vachellii, Schelhammeria multiflora, Buchnera linearis, Flemingia parviflora, Blumea saxitilis, Scleria brownii, Galactia* sp (Andoom AMorton 1149), *Crotalaria medicaginea, Crotalaria brevis*, *Polygala longifolia, Erythroxylum* sp (Cholmondely Ck JR Clarkson 9367) and *Spermacoce* species.

Occurrence in the Study Area: This vegetation community is dominant over the vast majority of the lateritic red earth plateau affected by bauxite mining, and covers a large proportion of the mining lease. Several variants of this community occur near the edges of the

bauxite plateau, including a similar community on eroding slopes to watercourses, and on localized ironstone outcrops.

Corresponding Land Unit (after, Gunness 1984): Directly correlates with Land Unit 2b (Tall Stringybark woodland on red earth soils), and also incorporates Land Units 2c (Tall Stringybark woodland on eroding slopes and yellow earth soils), Land Units 5k (Tall Stringybark woodland on ironstone outcrops).

Additional Information from REDD Database V6b

Vegetation Management Act Status (November 2009): Least concern

Biodiversity status: No concern at present

Subregion:

Estimated Extent:

Extent in Reserves: Low

Structure Category: Sparse

Protected Areas: Jardine River NP, Mungkan Kandju NP

Fire Management Guidelines: SEASON: Early to mid-dry season. INTENSITY: Light to moderate. Burn only under mild conditions. INTERVAL: 3-5 years. STRATEGY: Burn less than 30% in any year. Protection relies on broad-scale management of surrounding country with numerous small fires throughout the year so that wildfires will be very limited in extent. ISSUES: Restrict extent and intensity of fires, because intense and extensive fires degrade vegetation structure and destroy animal habitats. **Comments:** Associated with bauxite plateaus. Significant areas near Weipa cleared for bauxite mining. One of the most widespread REs in the bioregion.

RE 3.5.4 Semi-Deciduous Notophyll Vine Forest on Deeply Weathered Plateaus and Remnants

Description: This community is characterized by discrete patches of vine forest, or closed forest vegetation, on red, lateritic plateau soils, forming a dense even canopy up to 28m in height and supporting a diverse assemblage of closed forest plant species. Common and

characteristic canopy tree species include *Buchanania arborescens*, *Vavaea amicorum, Neolitsea brassii*, *Cryptocarya hypospodia, Canarium australianum*, *Dysoxylum oppositifolium*, *Celtis philippensis*, *Drypetes deplancea, Polyalthia nitidissima, Canarium australasicum, Erythrophleum chlorostachys* and *Alstonia actinophylla*.

Sparse to mid-dense sub-canopy and low tree layers are usually also present. Other canopy and sub-canopy species include *Ganophyllum falcatum, Mallotus esophilus, Aglaia ekeagagnoidea, Mimusops elengi, Sterculia quadrifida, Endiandra glauca, Atractocarpus sessilis, Bridelia exaltata, Zanthoxylum rhetsa, Helicia australasica* and the Palm *Ptychosperma elegans*. Thin wiry vines such as *Melodorum leichhardtii, Flagellaria indica, Smilax australis, Maclura cochinchinensis, Trophis scandens, Hippocratea barbata* and *Jasminum didymum* often reach the top of the canopy. The ground is sparse and often covered with a thick layer of leaf litter.

Occurrence in the Study Area: This vegetation community occurs as discrete patches on the bauxitie plateau, including several patches near the eastern margin of the mining lease on the track to Hey Point (this community best corresponds with RE variant RE 3.5.4x1).

Corresponding Land Unit (after, Gunness 1984): Directly correlates with Land Unit 3c (Notophyll vine forest on lateritic or bauxitic red earth soils).

Additional Information from REDD Database V6b

Vegetation Management Act Status (November 2009): Least concern

Biodiversity status: No concern at present

Subregion:

Estimated Extent:

Extent in Reserves: High

Structure Category: Dense

Protected Areas: Heathlands RR, Iron Range NP, Jardine River NP, Mungkan Kandju NP

Fire Management Guidelines: STRATEGY: Protection relies on broad-scale management of surrounding country with numerous small fires throughout the year so that wildfires will be very limited in extent. ISSUES: Fire sensitive vegetation type.

Comments: North of bioregion. Great variability in species composition between patches.

RE 3.5.22c Clarkson's Bloodwood (*Corymbia clarksoniana*) Woodland on Plains

Description: This community is characterized by a woodland to open woodland canopy from 10 to 18m in height, in which Clarkson's Bloodwood (*Corymbia clarksoniana*) is the diagnostic canopy tree. Other canopy trees present include Nonda (*Parinari nonda*), Cooktown Ironwood (*Erythrophleum chlorostachys*) and, particularly on the outer margins of drainage basins, Darwin Stringybark (*Eucalyptus tetrodonta*) and Melville Island Bloodwood (*Corymbia nesophila*).

Where present, the sparse sub canopy is most frequently dominated by Broad-leaved Teatree (*Melaleuca viridiflora*), Dwarf Fan Palm (*Livistona muelleri*) and Soapbush (*Alphitonia obtusifolia*), while Black Currant (*Antidesma ghaesembilla*) and White Currant (*Flueggea virosa subsp. melanthesoides*) are characteristic species of the sparse shrub layer.

The ground layer is sparse to dense and dominated by grasses including Native Panics (*Panicum mindaenense, P. seminudum*), Wanderrie Grasses (*Eriachne triseta, E. pallescens*), Fire Grass (*Schizachyrium* species) and also includes the Speargasses *Aristida macrantha, Heteropogon triticeus* and *H. contortus*.

Occurrence in the Study Area: This community occurs in the upper and outer margins of drainage corridors, typically on gentle slopes between the bauxite plateau and waterways, or low lying depressions in the landscape. This community is difficult to map accurately and may incorporate areas of red soil of the bauxite plateau, or grey colluvial soils where it adjoins waterways.

Corresponding Land Unit (after, Gunness 1984): Correlates with Land Unit 5e (Notophyll vine forest on lateritic or bauxitic red earth soils), and also may include areas encompassed within and Land Unit 5j (Bloodwood / Banksia woodland in upper parts of broad basins) and Land Unit 2c (Tall Stringybark woodland on eroding slopes and yellow earth soils)

Additional Information from REDD Database V6b

Vegetation Management Act Status (November 2009): Least concern

Biodiversity status: No concern at present

Subregion:

Estimated Extent:

Extent in Reserves: Medium

Structure Category: Sparse

Protected Areas:

Fire Management Guidelines: SEASON: Dry season. INTENSITY: Various. INTERVAL: 1-5 years. STRATEGY: Burn less than 30% in any year. Begin burning early in the fire season, followed by progressive patch fires burnt through the year. ISSUES: Management of this inherently stable, and fire tolerant vegetation type should be based on maintaining animal habitats and preventing extensive wildfire. Maintaining a fire mosaic will ensure protection of animal habitats and mitigate against wildfires.

Comments: Normanby and Kennedy Rivers and western Cape York Peninsula. The naturalised exotic forbs Hyptis (*Hyptis suaveolens*) and Gambia Pea (*Crotalaria goreensis*) can dominate the ground layer.

RE 3.5.11 Darwin Stringybark (*Eucalyptus tetrodonta*), Melville Island Bloodwood (*Corymbia nesophila*) Woodland on Lower Slopes of Plains and Rises

Description: This community is characterized by a woodland to open forest in which Darwin Stringybark (*Eucalyptus tetrodonta*) and Clarkson's Bloodwood (*Corymbia clarksoniana*) are dominant canopy species from 12 to 26m in height, although Melville Island Bloodwood (*Corymbia nesophila*), Cooktown Ironwood (*Erythrophleum chlorostachys*), Variable Bloodwood (*Corymbia stockeri*) and Nonda (*Parinari nonda*) are also often present.

This community is found on low slopes running from the bauxite plauteau to drainage areas, and is characterized by mesic elements in the sub-canopy and shrub layers. Although variable with fire history, these layers often include a sparse to mid-dense tall shrub layer merging into a sub-canopy to 16m in height, which includes Deplachea (*Deplanchea tetraphylla*), Guettarda (*Guettarda speciosa*) Swamp Box (*Lophostemon suaveolens*), Broad-leaved Teatree (*Melaleuca viridiflora*), Toothed Banksa (*Banksia dentata*), Bushman's Clothes Pegs (*Grevillea glauca*), Dwarf Cabbage Palm (*Livistona muelleri*) and Quinine Berry (*Petalostigma* species), in addition to more widespread species such as Roth's Wattle (*Acacia rothii*), Woody Pear (*Xylomelum scottianum*), Yellow Boxwood (*Pouteria pohlmaniana*), White Currant (*Flueggea virosa subsp. melanthesoides*) and Cocky Apple (*Planchonia careya*).

The ground layer may be open to mid-dense, typically dominated by grasses common to adjoining land units, although the height and composition varies with location.

Occurrence in the Study Area: Within the mining lease, this vegetation community occurs in lower-lying areas near the western coastline. A large expanse of this community occurs north of Norman Creek near to the coast, where an extensive low-lying plain of red to grey soils occur downslope from the bauxite plateau. A similar patch has been mapped on the southern side of Winda Winda Creek near the coast.

Corresponding Land Unit (after Gunness 1984): Correlates with Land Units 2c (Tall Stringybark woodland on eroding slopes and yellow earth soils), and also possibly encompasses small adjoining areas of Land Unit 2b (Tall Stringybark woodland on red earth soils).

Additional Information from REDD Database V6b

Vegetation Management Act Status (November 2009): Least concern

Biodiversity status: No concern at present

Subregion:

Estimated Extent:

Extent in Reserves: Low

Structure Category: Sparse

Protected Areas:

Fire Management Guidelines: SEASON: Dry season. INTENSITY: Various. INTERVAL: 1-5 years. STRATEGY: Burn less than 30% in any year. Begin burning early in the fire season, followed by progressive patch fires burnt through the year. ISSUES: Management of this inherently stable, and fire tolerant vegetation type should be based on maintaining animal habitats and preventing extensive wildfire. Maintaining a fire mosaic will ensure protection of animal habitats and mitigate against wildfires.

Comments: Predominantly in the central Peninsula. The presence of *Eucalyptus leptophleba* and *Corymbia clarksoniana* in the canopy or sub canopy and frequently *Melaleuca viridiflora* in the sub canopy layer are helpful indicators of 3.5.11. A variant (vegetation unit 103A) occurs in widely scattered areas. It is characterised by a conspicuous sub canopy layer of *Livistona muelleri* (5-9m tall; density 240-320 stems/ha). *Corymbia nesophila* usually dominates the canopy and *Eucalyptus tetrodonta* is also present. The other layers have a similar composition to 3.5.11.

RE 3.7.3 Cullen's Ironbark (*Eucalyptus cullenii*) ± Darwin Stringybark (*Eucalyptus tetrodonta*) Woodland on Erosional Escarpments and Plains

Description: This community is dominated by a grassy woodland in which Cullen's Ironbark (*Eucalyptus cullenii*) and/or Broad-leaved Cabbage Gum (*Corymbia confertiflora*) are the dominant trees, and form a sparse canopy from 10 to 22m in height. Other canopy trees may be present, particularly Darwin Stringybark (*Eucalyptus tetrodonta*) and Cooktown Ironwood (*Erythrophleum chlorostachys*) where Broad-leaved Cabbage Gum dominates on erosional slopes.

The very sparse to sparse shrub layer from 1 to 4m in height is most frequently composed of Quinine Berry (*Petalostigma* species), Cocky Apple (*Planchonia careya*) and Soapwood (*Alphitonia obtusifolia*).

The ground layer is typically mid-dense to dense and dominated by tall grasses, notably including Giant Speargrass (*Heteropogon triticeus*), Plumed Sorghum (*Sarga plumosum*), Northern Canegrass (*Mnesithea rottboelloides*) and Silky Browntop (*Eulalia mackinlayi*).

Occurrence in the Study Area: This community occurs as several small patches on the eastern boundary of the mining lease, where an erosional escarpment to the east gives way to more extensive areas of this community on adjoining low plains.

Corresponding Land Unit (after Gunness 1984): Directly correlates with Land Unit 5f (Grassy woodland on eroding slopes on colluvium, Broad-leaved Carbeen and stringybark) on eroding slopes, and Land Unit 5b (Cullen's Ironbark grassy woodland on undulating plains and erosional slopes.

Additional Information from REDD Database V6b

Vegetation Management Act Status (November 2009): Least concern

Biodiversity status: No concern at present

Subregion: 7, 4

Estimated Extent:

Extent in Reserves: Medium

Structure Category: Sparse

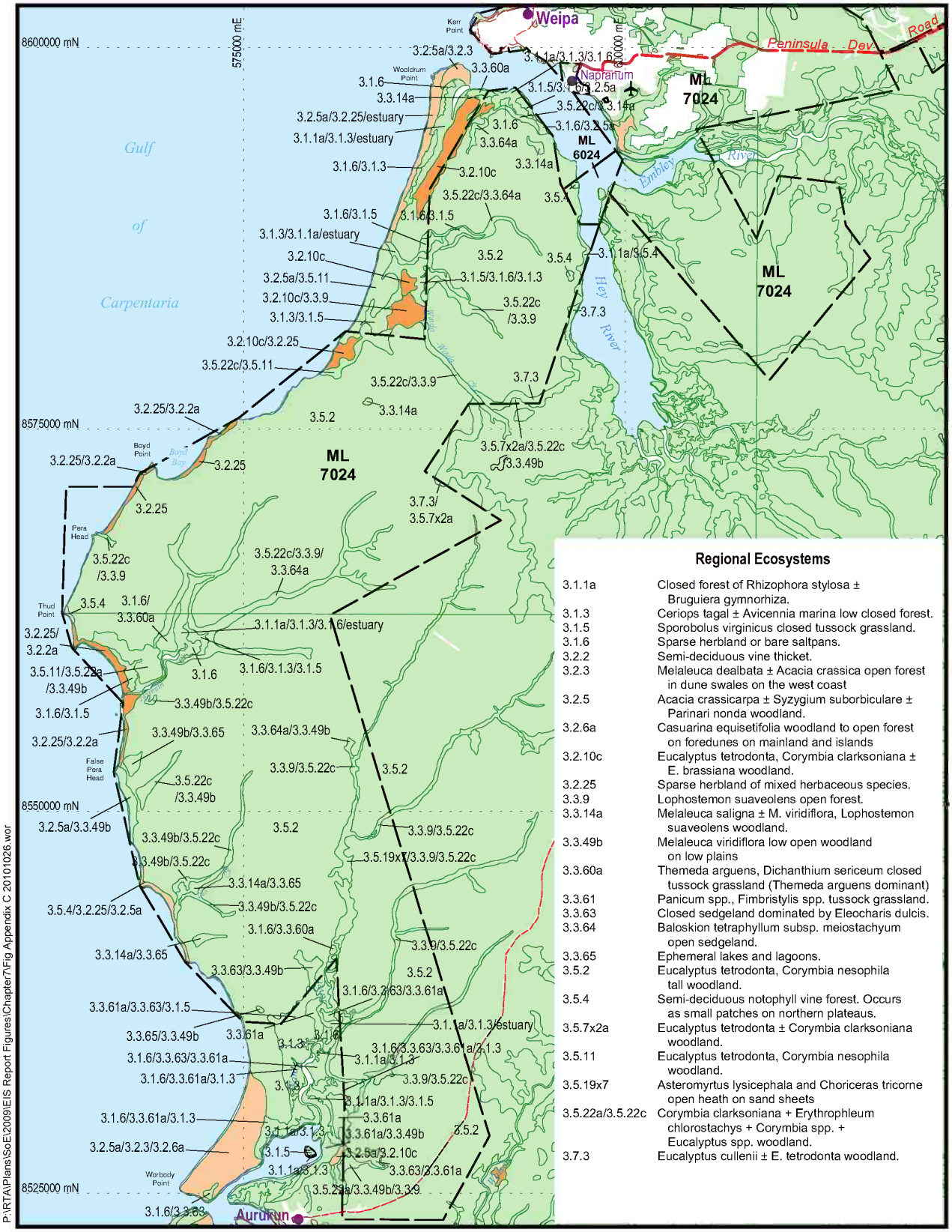
Protected Areas: Mungkan Kandju NP

Fire Management Guidelines: SEASON: Dry season. INTENSITY: Various. INTERVAL: 1-5 years. STRATEGY: Burn less than 30% in any year. Begin burning early in the fire season, followed by progressive patch fires burnt through the year. ISSUES: Management of this inherently stable, and fire tolerant vegetation type should be based on maintaining animal habitats and preventing extensive wildfire. Maintaining a fire mosaic will ensure protection of animal habitats and mitigate against wildfires.

Comments: Occurs on marginally deeper soils that are heavily weathered as well as shallow soils. Ironstone pebbles are a conspicuous feature of this community, indicating deep weathering, though outcrops are not common.

APPENDIX 7C

DERM REGIONAL ECOSYSTEM MAPPING



Regional Ecosystems

3.1.1a	Closed forest of Rhizophora stylosa ± Bruguiera gymnorhiza.
3.1.3	Ceriops tagal ± Avicennia marina low closed forest.
3.1.5	Sporobolus virginicus closed tussock grassland.
3.1.6	Sparse herbland or bare saltpans.
3.2.2	Semi-deciduous vine thicket.
3.2.3	Melaleuca dealbata ± Acacia crassica open forest in dune swales on the west coast
3.2.5	Acacia crassicarpa ± Syzygium suborbiculare ± Parinari nonda woodland.
3.2.6a	Casuarina equisetifolia woodland to open forest on foredunes on mainland and islands
3.2.10c	Eucalyptus tetrodonta, Corymbia clarksoniana ± E. brassiana woodland.
3.2.25	Sparse herbland of mixed herbaceous species.
3.3.9	Lophostemon suaveolens open forest.
3.3.14a	Melaleuca saligna ± M. viridiflora, Lophostemon suaveolens woodland.
3.3.49b	Melaleuca viridiflora low open woodland on low plains
3.3.60a	Themeda arguens, Dichanthium sericeum closed tussock grassland (Themeda arguens dominant)
3.3.61	Panicum spp., Fimbristylis spp. tussock grassland.
3.3.63	Closed sedgeland dominated by Eleocharis dulcis.
3.3.64	Baloskion tetraphyllum subsp. meiostachyum open sedgeland.
3.3.65	Ephemeral lakes and lagoons.
3.5.2	Eucalyptus tetrodonta, Corymbia nesophila tall woodland.
3.5.4	Semi-deciduous notophyll vine forest. Occurs as small patches on northern plateaus.
3.5.7x2a	Eucalyptus tetrodonta ± Corymbia clarksoniana woodland.
3.5.11	Eucalyptus tetrodonta, Corymbia nesophila woodland.
3.5.19x7	Asteromyrtus lysicephala and Choriceras tricorne open heath on sand sheets
3.5.22a/3.5.22c	Corymbia clarksoniana + Erythrophleum chlorostachys + Corymbia spp. + Eucalyptus spp. woodland.
3.7.3	Eucalyptus cullenii ± E. tetrodonta woodland.

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RTA Mining Lease boundary
Township
Road/track

Least Concern Regional Ecosystem
Of Concern Dominant Regional Ecosystem
Of Concern Sub-Dominant Regional Ecosystem
Non-remnant

Data Source: DERM RE VM Version 6

Rio Tinto Alcan

South of Embley Project

Appendix C: Current DERM Regional Ecosystem Mapping

N

5 0 5km

Datum/Projection: GDA94/MGA Zone 54 Date: 26/10/2010

APPENDIX 7D

FLORA SPECIES RECORDED FROM THE PROJECT AREA

Note: "Of concern" Regional Ecosystems (REs) comprise:

3.2.3 - *Melaleuca dealbata* ± *Acacia crassicarpa* open forest. Occurs in dune swales on the west coast

3.2.6 - *Casuarina equisetifolia* woodland. Occurs on foredunes

3.2.25 - Sparse herbland of mixed herbaceous species on foredunes and beach ridges.

In this Appendix:

"Riparian gallery forest along streams" = Riparian gallery forest and adjoining alluvial/colluvial flats along groundwater fed sections of freshwater streams

"Groundwater seepage areas" = Near-permanent groundwater seepage areas with rainforest/palm forest

"Vine Forest" = Vine Forest on coastal sands and the bauxite plateau.

Family	*Genus*	*Species*	NCA Status	EPBC Act Status	*Eucalyptus tetrodonta* Veg types	*'Of Concern' REs*	*Riparian gallery forest along streams*	*Ground-water seepage areas*	*Vine forest*
Acanthaceae	*Acanthus*	*ilicifolia*							
Acanthaceae	*Brunoniella*	*australis*			X				
Acanthaceae	*Dicliptera*	*spicata*							X
Acanthaceae	*Hygrophila*	*angustifolia*			X				
Acanthaceae	*Psuederanthemum*	*variabile*			X				
Adiantaceae	*Cheilanthes*	*contigua*			X				
Adiantaceae	*Cheilanthes*	*sieberi* subsp. *sieberi*			X				
Aizoaceae	*Sesuvium*	*portulacastrum*							
Amaranthaceae	*Achyranthes*	*aspera*				X			X
Amaranthaceae	*Gomphrena*	*flaccida*							
Anacardiaceae	*Buchanania*	*arborescens*			X		X		X
Anacardiaceae	*Euroshinus*	*falcata*							
Annonaceae	*Meiogyne*	*cylindrocarpa*							X
Annonaceae	*Melodorum*	*leichhardtii*				X			X
Annonaceae	*Milliusa*	*traceyi*							X
Annonaceae	*Polyalthia*	*nitidissima*							X
Annonaceae	*Uvaria*	*rufa*							X
Apocynaceae	*Alstonia*	*actinophylla*			X	X			X
Apocynaceae	*Alstonia*	*muellerana*			X				
Apocynaceae	*Alstonia*	*scholaris*							
Apocynaceae	*Alyxia*	*spicata*					X		X
Apocynaceae	*Carissa*	*laxiflora*							X
Apocynaceae	*Ceriopegia*	*cumingana*							X

Family	***Genus***	***Species***	**NCA Status**	**EPBC Act Status**	***Eucalyptus tetrodonta* Veg types**	***'Of Concern' REs***	***Riparian gallery forest along streams***	***Ground-water seepage areas***	***Vine forest***
Apocynaceae	*Dischidia*	*major*					X		
Apocynaceae	*Dischidia*	*nummularia*					X		
Apocynaceae	*Heterostemma*	*acuminata*							X
Apocynaceae	*Ichnocarpus*	*frutescens*							
Apocynaceae	*Parsonsia*	*lanceolata*			X				
Apocynaceae	*Parsonsia*	*velutina*							X
Apocynaceae	*Sarcostemma*	*viminale* ssp *brunonianum*							X
Apocynaceae	*Wrightia*	*saligna*			X				
Araliaceae	*Polyscias*	*elegans*							X
Araliaceae	*Schefflera*	*actinophylla*					X		X
Arecaceae	*Cocos*	*nucifera*					X		
Arecaceae	*Hydriastele*	*wendlandiana*					X	X	
Arecaceae	*Livistona*	*muellerii*			X		X		
Arecaceae	*Ptychosperma*	*elegans*							X
Asclepiadaceae	*Cynanchum*	*carnosum*							
Asclepiadaceae	*Hoya*	*australis*							X
Asclepiadaceae	*Marsdenia*	*connivens**			X				
Asclepiadaceae	*Marsdenia*	*cymulosa*							
Asclepiadaceae	*Marsdenia*	*leptophylla*			X				
Asclepiadaceae	*Marsdenia*	*viridiflora* ssp. *tropica*			X				
Asclepiadaceae	*Sarcostemma*	*australe*							
Asparagaceae	*Asparagus*	*ramosus*			X				
Asteraceae	*Blumea*	*mollis*							

Family	***Genus***	***Species***	**NCA Status**	**EPBC Act Status**	***Eucalyptus tetrodonta* Veg types**	***'Of Concern' REs***	***Riparian gallery forest along streams***	***Ground-water seepage areas***	***Vine forest***
Asteraceae	*Blumea*	*saxatilis**			X				
Asteraceae	*Cyanthilium*	*cinereum*			X				
Asteraceae	*Pleurocarpaea*	*denticulata*			X				
Asteraceae	*Pterocaulon*	*sphacelatum*							
Asteraceae	*Vernonia*	*cinerea*			X				
Asteraceae	*Wedelia*	*spilanthoides*			X	X			X
Asteraceae	*Wollastonia*	*biflora*							
Avicenniaceae	*Avicennia*	*marina*							
Barringtoniaceae	*Barringtonia*	*asiatica*					X		
Bignoniaceae	*Deplanchia*	*tetraphylla*					X	X	
Bignoniaceae	*Dolichandrone*	*heterophylla**			X				
Bignoniaceae	*Pandorea*	*pandorana*							
Blechnaceae	*Blechnum*	*indicum*					X	X	
Blechnaceae	*Stenochlaena*	*palustris*							
Bombaceae	*Bombax*	*ceiba*							X
Boraginaceae	*Messerschmidia*	*argentia*							
Boraginaceae	*Trichodesma*	*zeylanica*				X	X		
Burseraceae	*Canarium*	*australianum* var. *australianum*			X	X			X
Caesalpiniaceae	*Chamaecrista*	*mimosoides*			X				
Caesalpiniaceae	*Erythrophleum*	*chlorostachys*			X		X		
Campanulaceae	*Lobelia*	*dioica*					X		
Capparaceae	*Capparis*	*canescens*							
Capparaceae	*Capparis*	*sepiaria*							X

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Carophyllaceae	*Polycarpea*	*spirostylis* spp *densiflora*							
Casuarinaceae	*Allocasuarina*	*littoralis*					X		
Casuarinaceae	*Casuarina*	*equisetifolia*					X		
Celastraceae	*Denhamia*	*oleaster*							X
Celastraceae	*Hedraianthera*	*porphyropetala*							X
Celastraceae	*Maytenus*	*bilocularis*							X
Celastraceae	*Maytenus*	*cunninghamii*			X				
Celastraceae	*Pleurostylia*	*opposita*							X
Celastraceae	*Salacia*	*chinensis*							X
Celastraceae	*Siphonodon*	*australe*			X				
Chrysobalanaceae	*Maranthes*	*corymbosa*							X
Chrysobalanaceae	*Parinari*	*nonda*			X	X	X		X
Clusiaceae	*Calophyllum*	*australianum*							
Clusiaceae	*Calophyllum*	*inophyllum*							X
Clusiaceae	*Calophyllum*	*sil*						X	X
Clusiaceae	*Garcinia*	*warrenii*							X
Cochlospermaceae	*Cochlospermum*	*gilliveraei*			X				
Combretaceae	*Terminalia*	*catappa*				X	X		X
Combretaceae	*Terminalia*	*muellerii*			X	X			X
Combretaceae	*Terminalia*	*sericocarpa*				X			X
Combretaceae	*Terminalia*	*subacroptera*							X
Commelinaceae	*Cartonema*	*spicatum*							
Commelinaceae	*Commelina*	*ensifolia*							

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Convolvulaceae	*Evolvulus*	*alsinoides*			X				
Convolvulaceae	*Ipomoea*	*abrupta*							
Convolvulaceae	*Ipomoea*	*pes-caprae*					X		
Convolvulaceae	*Ipomoea*	sp.			X				
Convolvulaceae	*Merremia*	*quinata*			X				
Convolvulaceae	*Polymeria*	*ambigua*			X				
Cucurbitaceae	*Diplocyclos*	*palmatus*							X
Cyperaceae	*Baumea*	*rubiginosa*							
Cyperaceae	*Bulbostylis*	*barbata*				X	X		X
Cyperaceae	*Cyperus*	*aquatilis*							
Cyperaceae	*Cyperus*	*flaccidus*							
Cyperaceae	*Cyperus*	*haspan* subsp. *haspan*							
Cyperaceae	*Cyperus*	*polystachyos* var *polystachyus*							
Cyperaceae	*Eleocharis*	*geniculata*							
Cyperaceae	*Eleocharis*	sp.					X		
Cyperaceae	*Fimbristylis*	*nutans*					X		
Cyperaceae	*Fimbristylis*	*pauciflora*							
Cyperaceae	*Fimbristylis*	sp.							
Cyperaceae	*Fuirena*	*arenosa*							
Cyperaceae	*Fuirena*	*ciliaris*							
Cyperaceae	*Gahnia*	*sieberana*							
Cyperaceae	*Hypolytrum*	*proliferum*							
Cyperaceae	*Lepironia*	*articulata*							

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Cyperaceae	*Rhynchospora*	*rubra*							
Cyperaceae	*Schoenus*	*calostachyus*							
Cyperaceae	*Schoenus*	*sparteus*					X		
Cyperaceae	*Scleria*	*brownii*			X				
Cyperaceae	*Scleria*	*scrobiculata*					X		
Cyperaceae	*Scleria*	*terrestris*							
Dilleniaceae	*Dillenia*	*alata*			X		X	X	
Dilleniaceae	*Hibbertia*	*candicans*							
Dilleniaceae	*Hibbertia*	*dealbata*			X				
Dioscoreaceae	*Dioscorea*	*bulbifera*							
Dioscoreaceae	*Dioscorea*	*transversa*			X	X			X
Droseraceae	*Drosera*	*burmannii*					X		
Droseraceae	*Drosera*	*indica*					X		
Droseraceae	*Drosera*	*petiolaris*			X		X		
Ebenaceae	*Diospyros*	*calycantha*							X
Ebenaceae	*Diospyros*	*compacta*							
Ebenaceae	*Diospyros*	*ferrea*							X
Ebenaceae	*Diospyros*	*geminata*					X		
Elaeocarpaceae	*Elaeocarpus*	*arnhemicus*							
Eriocaulaceae	*Eriocaulon*	*depressum*					X		
Eriocaulaceae	*Eriocaulon*	*fistulosum*					X		
Eriocaulaceae	*Eriocaulon*	*scariosum*					X		
Eriocaulaceae	*Eriocaulon*	sp.					X		

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Erythroxylaceae	*Erythroxylum*	*australe*			X				
Erythroxylaceae	*Erythroxylum*	sp. *(cholmondely ck)*			X				
Euphorbiaceae	*Antidesma*	*ghaesembilla**			X				
Euphorbiaceae	*Antidesma*	*parviflorum*			X				
Euphorbiaceae	*Antidesma*	sp.							
Euphorbiaceae	*Breynia*	*oblongifolia*			X				
Euphorbiaceae	*Breynia*	*cernia*			X	X			X
Euphorbiaceae	*Bridelia*	*leichardtii*			X	X			X
Euphorbiaceae	*Calycopeplus*	*casuarinoides*				X	X		
Euphorbiaceae	*Chamaesyce*	*vachellii*							
Euphorbiaceae	*Drypetes*	*deplanchea*							X
Euphorbiaceae	*Euphorbia*	*tannensis*			X				
Euphorbiaceae	*Euphorbia*	*vachelli*			X				
Euphorbiaceae	*Excoecaria*	*agallocha*					X		
Euphorbiaceae	*Flueggea*	*virosa* subsp. *melanthesoides**			X				
Euphorbiaceae	*Glochidion*	*benthamiana*					?		
Euphorbiaceae	*Glochidion*	*lobocarpum*					?		
Euphorbiaceae	*Macaranga*	*tanarius*							X
Euphorbiaceae	*Mallotus*	*discolor*							X
Euphorbiaceae	*Mallotus*	*nesophilus*							X
Euphorbiaceae	*Mallotus*	*philippensis*							X
Euphorbiaceae	*Mallotus*	*polyadenos*							
Euphorbiaceae	*Microstachys*	*chamaelea**			X				

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Euphorbiaceae	*Phyllanthus*	*virgatus*			X	X			
Fabaceae	*Abrus*	*precatorius*				X			X
Fabaceae	*Aeschynomene*	*indica*			X				
Fabaceae	*Alysicarpus*	*rugosus*			X				
Fabaceae	*Aphyllodium*	*biarticulatum*					X		
Fabaceae	*Austrodolichos*	*errabundus*			X		X		
Fabaceae	*Austrosteenisia*	*blackii*							X
Fabaceae	*Callerya*	*pinnata*							
Fabaceae	*Canavalia*	*rosea*					X		
Fabaceae	*Crotalaria*	*brevis*			X				
Fabaceae	*Crotalaria*	*linifolia*			X				
Fabaceae	*Crotalaria*	*medicaginea*			X				
Fabaceae	*Crotalaria*	*montana**			X				
Fabaceae	*Crotalaria*	sp.			X				
Fabaceae	*Dalbergia*	*densa* var. *densa*							X
Fabaceae	*Desmodium*	*brachypodum**			X				
Fabaceae	*Desmodium*	*heterocarpon* var. *heterocarpon*			X				
Fabaceae	*Desmodium*	sp.							
Fabaceae	*Entada*	*rheedi*							X
Fabaceae	*Flemingia*	*parviflora*			X				
Fabaceae	*Galactia*	*muelleri*			X				
Fabaceae	*Galactia*	*tenuifolia*			X				
Fabaceae	*Glycine*	*tomentella*			X				

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Fabaceae	*Hardenbergia*	*violaceae*			X				
Fabaceae	*Indigofera*	*colutea*			X				
Fabaceae	*Pongamia*	*pinnata*				X			X
Fabaceae	*Pycnospora*	*lutescens*			X				
Fabaceae	*Rhynchosia*	*minima* var *minima*			X		X		
Fabaceae	*Sophora*	*tomentosa*							
Fabaceae	*Stylosanthes*	*scabra*			X				
Fabaceae	*Tephrosia*	*filipes* var. *latifolia*			X				
Fabaceae	*Tephrosia*	*juncea*			X				
Fabaceae	*Tephrosia*	*purpurea*			X		X		
Fabaceae	*Tephrosia*	sp (c2258)							
Fabaceae	*Uraria*	*cylindrica*			X				
Fabaceae	*Uraria*	*picta*			X				
Fabaceae	*Vigna*	*marina*					X		
Fabaceae	*Vigna*	*vexillata* var. *angustifolia*							
Fabaceae	*Xornia*	*muelleriana*			X				
Flagellariaceae	*Flagellaria*	*indica*				X	X	X	X
Gleicheniaceae	*Dicranopteris*	*linearis*							
Gleicheniaceae	*Sticherus*	*flabellatus*							
Goodeniaceae	*Hibbertia*	*dealbata*			X				
Goodeniaceae	*Scaevola*	*sericea*				X	X		X
Haemodoraceae	*Haemodorum*	*coccineum*							
Hemerocallidaceae	*Tricoryne*	*anceps*					X		

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Hernandiaceae	*Gyrocarpus*	*americanus*							X
Hippocrateaceae	*Hippocratea*	*barbata*							X
Lamiaceae	*Anisomeles*	*malabarica*			X				
Lamiaceae	*Clerodendrum*	*floribundum* var. *ovatum*				X			X
Lamiaceae	*Clerodendrum*	*inerme*							
Lamiaceae	*Clerodendrum*	*tomentosum*							
Lamiaceae	*Gmelina*	*dalrympleana*					X		
Lauraceae	*Beilschmedia*	*obtusifolia*							X
Lauraceae	*Cassytha*	*filiformis*			X	X	X		
Lauraceae	*Cassytha*	sp *(pubescens?)*			X				
Lauraceae	*Cassytha*	*pubescens*					X		
Lauraceae	*Cryptocarya*	*bamaga*							
Lauraceae	*Cryptocarya*	*hypospodia*							X
Lauraceae	*Cryptocarya*	*mackinnoniana*							
Lauraceae	*Cryptocarya*	*rhodosperma*							
Lauraceae	*Cryptocarya*	*triplinervis*							X
Lauraceae	*Endiandra*	*glauca*					X		
Lauraceae	*Litsea*	*fawcettiana*							
Lauraceae	*Litsea*	*glutinosa*							X
Lauraceae	*Neolitsea*	*brassii*							X
Lecythidaceae	*Planchonia*	*careya*			X	X	X		X
Lentibulariaceae	*Utricularia*	*caerulea*			X		X		
Lentibulariaceae	*Utricularia*	*chrysantha*					X		

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Lentibulariaceae	*Utricularia*	sp.					X		
Liliaceae	*Crinum*	*pedunculatum*							
Liliaceae	*Curculigo*	*ensifolia*							
Liliaceae	*Dianella*	*caerulea*							
Liliaceae	*Dianella*	*longifolia* var. *longifolia*			X				
Liliaceae	*Dianella*	*odorata**			X				
Liliaceae	*Dianella*	sp (c2248)							
Liliaceae	*Dianella*	sp.					X		
Liliaceae	*Drymophila*	*cyanea*			X				
Liliaceae	*Schelhammera*	*multiflora*			X				
Liliaceae	*Thysanotus*	*tuberosus*			X		X		
Liliaceae	*Tricoryne*	*platyptera*			X				
Lindsaeaceae	*Lindsaea*	*ensifolia* subsp. *agatii*					X		
Lindsaeaceae	*Lindsaea*	*ensifolia* subsp. *ensifolia*							
Lindsaeaceae	*Lindsaea*	*media*							
Loganiaceae	*Fagraea*	*racemosa*							
Loranthaceae	*Dendrophthoe*	*glabrescens*							
Lycopodiaceae	*Lycopodiella*	*cernua*							
Malvaceae	*Abelmoschus*	*moschatus* subsp. *tuberosus*			X				
Malvaceae	*Hibiscus*	*meraukensis**			X				
Malvaceae	*Hibiscus*	*tiliaceus*							
Malvaceae	*Thespesia*	*populnea*							
Malvaceae	*Urena*	*lobata*							

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Melastomataceae	*Melastoma*	*affine*					X		
Melastomataceae	*Melastoma*	*polyanthum*			X			X	
Melastomataceae	*Memecylon*	*pauciflorum* var. *pauciflorum*							X
Melastomataceae	*Pternandra*	*coerulescens*							X
Meliaceae	*Aglaia*	*elaeagnoidea*							X
Meliaceae	*Dysoxylum*	*acutangulum* spp *foveolatum*							
Meliaceae	*Dysoxylum*	*oppositifolium*			X				X
Meliaceae	*Owenia*	*vernicosa*			X				
Meliaceae	*Turraea*	*pubescens*							
Meliaceae	*Vavaea*	*amicorum*							X
Meliaceae	*Xylocarpus*	*granatum*							
Menispermaceae	*Pacygone*	*ovata*							X
Menispermaceae	*Pycnarrhena*	*novoguineensis*							X
Menispermaceae	*Stephania*	*japonica*			X	X			X
Menispermaceae	*Tinospora*	*esiangkara*	R		X				
Menispermaceae	*Tinospora*	*smilacina*							
Menyandiaceae	*Villarsia*	*exaltata*							
Menyanthaceae	*Nymphoides*	sp.							
Mimosaceae	*Acacia*	*aulacocarpa*			X				
Mimosaceae	*Acacia*	*calyculata*							
Mimosaceae	*Acacia*	*crassicarpa*			X		X		
Mimosaceae	*Acacia*	*disparrima*			X				
Mimosaceae	*Acacia*	*leptocarpa*					X		

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Mimosaceae	*Acacia*	*mangium*							
Mimosaceae	*Acacia*	*polystachya*							
Mimosaceae	*Acacia*	*rothii*			X	X	X		
Mimosaceae	*Acacia*	*torulosa*							
Mimosaceae	*Adenthera*	*abrosperma*							
Mimosaceae	*Albixia*	*procera*							
Mimosaceae	*Archidendron*	*grandiflorum*							
Mimosaceae	*Archidendron*	*? hirsutum*							X
Moraceae	*Antiaris*	*toxicaria* v. *macrophylla*							X
Moraceae	*Ficus*	*atricha*							X
Moraceae	*Ficus*	*opposita*			X				
Moraceae	*Ficus*	*platypoda*							
Moraceae	*Ficus*	*racemosa*							
Moraceae	*Ficus*	sp.							
Moraceae	*Ficus*	*virens*							X
Moraceae	*Ficus*	*virens* var *sublanceolata*							
Moraceae	*Maclura*	*cochinchinensis*							X
Moraceae	*Trophis*	*scandens*							X
Myristicaceae	*Horsfieldia*	*australiana*							
Myristicaceae	*Myristica*	*insipida*							
Myrsinaceae	*Aegiceras*	*corniculatum*							
Myrsinaceae	*Myrsine*	*porosa*							X
Myrsinaceae	*Rapanea*	sp *(*aff *howittiana)*							

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Myrsinaceae	*Rapanea*	*urceolata*							
Myrtaceae	*Asteromyrtus*	*symphyocarpa*					X		
Myrtaceae	*Corymbia*	*clarksoniana*			X				
Myrtaceae	*Corymbia*	*nesophila*			X				
Myrtaceae	*Corymbia*	*polycarpa*			X	X	X		
Myrtaceae	*Corymbia*	*stockeri*			X				
Myrtaceae	*Corymbia*	*tesselaris*							
Myrtaceae	*Eucalyptus*	*brassiana*			X	X	X		
Myrtaceae	*Eucalyptus*	*leptophleba*			X				
Myrtaceae	*Eucalyptus*	*tetrodonta*			X		X		
Myrtaceae	*Eugenia*	*reinwardtiana*							X
Myrtaceae	*Gossia*	*floribunda*							X
Myrtaceae	*Gossia*	*retusa*							X
Myrtaceae	*Lophostemon*	*suaveolens*			X	X	X	X	
Myrtaceae	*Melaleuca*	*acacioides*							
Myrtaceae	*Melaleuca*	*argentea*					X		
Myrtaceae	*Melaleuca*	*brassii*					X		
Myrtaceae	*Melaleuca*	*cajuputi*							
Myrtaceae	*Melaleuca*	*clarksonii*					X		
Myrtaceae	*Melaleuca*	*dealbata*					X		
Myrtaceae	*Melaleuca*	*leucadendra*							
Myrtaceae	*Melaleuca*	*nervosa*							
Myrtaceae	*Melaleuca*	*quinquenervia*							

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Myrtaceae	*Melaleuca*	*saligna*				X	X		
Myrtaceae	*Melaleuca*	*stenostachya*			X		X		
Myrtaceae	*Melaleuca*	*viridiflora*			X	X	X		
Myrtaceae	*Neofabricea*	*myrtifolia*							
Myrtaceae	*Osbornea*	*octodonta*							
Myrtaceae	*Syxygium*	*angophoroides*					X	X	
Myrtaceae	*Syxygium*	*forte* subsp. *potamophilum*			X				
Myrtaceae	*Syxygium*	*suborbiculare*			X		X		
Myrtaceae	*Thryptomene*	*obligandra*							
Myrtaceae	*Welchiodendron*	*longivalve*							
Nepenthaceae	*Nepenthes*	*mirabilis*	E	V			X		
Nyctaginaceae	*Pisonia*	*aculeate*							X
Nymphaceae	*Nymphaea*	*violacea*							
Oleaceae	*Chionanthus*	*ramiflora*							
Oleaceae	*Jasminum*	*didymium* ssp. *didymum*				X			X
Onagraceae	*Ludwigia*	*octavalvis*							
Opiliaceae	*Cansjera*	*leptostachya*							X
Orchidaceae	*Cymbidium*	*canaliculatum*			X				
Orchidaceae	*Dendrobium*	*bigibbum*	V	V					X
Orchidaceae	*Dendrobium*	*canaliculatum*							
Orchidaceae	*Dendrobium*	*johannis*	V	V			X		
Pandanaceae	*Freycinetia*	*excelsa*							
Pandanaceae	*Pandanus*	*spiralis*			X		X		

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Passifloraceae	*Passiflora*	*foetida* var *foetida*			X				
Philesiaceae	*Eustrephus*	*latifolius*			X				X
Philydraceae	*Philydrum*	*lauginosum*							
Phyllanthaceae	*Breynia*	*cernua*					X		
Phyllanthaceae	*Briedelia*	*exaltata*							X
Phyllanthaceae	*Briedelia*	*tomentosa*							X
Phyllanthaceae	*Glochidion*	*disparipes*					X		
Phyllanthaceae	*Phyllanthus*	sp.					X		
Plumbaginaceae	*Plumbago*	*xeylanica*							X
Poaceae	*Alloteropsis*	*semialata*					X		
Poaceae	*Aristida*	*holathera* var *holathera*							
Poaceae	*Aristida*	*macroclada*					X		
Poaceae	*Aristida*	*utilis*			X		X		
Poaceae	*Aristida*	*warburgii*			X				
Poaceae	*Arundinella*	*nepalensis*			X				
Poaceae	*Bothriochloa*	*erianthoides*			X				
Poaceae	*Capillipedium*	*parviflorum*			X				
Poaceae	*Chrysopogon*	*elongatus*							
Poaceae	*Chrysopogon*	*fallax*			X				
Poaceae	*Cymbopogon*	*globosus*			X				
Poaceae	*Cymbopogon*	*refractus*			X				
Poaceae	*Dactyloctenium*	*australe*							
Poaceae	*Dichanthium*	*sericeum*					X		

Family	*Genus*	*Species*	NCA Status	EPBC Act Status	*Eucalyptus tetrodonta* Veg types	*'Of Concern' REs*	*Riparian gallery forest along streams*	*Ground-water seepage areas*	*Vine forest*
Poaceae	*Ectrosia*	*leporina*			X	X	X		
Poaceae	*Ectrosia*	*scabrida*							
Poaceae	*Eragrostis*	*brownii*			X				
Poaceae	*Eragrostis*	*cumingii*							
Poaceae	*Eragrostis*	*schultxii*			X				
Poaceae	*Eragrostis*	sp (l11)			X				
Poaceae	*Eriachne*	*armitii*			X		X		
Poaceae	*Eriachne*	*burkittii*			X	X	X		
Poaceae	*Eriachne*	*pallescens*			X				
Poaceae	*Eriachne*	*triseta*			X	X	X		
Poaceae	*Eulalia*	*mackinlayi*			X		X		
Poaceae	*Heteropogon*	*contortus*			X				
Poaceae	*Heteropogon*	*triticeus*			X		X		
Poaceae	*Imperata*	*cylindrica*			X				
Poaceae	*Isachne*	*globosa*					X		
Poaceae	*Ischaemum*	*decumbens*							
Poaceae	*Ischaemum*	*fragile*					X		
Poaceae	*Mnesithea*	*rottboellioides*			X				
Poaceae	*Oplismenus*	*aemulus*				X			X
Poaceae	*Panicum*	*mindanaense**			X				
Poaceae	*Panicum*	*seminudum* var *cairnsianum**			X		X		
Poaceae	*Panicum*	*trichoides*				X			X
Poaceae	*Pseudogognatherum*	*contortus*							

Family	*Genus*	*Species*	NCA Status	EPBC Act Status	*Eucalyptus tetrodonta* Veg types	*'Of Concern' REs*	*Riparian gallery forest along streams*	*Ground-water seepage areas*	*Vine forest*
Poaceae	*Sacciolepis*	*indica*					X		
Poaceae	*Schixachyrium*	*fragile*					X		
Poaceae	*Schixachyrium*	*pachyarthron*					X		
Poaceae	*Sehima*	*nervosum*			X				
Poaceae	*Sorghum*	*nitidum*			X				
Poaceae	*Sorghum*	*plumosum*			X				
Poaceae	*Sorghum*	*timorense*			X				
Poaceae	*Spinifex*	*hirsutus*							
Poaceae	*Sporobolus*	*virginicus*							
Poaceae	*Thaumastochloa*	*major*							
Poaceae	*Thaumastochloa*	*pubescens*			X				
Poaceae	*Thaumastochloa*	*rariflora*			X				
Poaceae	*Themeda*	*arguens*			X				
Polygalaceae	*Polygala*	*longifolia**			X				
Polypodiaceae	*Drynaria*	*quercifolia*							X
Proteaceae	*Banksia*	*dentata*			X		X		
Proteaceae	*Grevillea*	*glauca*			X	X	X		
Proteaceae	*Grevillea*	*parallela*			X				
Proteaceae	*Grevillea*	*pteridifolia*							
Proteaceae	*Helicia*	*australasica*							X
Proteaceae	*Persoonia*	*falcata*			X				
Proteaceae	*Stenocarpus*	*verticis*							X
Proteaceae	*Xylomelum*	*salicinum*			X				

Family	*Genus*	*Species*	NCA Status	EPBC Act Status	*Eucalyptus tetrodonta* Veg types	*'Of Concern' REs*	*Riparian gallery forest along streams*	*Ground-water seepage areas*	*Vine forest*
Pteridaceae	*Acrostichum*	*speciosum*							
Ranunculaceae	*Clematis*	*pickeringii*							X
Restionaceae	*Dapsilanthus*	*elatior*			X		X		
Restionaceae	*Dapsilanthus*	*ramosus*					X		
Restionaceae	*Dapsilanthus*	*spathaceus*							
Rhamnaceae	*Alphitonia*	*excelsa*			X	X	X		X
Rhamnaceae	*Alphitonia*	*obtusifolia*							
Rhamnaceae	*Colubrina*	*asiatica*							
Rhamnaceae	*Emmenosperma*	*cunninghamii*							
Rhamnaceae	*Ventilago*	*ecorollata*							X
Rhizophoraceae	*Bruguiera*	*gymnorhixa*							
Rhizophoraceae	*Bruguiera*	*exaristata*							
Rhizophoraceae	*Carallia*	*brachiata*			X		X	X	
Rhizophoraceae	*Ceriops*	*decandra*							
Rhizophoraceae	*Ceriops*	*tagal*							
Rhizophoraceae	*Rhizophora*	*apiculata*							
Rhizophoraceae	*Rhizophora*	*stylosa*							
Rubiaceae	*Aidia*	*racemosa*							X
Rubiaceae	*Atractocarpus*	*sessilis*							X
Rubiaceae	*Canthium*	*coprosmoides*							
Rubiaceae	*Coelospermum*	*reticulatum*			X		X		
Rubiaceae	*Guettarda*	*speciosa*							
Rubiaceae	*Ixora*	*timorensis*			X				X

Family	*Genus*	*Species*	NCA Status	EPBC Act Status	*Eucalyptus tetrodonta* Veg types	*'Of Concern' REs*	*Riparian gallery forest along streams*	*Ground-water seepage areas*	*Vine forest*
Rubiaceae	*Morinda*	*citrifolia*							X
Rubiaceae	*Pavetta*	*australiensis*							X
Rubiaceae	*Psychotria*	*loniceroides*							
Rubiaceae	*Psychotria*	*nesophilis*							
Rubiaceae	*Psychotria*	*poliostemma*							X
Rubiaceae	*Psydrax*	*attenuatum*							X
Rubiaceae	*Randia*	*sessilis*							
Rubiaceae	*Spermacoce*	*brachystema*			X		X		
Rubiaceae	*Spermacoce*	sp.			X				
Rubiaceae	*Spermacoce*	*stenophylla**			X				
Rubiaceae	*Tarenna*	*dallachiana*							
Rubiaceae	*Timonius*	*timon*			X				
Rutaceae	*Dinosperma*	*erythrococcum*							X
Rutaceae	*Glycosmis*	*trifoliata*							X
Rutaceae	*Halfordia*	*kendak*							X
Rutaceae	*Micromelum*	*minutum*							X
Rutaceae	*Murraya*	*ovatifolia*							X
Rutaceae	*Xanthoxylum*	*rhetsa*							X
Santalaceae	*Exocarpus*	*latifolius*				X			X
Sapindaceae	*Alectryon*	*reticulatus*							
Sapindaceae	*Atalaya*	*variifolia*							
Sapindaceae	*Cupaniopsis*	*anacardiodes*				X			X
Sapindaceae	*Cupaniopsis*	*fleckeri*							X

Family	*Genus*	*Species*	NCA Status	EPBC Act Status	*Eucalyptus tetrodonta* Veg types	*'Of Concern' REs*	*Riparian gallery forest along streams*	*Ground-water seepage areas*	*Vine forest*
Sapindaceae	*Dodonaea*	*polyandra*							
Sapindaceae	*Ganophyllum*	*falcatum*							X
Sapindaceae	*Guioa*	*acutifolia*							
Sapindaceae	*Jagera*	*pseudorhys* forma *pilosiuscula*							
Sapotaceae	*Mimusops*	*elengi*							X
Sapotaceae	*Palaquium*	*galactoxylon*							
Sapotaceae	*Pouteria*	*chartacea*							X
Sapotaceae	*Pouteria*	*pohlmaniana**			X	X			X
Sapotaceae	*Pouteria*	*sericea*			X	X			X
Sapotaceae	*Pouteria*	*unmackiana**			X				
Schizaeaceae	*Lygodium*	*microphyllum*						X	
Schizaeaceae	*Schixaea*	*dichotoma*			X		X		
Scrophulariaceae	*Bacopa*	*floribunda*			X				
Scrophulariaceae	*Buchnera*	*linearis*			X		X		
Scrophulariaceae	*Buchnera*	*tetragona*			X				
Scrophulariaceae	*Buchnera*	sp.			X				
Scrophulariaceae	*Lindernia*	*subulata*							
Scrophulariaceae	*Stemodia*	sp.							
Scrophulariaceae	*Striga*	*curviflora**			X				
Smilacaceae	*Ripogonum*	*album*							
Smilacaceae	*Smilax*	*australis*			X	X	X		X
Sonneratiaceae	*Sonneratia*	*alba*							
Sterculiaceae	*Brachychiton*	*garrawayae*			X				

Family	*Genus*	*Species*	NCA Status	EPBC Act Status	*Eucalyptus tetrodonta* Veg types	*'Of Concern' REs*	*Riparian gallery forest along streams*	*Ground-water seepage areas*	*Vine forest*
Sterculiaceae	*Helicteres*	sp.			X		X		
Sterculiaceae	*Heritiera*	*littoralis*							
Sterculiaceae	*Sterculia*	*quadrifida*				X			X
Strynaceae	*Strychnos*	*lucida*							X
Taccaceae	*Tacca*	*leontopetaloides*			X				X
Tiliaceae	*Grewia*	*oxyphylla*							X
Tiliaceae	*Grewia*	*retusifolia*			X				
Tiliaceae	*Grewia*	*rustica*			X				
Tiliaceae	*Triumfetta*	*rhomboidea*			X				
Ulmaceae	*Celtis*	*paniculata*							
Ulmaceae	*Celtis*	*philippensis*							X
Ulmaceae	*Trema*	*tomentosa* var. *viridis*							
Verbenaceae	*Clerodendrum*	*costatum**			X				
Verbenaceae	*Clerodendrum*	*floribundum* var. *ovatum*			X				
Verbenaceae	*Glossocarya*	*hemiderma*							X
Verbenaceae	*Vitex*	*glabrata*							
Verbenaceae	*Vitex*	*trifolia*					X		
Vitaceae	*Ampelocissus*	*acetosa*			X		X		
Vitaceae	*Cayratia*	*trifolia*			X				X
Vitaceae	*Cayratia*	*acris*							X
Vitaceae	*Cayratia*	*cardiophylla*							X
Vitaceae	*Cissus*	*opaca*			X				
Vitaceae	*Cissus*	*repens*							

Family	*Genus*	*Species*	NCA Status	EPBC Act Status	*Eucalyptus tetrodonta* Veg types	*'Of Concern' REs*	*Riparian gallery forest along streams*	*Ground-water seepage areas*	*Vine forest*
Xanthorrhoeaceae	*Lomandra*	*banksii*							
Xanthorrhoeaceae	*Lomandra*	*longifolia*			X		X		
Xanthorrhoeaceae	*Lomandra*	*multiflora*			X				
Xyridaceae	*Xyris*	*complanata*					X		

Note: Species with a sp. follow scientific convention and indicate species that could not be identified to species level but could confidently be identified to genus level. Most of these species could not be identified to species level because reproductive material such as flowers, fruit or seeds which is usually required to make positive ID was not available. In these instances specimens were not sent to the Herbarium for ID as the Herbarium botanists rely on the same features for ID. A number of specimens with reproductive material were sent to the Herbarium and positively ID'd and have been incorporated into the species list with their full name

Species with '?' were not positively confirmed due to absence of diagnostic reproductive material.

* indicates specimen identified by Queensland Herbarium

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APPENDIX 7E

FAUNA METHODOLOGY

Available Literature

A search of literature and online resources was undertaken to locate existing records of fauna and descriptions of habitats within the Project area. The Queensland DERM Wildlife Online database was searched for records of fauna within and immediately adjacent to the Project area. The search areas are provided in **Table 7E-1** below.

Table 7E-1 Wildlife Online Search Area Coordinates

Corner Point	Latitude (Decimal degrees)	Longitude (Decimal degrees)
North west	-12.62	141.55
North east	-12.62	142.00
South west	-13.40	141.55
South east	-13.40	142.00

Fauna Habitats

An initial assessment of fauna habitats present within the Project area was undertaken using aerial imagery and review of the Land Unit descriptions of Godwin (1985) and Gunness *et al.* (1987). A further appreciation of the fauna habitats present was gained during the preliminary studies in 2006 and May 2007. During the main EIS surveys (Dec 2007 to May 2009) extensive traverse were undertaken throughout the Project area to identify the full suite of habitats opportunities available for fauna. Design of the fauna survey program including identification of the threatened fauna species potentially present was based on this understanding of the habitats present.

Overall Fauna Community

- A comprehensive site based fauna survey program was conducted to determine the fauna community within the Project area. During the May 2008 survey event nine sites were surveyed using a range of techniques as outlined in **Table 7E-2**. Three survey sites were also surveyed during the May 2007 survey event. Sites were representative of the main habitats present within the Project area. The location and details for each of the twelve comprehensive survey sites are provided in **Table 7E-3** and **Figure 7-10** (Section 7 of the EIS).
- A number of supplementary fauna sites were also undertaken during the 2006 survey event where a sub set of the comprehensive fauna survey suite was employed. These sites were undertaken to compliment the comprehensive sites in areas where full survey effort was not possible due to access constraints or where specific site characteristics precluded some survey techniques (e.g. inundated areas, or recently burned areas).

Elliott traps

A total of 50 Elliott traps were used to capture small, ground-dwelling mammals at each site. Traps were laid in parallel transects approximately 30-40m apart with trap intervals of about 10 m. Each transect had an equal number of traps and was approximately 250-270 m in length. Traps were left open for four consecutive nights baited with a peanut butter, rolled oats and vanilla essence mix, which was refreshed as required. Every fifth trap was additionally baited with salami to broaden the range of species targeted. Traps were checked early each morning and any captured animals removed.

Pitfall traps

Pitfall traps were used during the preliminary surveys in 2006 and 2007, but were replaced by funnel traps for subsequent surveys. Two pitfall lines were installed at each site and opened for four nights, each comprising 5 pitfalls linked by a 20m drift fence. Pitfalls were constructed of 150mm diameter PVC storm water pipe with insect netting placed at the bottom of the hole. Drift fences comprised 40mm wide plastic damp course held in place with steel pins. Pitfalls were checked at least twice per day. At each site, pitfall sites were selected to sample any variation in ground cover habitat.

Funnel Traps

Funnel traps comprise a sprung steel frame covered in shade mesh with an opening either end, and measure approximately 750mm long x 180mm high x 180mm wide. Funnel traps were incorporated into the 2007 survey as part of the pitfall lines. Four pairs of traps were installed straddling the fence in between pits (total 8 funnel traps). Funnel traps were found to capture an equal or higher diversity of reptiles and amphibians compared to pitfall traps and were subsequently used instead of pitfall traps. For the May 2008 survey, 2 x funnel trap lines were installed at each of the primary survey sites comprising 7 x pairs of traps straddling a 20m drift fence. For all applications of funnel traps, traps were set in place for a period of four nights and checked twice daily.

Hair tubes

Hair tubes were used to sample ground mammals that may not be captured by Elliott traps. Hair tubes were set in conjunction with Elliott trap lines or as a separate transect. Tubes were baited with the same oat-based mix used in Elliott traps and left in place for four consecutive nights. Each trap was also baited with salami to broaden the range of species targeted. A total of six hair tubes were set for a period of four days at each site and the collected hair was then consigned to Scatsabout for identification.

Bird searches

Bird observations were conducted in the morning after trap clearing. The searches included observations of birds and identification of bird calls. Unidentifiable bird calls were also 'chased down' within the survey site. Bird searches were carried out on two mornings at comprehensive survey sites with additional observations made randomly at other sites of interest within the Project area.

Cage Traps

Cages traps were used during the 2006 and 2007 surveys only. Two cage traps were installed at either end of Elliott trap lines. Cage traps were baited with peanut butter mixture and salami and opened for four nights. Due to zero captures during the preliminary surveys, the use of cage traps was discontinued for subsequent surveys.

Spotlight searches

Spotlight searches for nocturnally active arboreal and ground fauna were conducted at all comprehensive and supplementary survey sites. Foot based searches using head torches and spotlights were the main activity undertaken although vehicle based spotlight transects using hand held spotlights were also conducted to identify arboreal and large ground mammals over greater survey areas using tracks as survey transects.

Specific (Herpetofauna) searches

Diurnal searches for reptiles and amphibians were conducted at each comprehensive site with additional observations made randomly at other sites. Total search time per site differed based on the abundance of microhabitat at each site. Diurnal searches were undertaken by two ecologists walking through the survey site and searching beneath bark, leaves and logs and upon vegetation for reptiles and other fauna. Specific searches were also undertaken at certain supplementary survey sites.

Anabat

A single night Anabat session was conducted at each comprehensive survey site and selected supplementary sites. The sessions involved recording bat calls using an Anabat II bat detector connected to a ZCAIM digital storage device. The Anabat assembly was set in a position to maximise the likelihood of interception of foraging bats and left overnight. Anabat recordings were analysed by Anabat identification expert Mr. Greg Ford.

Harp trap

A double bank (4.2m^2) AustBat harp trap was utilised to capture microbats at comprehensive survey sites and some supplementary survey sites. The harp trap was erected in positions to coincide with likely flyways of microbats especially in association with riparian corridors and tracks through closed canopy vegetation. Harp traps were set just after sunset and cleared early the following morning

Indirect and incidental observations

Incidental observations of fauna were recorded throughout the Project area during all survey events resulting in the addition of several species that were not recorded using standardised methods.

Call broadcasting

Call broadcast was employed at selected sites where there was a possibility of locating threatened owl species. Calls were broadcast to elicit response by either return calls or observation of respondent birds. Calls were broadcast for at least ten minutes interspersed by listening and observing periods. Call recordings for the Rufous Owl, Masked Owl, and Marbled Frogmouth from Nature Sound (1998) Bird Observers Club of Australia (2001) were utilised for broadcasts. Calls were broadcast via an MP3 player connected to a Toa megaphone.

Table 7E-2 Fauna Survey Methods Versus Target Fauna Groups

Fauna Group	Elliot Traps	Funnel Traps	Pitfall Traps	Hair Tubes	Cage Traps	Bird Searches	Spot Light	Herpetofauna Searches	Anabat	Harp trap	Observation	Call Playback
Birds						X	X				X	X
Amphibians		x	x				X	X			X	
Reptiles		x	x				X	X			X	
Ground dwelling mammals	x	x	x	x	x		X				X	
Arboreal mammals				x	x		X				X	
Microbats									X	X		

Field survey data was collated from field notebooks onto MS Excel spreadsheets.

Table 7E-3 Comprehensive Fauna Site Details

Site no.	Easting	Northing	Survey Event	Site Description	Location
A	567438	8556767	May 2008	Coastal Vine Forest	near the mouth of Norman Creek
B	578758	8545086	May 2008	Darwin Stringybark Open Forest	Ina Creek/Ward River area
C	567163	8553276	May 2008	Paperbark Woodland/colluvial woodland	False Pera Head
D	590160	8577254	May 2008	Riparian Gallery Forest and associated alluvial/colluvial Woodland	Winda Winda Creek upper reaches
E	596094	8584290	May 2008	Darwin Stringybark Open Forest	Hey Point area
F	596296	8585122	May 2008	Notophyll Vine Forest on lateritic red earths	Hey Point area
G	581196	8565972	May 2008	Riparian Gallery Forest and associated alluvial/colluvial Woodland	Norman Creek tributary
H	575068	8568621	May 2008	Riparian Gallery Forest and associated alluvial/colluvial Woodland	Norman Creek tributary
I	569359	8570156	May 2008	Paperbark Woodland/colluvial woodland	Boyd Bay area
J	581117	8558750	May 2007	Darwin Stringybark Open Forest	Norman Creek area
K	573994	8556737	May 2007	Darwin Stringybark Open Forest	Norman Creek area
L	572134	8556234	May 2007	Darwin Stringybark Open Forest	Norman Creek area

Threatened Fauna

A review of available habitats and existing records for threatened fauna within and adjacent to the Project area was undertaken to determine a list of threatened fauna species that potentially occurred in the area. Targeted survey programs were developed for each species, although due to the inherent scarcity and low detectability of some species, a practical timely survey approach was not readily available for all species. **Table 7E-4** details the potential threatened fauna species covered by the targeted survey program. Survey activities for threatened species were based on the premise of extensive survey activity in many locations being more likely to intersect individuals than intensive survey in fewer locations. However, the comprehensive site based survey activities also provided opportunities to detect threatened species when undertaking the more intensive survey work.

Targeted surveys for threatened fauna were conducted in May 2007, November 2007, May 2008, December 2008 and May 2009. A total of 27 days of targeted survey effort were undertaken with additional survey effort provided during the comprehensive site based surveys. For instance, during spotlighting sessions at comprehensive survey sites, call playback surveys were undertaken for the Rufous Owl (*Ninox rufa*) and Masked Owl (*Tyto alba*), and spotlighting traverses produced appreciable survey effort for the Common Spotted Cuscus (*Spilocuscus maculatus*).

Table 7E-4 Targeted Survey Activities Undertaken for Threatened and Migratory Fauna Species

Common Name	Survey activities	Comments
Reptiles		
Estuarine Crocodile *Crocodylus porosus*	Extensive population survey not undertaken for Project area. Traverses undertaken to assess the availability of potential breeding habitat. Nocturnal spotlight transects undertaken in the Ward River estuary.	A ubiquitous and frequently observed species within marine, wetland and stream habitats. Extensive systematic population survey not required to determine the occurrence of the species due to many incidental observations. Targeted survey activities focused on establishing the extent of reproductive activity within the Project area.
Rusty Monitor *Varanus semiremex*	Boat based survey undertaken in Norman Creek. Foot based traverses undertaken within mangrove and wetland areas in the Norman Creek, Ward River and Ina Creek catchments, and behind mangrove areas at Hey Point. Targeted funnel trapping undertaken in one location in Melaleuca swamp forest on Norman Creek.	A reclusive species with low detectability predominantly due to its preference for mangrove and wetland habitats. The actual trapability of this species with funnel traps is not known but it is assumed that the species would enter these traps as with similar sized varanids such as *V. tristis* and *V. scalaris*.
(a Burrowing Snake) *Antairoserpens warro*	Targeted funnel trapping in potential habitat at 2 locations close to known record near Beagle Camp (records outside Project area). Searches of leaf litter also undertaken at numerous localities during threatened fauna traverses.	A diminutive species that is difficult to detect given its fossorial/litter dwelling habit.
Birds		
Radjah Shelduck *Tadornah radjah rufitergum*	Traverses of wetland, estuary, and riparian areas undertaken throughout the Project area.	A readily distinguished and detectable species.
Eastern Curlew *Numenius madagascariensis*	Traverses of wetland and beach areas undertaken throughout the Project area. observation of beach locations using a spotting scope undertaken throughout the Project area. Boat based observations also undertaken on Norman Creek and the Ward River.	A readily distinguished and detectable species.
Beach Stone-curlew *Esacus magnirostris*	Traverse of beach areas and spot observation of beach locations using a spotting scope undertaken throughout the Project area.	A readily distinguished species though can be cryptic.
Black-necked Stork *Ephippiorhynchus asiaticus*	Traverses of wetland and beach areas undertaken throughout the Project area. Boat based observations also undertaken on Norman Creek and the Ward River.	A readily distinguished and detectable species.
Square-tailed Kite *Lophoictinia isura*	Vehicle based observational traverses undertaken throughout the Project area. Foot based traverses undertaken in coastal areas where there was heightened raptor activity including the coastline between Pera Head and Boyd Point, Boyd Bay, tributaries and wetlands in the Norman Creek and Ward River systems.	This species requires extended survey effort due to low density, however surveys were concentrated in riparian and coastal areas where bird prey is most abundant. Can be difficult to confidently identify at a great distance.
Grey Goshawk *Accipiter novaehollandiae*	Vehicle based observational traverses undertaken throughout the Project area.	A readily distinguished and detectable species that is known to soar above the canopy.

Common Name	Survey activities	Comments
	Traverses of riparian gallery forest along Norman Ck and coastal vine forest and bauxite plateau hosted vine forest near Hey Point.	
Red Goshawk *Erythrotriorchis radiatus*	Vehicle based observational traverses undertaken throughout the Project area. Foot based traverse and observation undertaken in wetland areas during late wet season and late dry season. Foot based traverses undertaken in coastal areas where there was heightened raptor activity including the coastline between Pera Head and Boyd Point, Boyd Bay, tributaries and wetlands in the Norman Creek and Ward River systems.	A secretive species that is difficult to detect. Can be difficult to confidently identify at a great distance.
Little Tern *Sterna albifrons*	Traverses of beach areas and spot observation of beach and reef locations using a spotting scope undertaken throughout the Project area.	Can be difficult to confidently identify at a distance when in flight.
Palm Cockatoo *Probosciger aterrimus macgillivrayi*	Traverses throughout the Project area covering all habitats but especially vine forest and riparian gallery forest areas.	A readily distinguished and detectable species often observed or heard flying in small groups above the canopy.
Rufous Owl *Ninox rufa meesi*	Night time and daytime traverses within riparian gallery forest, vine forest, mangroves and wetland margins. Evening call playback sessions during targeted spotlight sessions and general site based comprehensive fauna surveys.	The actual tendency for this species to respond to call playback is not well known; however most owl species are more inclined to respond to call playback during the breeding season between June to August (Pizzey and Knight 2003) A secretive species but readily identified if observed or heard.
Masked Owl *Tyto novaehollandiae kimberli*	Night time and daytime traverses within riparian gallery forest, vine forest, mangroves and wetland margins. Evening call playback sessions during targeted survey spotlight sessions and general site based comprehensive fauna surveys.	This species is known to respond to call playback but the technique may vary in effectiveness at different times of the year.
Mammals		
Northern Quoll *Dasyurus hallucatus*	This is a very rare species with no recent sightings or Traditional Owner knowledge within or adjacent to the Project area. Survey relied on potential detection of the species during general day and night survey activities.	
Chestnut Dunnart *Sminthopsis archeri*	Survey effort relied on potential detection during the site based comprehensive survey program which included habitat of the species.	
Common Spotted Cuscus *Spilocuscus maculatus nudicaudatus*	Night time spotlight traverses within riparian gallery forest, vine forest, mangroves and wetland margins. Also daytime traverses in same habitats but lower detectability during daytime.	This species is easily detected at night with a bright eye shine. The species can also be located during the day by observations of the leafy nest occupied by the species.
Papuan Sheathtail-bat *Saccolaimus mixtus*	Anabat and Harp Trap surveys undertaken at numerous points throughout the Project area in addition to generic bat surveys.	Positive identification of this species from Anabat data is not possible although calls can be possibly attributed to the species. The propensity of the species to be caught in Harp Traps also appears low.

Threatened and Migratory Fauna listed under the EPBC Act

The fauna survey satisfied the 6 steps of planning and design of surveys as outlined in the EPBC *Survey Guidelines for Australia's Threatened Birds*, *Bats* and *Frogs* (DEWHA 2010a, 2010b, 2010c respectively).

For the Red Goshawk and Masked Owl, the following survey approach and methodology was employed which satisfied the respective recommended survey methods and survey effort requirements for these species described in *Survey Guidelines for Australia's Threatened Birds* (DEWHA 2010a).

Red Goshawk (*Erythrotriorchis radiates)*

The Red Goshawk (if present) would be expected to occupy predominantly coastal, wetland and riparian habitats and immediately adjoining areas of Darwin Stringybark woodland. This assumption is supported by the results of the fauna surveys which revealed low diversity and abundance of potential bird prey within Darwin Stringybark dominated habitats, and also the observation that the highest raptor activity was consistently evident within coastal areas.

Advice was sought from Mr Greg Czechura (Senior Information officer at the Queensland Museum and Queensland raptor expert) as to the best locations for targeting survey effort. He advised that any areas where there were hot spots of raptor activity or a mosaic of different habitat types would be ideal locations for observing the Red Goshawk if they were present.

The survey approach was to spend as much time as possible traversing the general study area with more targeted survey of likely locations where Red Goshawk may be foraging. A total of 410 hours of survey applicable to the Red Goshawk was undertaken comprising 159 hours of vehicle traverses and 251 hours of targeted survey activities including foot based observational traverses, bird searches, coastal observations with a spotting scope, all terrain vehicle (ATV) beach traverses and boat traverses of Norman Creek. Targeted observational traverses focused on wetland/riparian habitat mosaics, including riparian gallery forest and freshwater/estuarine wetlands occurring near the coast. The coastal and beach observation activities were also important for detecting the Red Goshawk.

Surveys were conducted over 57 days, during six survey events between July 2006, and May 2009. Some surveys had a two person team bringing total applicable survey effort to 756 person hours. Surveys were conducted in April-May and in November when the species is likely to be particularly evident due to breeding activity.

Foot based observational traverses provided the greatest level of survey effort, and approximately 162 hours of foot traverses were undertaken in likely wetland and riparian habitat. The survey included searches for nests in riparian areas and searches of the Dam C footprint.

Gouldian Finch (*Erythrura gouldiae)*

The Project area supports grass species that are favoured by the Gouldian Finch, but the current regime of frequent extensive fires is likely to affect the availability of seed during the dry season over large areas of the Project area. In most years, fresh water does not persist across the vast majority of the Project area during the dry season, and it is likely that fresh surface water is totally absent following poor wet seasons.

The characteristic vagaries of seed and fresh water availability within the Project area are anticipated to render the area unsuitable for the Gouldian Finch, nevertheless, substantial components of the fauna survey activities undertaken during preliminary and EIS surveys were suitable for locating the Gouldian Finch. Surveys conducted within the Project area that were applicable to the Gouldian Finch totalled approximately 370 hours in duration, comprising 159 hours of vehicle traverses and 211 hours of foot traverses, site based searches and other observational activities, over a total of 57 survey days. These surveys were undertaken during six survey events spanning July 2006 to May 2009. Survey effort included observational sessions in the lower Norman Creek area which is regarded as the location most likely to support the species (i.e. most persistent surface water) if present in the Project area.

Observations and searches carried out in the lower Norman Creek area comprised approximately 35 hours spread over both late wet season and late dry season survey events.

Masked Owl (*Tyto novaehollandiae kimberli)*

There are no trapping or remote/automatic survey techniques suitable for the Masked Owl, and field observation of individuals and use of call broadcast surveys remain the only practical survey techniques. The use of call broadcasts to elicit responses from any individuals that may be present within the broadcast area is the preferred method as, if successful, it will draw individuals in to the observer that may not have otherwise been observed.

The efficacy of call playback may vary during the year with surveys conducted during the breeding season likely to yield the best results. The breeding season of the Masked Owl is poorly known especially on western Cape York where few records of the species exist; however, the species potentially breeds in the period March-October. Call broadcast surveys may fail to elicit responses from individuals at certain times of year even if they are present within the broadcast area.

Given the potential limitations of call broadcast surveys, they were not the sole survey technique employed for detecting the Masked Owl. Spotlight sessions and nocturnal vehicle traverses were also included as appropriate survey techniques for detecting the species.

The Masked Owl is a predator of small-medium sized terrestrial mammals in particular, and EIS surveys revealed that these were virtually absent from the Darwin Stringybark woodland. Call broadcast surveys were initially undertaken in Darwin Stringybark woodland (i.e. during preliminary surveys in 2006 & 2007), however, subsequent call broadcast surveys focused on riparian habitats, paperbark swamps and the landward margin of mangroves all of which were found to support at least low densities of ground mammals (mainly *Melomys burtoni*).

A total of 8.6 hours of call broadcast surveys was employed at 26 sites, over 13 nights, during four survey events between July 2006 and May 2009. Each call broadcast session employed repetitions of the scan/playback/listen technique, as recommended in *Survey Guidelines for Australia's Threatened Birds* (DEWHA 2010a), with an average total time of 20 minutes for each playback session. The majority of survey sites were located in riparian, wetland and mangrove habitats, where the species was regarded as most likely to be foraging, if present.

In addition to the call broadcast surveys, 87 hours of spotlighting and nocturnal vehicle traverses were undertaken, over a total of 37 survey days, during six survey events between July 2006 to May 2009 in both target habitats and Darwin Stringybark woodland. The survey effort included the Dam C footprint.

Call broadcast surveys, spotlighting, and nocturnal vehicle traverses were conducted during the potential breeding season (March-October) when they are most likely to yield the best results.

Northern Quoll (*Dasyurus hallucatus)*

There are currently no survey guidelines for the Northern Quoll. The Northern Quoll has not been located on Cape York since the 1980's and it appears that if the species does persist in the region it most likely currently occurs in association with optimal habitat areas rather than more marginal habitats. The Project area does not support any optimal habitat for the species, which is widely accepted to comprise rocky habitats such as rocky outcrops, hills, and gullies. The absence of this habitat within the 100,000 ha Project area made it difficult to devise a targeted survey for the species as there were no habitat areas within the Project area that appeared more likely to support the species than any other. Consequently the adopted survey approach for Northern Quoll was to rely on the overall fauna survey program to detect the species if present. Given the wide array of survey techniques included in the fauna survey program this was regarded as an appropriate survey approach rather than a speculative targeted survey.

The detectability of Northern Quolls peaks in the lead up to the mating season when males are actively seeking females and typically are less wary of predators. All males die after mating, leading to a significant temporary adult population reduction until young are born (mid dry season) and become independent from their mothers. The timing of surveys within the Project

area (i.e. April-May and December) coincided with periods of the Northern Quoll lifecycle when a high adult population would be present (April-May) and when new recruits would be actively independent (December). Consequently surveys were well timed for maximum detectability of the species.

Survey effort appropriate for detecting the Northern Quoll comprised a total of 2,400 Elliot trap nights; 360 hair tube trap nights; 16 cage trap nights; 37.5 hours of spotlighting; and, 50 hours of nocturnal vehicle traverses, over several survey events in different seasons at numerous survey sites throughout the Project area. This survey effort is regarded as sufficient to provide a good chance of detecting the species if present.

Bare-rumped Sheathtail Bat (*Saccolaimus saccolaimus nudicluniatus*)

The Bare-rumped Sheathtail Bat is a poorly known species that is difficult to detect. The species is not readily captured using existing bat trapping techniques, and cannot be reliably identified from Anabat recordings.

Records of the species from Iron Range and Coen indicate that the species may favour riparian forest and vine forest and adjacent woodland including Darwin Stringybark dominated habitats. The species was found roosting in Darwin Stringybark at Iron Range. Based on this information, large areas of the Project area may be suitable for the species, especially in the vicinity of riparian gallery forest and vine forest patches but potentially also deeper into the Darwin Stringybark woodland that occurs across the majority of the Project area.

Survey effort for bats within the Project area focussed on the use of Anabat detectors with harp traps also used. Anabat survey effort included overnight and part night stationery deployment of Anabat units and overnight Harp trap sets at all survey sites and at additional locations as part of the targeted threatened fauna surveys. A total of 25 detector (Anabat) nights and 19 harp trap nights were conducted during the survey.

Anabat analysis (undertaken by Greg Ford, Balance Environmental) identified the presence of *Saccolaimus spp*. at 10 sites and attributed these calls predominantly to *Saccolaimus flaviventris* and probably *Saccolaimus mixtus* and *Mormopterus beccarii*. No calls were attributed to the Bare-rumped Sheathtail Bat, however, identification of this species using Anabat analysis and separation from species with similar calls is currently unreliable.

Migratory Fauna

A review of available habitats and existing records for migratory fauna within and adjacent to the Project area was undertaken to determine a list of species that potentially occurred in the area. This review did not identify any migratory species that required specific survey activities for detection, and the overall survey program was relied on to detect migratory species within the Project area. Survey activities for migratory shorebirds are described below.

Migratory Shorebirds

Given the location of the Project area within the East Asian-Australasian Flyway, migratory shorebirds were identified in preliminary reviews as a key fauna group for field surveys.

Initial observations of likely shorebird habitats including the Gulf shoreline, the lower and upper estuary of Norman Creek, Hey Point estuary, and coastal wetlands associated with Norman Creek and the Ward River revealed a notable paucity of migratory shorebirds both in terms of species diversity and density of individuals. It was also noted that despite the large rise and fall of tides that can occur in the Gulf, the Project area did not support any extensive inter-tidal flats and the shoreline of the Gulf coast in particular was predominantly sandy and of sufficient gradient to expose only minimal tidal flats at the mouth of Norman Creek. Furthermore, seasonal coastal wetlands formed by freshwater inundation of marine plains during the wet season were invariably dry during December survey events and frequently heavily impacted by feral pig activity.

Given the paucity of migratory shorebirds, the survey approach focussed on continually extending the search area for migratory shorebirds rather than undertaking dedicated shorebird count surveys of a handful of individuals. Dedicated observation sessions for migratory

shorebirds were subsequently conducted at a number of locations within the Project area in order to further assess the apparent paucity of migratory shorebirds. Survey locations included the Gulf coastline between Pera Head and Red Cliffs, at Ina Creek, south of False Pera Head, and between False Pera Head and Norman Creek; the Hey River estuary around Hey Point; seasonal coastal wetlands associated with Norman Creek and the Ward River; and, the lower Norman Creek estuary to the mouth. A combination of static observation sessions with a spotting scope, all terrain vehicle (ATV) traverses of beaches, and boat based observations were employed during these surveys.

Surveys were undertaken during a range of tidal conditions and during different times of the day but predominantly between dawn and mid-afternoon.

Migratory shorebirds typically arrive in northern Australia around August to September and depart around April to May, although many individuals remain over winter in the Southern Gulf. Field surveys within the Project area coincided with the typical departure period (April/May surveys in 2008 and 2009) and the period following the initial arrival of birds (December 2007 and December 2008). Field survey timing was appropriate for detecting migratory waders when they are most likely to be using habitats along the west coast of the Gulf of Carpentaria.

Surveys conducted within the Project area that were applicable to migratory shorebirds totalled approximately 93 hours, comprising 53 hours of foot traverses, 24 hours of static coastal observations, 9.5 hours of ATV beach traverses, and 6.5 hours of boat traverse on Norman Creek. These surveys were undertaken during four survey events in December 2007 and 2008, and April/May 2008 and 2009.

This survey approach and methodology is consistent with the guidelines for determining whether a site meets the criteria for important habitat described in the *Significant impact guidelines for 36 migratory shorebird species* (DEWHA 2009).

Other Migratory Birds

The balance of the migratory birds confirmed to occur or potentially occurring in the Project area comprise mainly diurnally active species of woodland and wetland habitats and aerial species that are active over a broad range of vegetation and habitat types. Survey effort for these species coincided with site based survey activities and targeted survey activities for threatened fauna and comprised a considerable overall survey period and duration. Daytime survey activity totalled over 410 hours of observations employed over several survey events during different seasons including approximately 159 hours of vehicle traverses and 251 hours of observational activity.

References

DEWHA (2009). Draft EPBC Act Policy Statement 3.21 Significant Impact Guidelines for 36 Migratory Shorebird Species. Department of Environment, Water, Heritage and the Arts, Commonwealth Government.

DEWHA (2010a). Survey Guidelines for Australia's Threatened Birds. Department of the Environment, Water, Heritage and the Arts, Commonwealth Government.

DEWHA (2010b). Survey Guidelines for Australia's Threatened Bats. Department of the Environment, Water, Heritage and the Arts, Commonwealth Government.

DEWHA (2010c). Survey Guidelines for Australia's Threatened Frogs. Department of the Environment, Water, Heritage and the Arts, Commonwealth Government.

APPENDIX 7F

FAUNA SPECIES LIST

Genus	Species	Common Name	Relative Abundance in suitable habitat	Comprehensive Fauna Sites												Supplementary sites and Targeted surveys	Main Habitats						
				A	B	C	D	E	F	G	H	I	J	K	L		Darwin Stringybark Open Forest	Riparian Gallery Forest/alluvial woodland	Vine Forest on bauxite	Paperbark Woodland and Wetland Swamps	Foreshores, Tidal Flats, Beach	Coastal Vine Forest	Mangrove and Estuary
Amphibians																							
Crinia	remota	Torrid Froglet	a	x		x												x		x			
Limnodynastes	convexiusculus	Marbled Frog	c			x										x		x		x			
Limnodynastes	ornatus	Ornate Burrowing Frog	a	x		x	x			x								x		x			
Uperoleia	mimula	Torres Gungan	a			x										x		x		x			
Cyclorana	novaehollandiae	Eastern Snapping-frog	c													x	x	x		x			
Litoria	bicolor	Dwarf Tree Frog	c	x		x										x		x		x			
Litoria	caerulea	Green Tree Frog	c	x												x	x	x	x	x		x	x
Litoria	dorsalis	Dwarf Rocket Frog	c													x		x		x			
Litoria	inermis	Bumpy Rocketfrog	a													x		x					
Litoria	infrafrenata	Giant Tree Frog	c	x															x	x		x	
Litoria	nasuta	Rocket Frog	a	x		x	x			x	x					x		x		x			
Litoria	nigrofrenata	Ground Frog	c			x	x									x		x		x			
Litoria	pallida	Pallid Frog	r				x									x		x		x			
Litoria	rubella	Desert Tree Frog	r													x	x	x		x			
Litoria	rothii	Brown Tree Frog	c			x	x			x						x		x		x			
Sphenophryne	gracilipes	Microhylid Frog	a	x												x		x		x			
Rana	daemelii	Wood Frog	c				x			x	x					x		x					
Bufo	marinus	Cane Toad*	r	x		x	x		x	x						x	x	x	x	x	x	x	x
Reptiles																							
Crocodylus	porosus	Estuarine Crocodile	a													x		x		x	x		x
Lialis	burtonis	Burton's Legless Lizard	c											x	x	x	x	x					
Gehyra	dubia	Tree Dtella	c										x				x	x					
Nactus	pelagicus	Pelagic Gecko	a					x	x	x	x	x	x	x	x	x	x	x		x		x	
Hemidactylus	*frenatus*	Asian House Gecko	c													x							
Oedura	castelnaui	Northern Velvet Gecko	r		x								x	x	x	x	x	x					

Genus	Species	Common Name	Relative Abundance in suitable habitat	Comprehensive Fauna Sites												Supplementary sites and Targeted surveys	Main Habitats						
				A	B	C	D	E	F	G	H	I	J	K	L		Darwin Stringybark Open Forest	Riparian Gallery Forest/alluvial woodland	Vine Forest on bauxite	Paperbark Woodland and Wetland Swamps	Foreshores, Tidal Flats, Beach	Coastal Vine Forest	Mangrove and Estuary
Oedura	rhombifer	Zig-zag Gecko	c										x	x		x	x	x					
Pseudothecadactylus	australis	Tree Gecko	r	x												x						x	
Chlamydosaurus	kingii	Frilled-neck Lizard	r													x	x	x					
Diporiphora	bilineata	Dragon	c		x								x		x	x	x	x		x			
Lophognathus	temporalis	Dragon	r													x		x					
Carlia	longipes	Skink	a	x	x								x	x	x	x	x	x	x	x		x	x
Carlia	storri	Skink	c				x			x	x					x				x			
Carlia	vivax	Lively Skink	r													x				x			
Cryptoblepharus	litoralis		r													x					x		
Cryptoblepharus	virgatus	Fence Skink	c							x				x		x	x	x		x			
Ctenotus	robustus	Skink	r													x					x		
Ctenotus	spaldingi	Skink	c			x		x					x	x	x	x	x	x					
Ctenotus	essingtonii brevipes	Skink	r													x	x						
Glaphyromorphus	nigricaudis	Skink	c			x										x		x	x	x		x	
Glaphyromorphus	pumilus	Skink	r						x										x				
Morethia	taeniopleura	Fire-tailed Skink	r													x		x					
Tiliqua	scincoides	Eastern Blue-tongue Lizard	r													x		x					
Varanus	indicus	Mangrove Monitor	c													x					x		x
Varanus	panoptes	a goanna	r													x	x						
Varanus	scalaris	Spotted Tree Monitor	c										x	x	x	x	x	x		x			
Ramphotyphlops	chamodracaena	Blind Snake	r													x	x						
Ramphotyphlops	polygrammicus	Blind Snake	r													x		x					
Aspidites	melanocephalus	Black-headed Python	r													x	x						
Liasis	maculosus	Spotted Python	r		x									x		x	x						
Morelia	amethistina	Amethystine Python	r	x												x						x	

Genus	Species	Common Name	Relative Abundance in suitable habitat	Comprehensive Fauna Sites												Supplementary sites and Targeted surveys	Main Habitats						
				A	B	C	D	E	F	G	H	I	J	K	L		Darwin Stringybark Open Forest	Riparian Gallery Forest/alluvial woodland	Vine Forest on bauxite	Paperbark Woodland and Wetland Swamps	Foreshores, Tidal Flats, Beach	Coastal Vine Forest	Mangrove and Estuary
Acrochordus	granulatus	Little File Snake	r													x				x			
Boiga	irregularis	Brown Tree Snake	r													x	x	x					
Enhydris	polylepis	Macleay's Water Snake	r													x		x		x			
Tropidonophis	mairii	Freshwater Snake	c				x			x						x		x		x			
Stegnotus	cuculatus	Slaty Grey Snake	c	x		x					x		x			x	x	x	x			x	
Dendrelaphis	punctulatus	Green Tree Snake	c													x	x						
Acanthophis	praelongus	Northern Death Adder	r													x		x					
Demansia	vestigiata	Black Whip Snake	c						x	x			x	x		x	x	x		x			
Demansia	papuensis	Papuan Whip Snake	r													x	x	x		x			
Furina	ornata	Orange-naped Snake	r										x				x	x					
Furina	tristis	Brown-headed Snake	c			x										x		x				x	
Pseudechis	australis	King Brown Snake	r												x		x						
Rhinoplocephalus	nigrostriatus	Black-striped Snake	c													x		x	x			x	
Suta	suta	Curl Snake	r													x		x					
Birds	45																						
Dromaius	novaehollandiae	Emu	r		x									x		x	x	x					
Alectura	lathami purpureicollis	Australian Brush-turkey	c	x					x							x	x	x	x			x	
Megapodius	reinwardt	Orange-footed Scrubfowl	c	x					x							x			x			x	
Coturnix	ypsilophora	Brown Quail	c													x	x	x					
Dendrocygna	guttata	Spotted Whsitling Duck	r													x							x
Actitis	hypoleucos	Comon Sandpiper	r													x					x		
Calidris	tenuirostris	Great Knot	r													x					x		
Limicola	falcinellus	Broad-billed Sandpiper	r													x					x		
Tringa	nebularia	Common Greenshank	r													x					x		
Tringa	stagnatilis	Marsh Sandpiper	r													x					x		

Genus	Species	Common Name	Relative Abundance in suitable habitat	Comprehensive Fauna Sites												Supplementary sites and Targeted surveys	Main Habitats						
				A	B	C	D	E	F	G	H	I	J	K	L		Darwin Stringybark Open Forest	Riparian Gallery Forest/alluvial woodland	Vine Forest on bauxite	Paperbark Woodland and Wetland Swamps	Foreshores, Tidal Flats, Beach	Coastal Vine Forest	Mangrove and Estuary
Cygnus	atratus	Black Swan	r													x				x			
Anseranas	semipalmata	Magpie Goose	c													x				x			
Nettapus	pulchelus	Green Pygmy-goose	r													x				x			
Anas	gracilis	Grey Teal	c													x				x			
Anas	superciliosa	Pacific Black Duck	c													x				x			
Tadorna	radjah	Radjah Shelduck	a													x				x	x		x
Tachybaptus	novaehollandiae	Australasian Grebe	c													x				x			
Anhinga	melanogaster	Darter	c													x				x	x		x
Phalacrocorax	melanoleucas	Little Pied Cormorant	c													x				x	x		x
Phalacrocorax	sulcirostris	Little Black Cormorant	c													x				x	x		x
Phalacrocorax	varius	Pied Cormorant	c													x				x	x		
Pelicanus	conspicillatus	Australian Pelican	r													x				x			
Asaula	*leucogaster*	Brown Booby	r													x					x		
Fregata	minor	Great Frigatebird	c													x					x		
Fregeta	ariel	Lesser Frigatebird	c													x					x		
Egretta	garzetta	Little Egret	r													x				x			
Egretta	novaehollandiae	White-faced Heron	c	x												x		x		x			x
Egretta	*sacra*	Eastern Reef Egret	c													x					x		x
Ardea	alba	Great Egret	r													x				x			
Ardea	*intermedia*	Intermediate Egret	c													x				x			
Ardea	*picata*	Pied Heron	c													x				x	x		
Ardea	*sumatranum*	Great-billed Heron	r													x							x
Nycticorax	caledonicus	Nankeen Night Heron	c													x		x		x	x		x
Butorides	*striatus*	Striated Heron	r													x							x
Ixobrychus	*flavicollis*	Black Bittern	r													x							x
Plegadis	*falcinellus*	Glossy Ibis	r													x				x			

Genus	Species	Common Name	Relative Abundance in suitable habitat	Comprehensive Fauna Sites												Supplementary sites and Targeted surveys	Main Habitats							
				A	B	C	D	E	F	G	H	I	J	K	L		Darwin Stringybark Open Forest	Riparian Gallery Forest/alluvial woodland	Vine Forest on bauxite	Paperbark Woodland and Wetland Swamps	Foreshores, Tidal Flats, Beach	Coastal Vine Forest	Mangrove and Estuary
Threskiornis	molucca	Australian White Ibis	c													x				x			
Threskiornis	spinicollis	Straw-necked Ibis	c													x				x			
Ephippiorhynchus	asiaticus	Black-necked Stork	r													x				x	x		x
Platalea	*regia*	Royal Spoonbill	r													x				x			
Pandion	haliaetus	Osprey	c				x			x						x	x	x		x	x		x
Aviceda	subcristata	Pacific Baza	r													x		x					
Hamirostra	melanosternon	Black-breasted Buzzard	r													x		x					
Milvus	migrans	Black Kite	r													x					x		
Haliastur	sphenurus	Whistling Kite	c													x	x	x		x	x	x	x
Haliaeetus	leucogaster	White-bellied Sea-eagle	c													x	x			x	x		x
Circus	approximans	Swamp Harrier	r													x		x					
Haliastur	indus	Brahminy Kite	c													x	x			x	x	x	x
Aquila	audax	Wedge-tailed Eagle	r													x	x	x					
Falco	berigora	Brown Falcon	c													x	x	x					
Falco	perigrinus	Peregrine Falcon	c													x		x					
Falco	longipennis	Australian Hobby	c													x		x					
Falco	cenchroides	Nankeen Kestrel	c													x							
Accipiter	fasciatus	Brown Goshawk	a													x	x	x					
Accipiter	cirrhocephalus	Collared Sparrowhawk	c													x	x	x					
Grus	rubicunda	Brolga	c													x				x			
Ardeotis	australis	Australian Bustard	r													x	x						
Turnix	maculosa	Red-backed Button-quail	r													x		x					
Vanellus	miles	Masked Lapwing	r													x				x			
Numenius	madagascariensis	Eastern Curlew	r													x					x		x
Numenius	*phaeopus*	Whimbrel	r													x					x		x
Burhinus	grallarius	Bush Stone-curlew	r													x	x	x					

Genus	Species	Common Name	Relative Abundance in suitable habitat	Comprehensive Fauna Sites												Supplementary sites and Targeted surveys	Main Habitats							
				A	B	C	D	E	F	G	H	I	J	K	L		Darwin Stringybark Open Forest	Riparian Gallery Forest/alluvial woodland	Vine Forest on bauxite	Paperbark Woodland and Wetland Swamps	Foreshores, Tidal Flats, Beach	Coastal Vine Forest	Mangrove and Estuary
Esacus	neglectus	Beach Stone-curlew	c													x					x		x
Haematopus	longirostris	Pied Oystercatcher	c													x					x		
Himantopus	himantopus	Black-winged Stilt	c													x				x	x		
Charadrius	*ruficapillus*	Red-capped Plover	r													x					x		
Charadrius	*mongolus*	Lesser Sand Plover	r													x					x		
Stiltia	isabella	Australian Pratincole	r													x				x			
Sterna	bengalensis	Lesser Crested tern	c													x					x		
Sterna	nilotica	Gull-billed Tern	c													x					x		x
Sterna	albifrons sinensis	Little Tern	r													X					x		
Sterna	bergii	Crested Tern	c													x					x		x
Sterna	hirundo	Common Tern	c													x					x		
Chlidonias	hybridus	Whiskered Tern	r													x					x		x
Chlidonias	leucopterus	White-winged Black tern	r													x					x		
Hydropogne	caspia	Caspian Tern	r													x					x		x
Ducula	bicolor	Torresian Imperial Pigeon	c													x	x	x	x	x		x	x
Geopelia	striata	Peaceful Dove	a	x		x	x			x	x	x	x	x		x	x	x		x			
Geopelia	humeralis	Bar-shouldered Dove	a	x	x	x	x			x		x	x		x	x	x	x					
Ptilinopus	magnificus	Wompoo Fruit-dove	r						x							x			x	x		x	
Ptilinopus	regina	Rose-crowned Fruit-dove	r						x							x			x			x	
Calyptorhynchus	banksii	Red-tailed Black Cockatoo	r													x	x						
Probosciger	aterrimus	Palm Cockatoo	r													x	x	x	x	x			
Cacatua	galerita	Sulphur-crested Cockatoo	a			x				x	x		x	x	x	x	x	x	x	x			
Cacatua	sanguinea	Little Corella	r													x		x					
Trichoglossus	haematodus	Rainbow Lorikeet	a	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x
Aprosmictus	erythropterus	Red-winged Parrot	a	x			x			x		x	x	x		x	x	x					
Platycerus	adscitus adscitus	Pale-headed Rosella	a		x									x	x	x	x	x					

Genus	Species	Common Name	Relative Abundance in suitable habitat	Comprehensive Fauna Sites												Supplementary sites and Targeted surveys	Main Habitats						
				A	B	C	D	E	F	G	H	I	J	K	L		Darwin Stringybark Open Forest	Riparian Gallery Forest/alluvial woodland	Vine Forest on bauxite	Paperbark Woodland and Wetland Swamps	Foreshores, Tidal Flats, Beach	Coastal Vine Forest	Mangrove and Estuary
Cacomantis	variolus	Brush Cuckoo	r													x		x					
Cuculus	pallidus	Pallid Cuckoo	r													x		x					
Cacomantis	flabelliformis	Fan-tailed Cuckoo	r												x	x	x	x					
Chrysococcyx	lucidus	Shining Bronze-Cuckoo	r													x		x					
Scythrops	novaehollandiae	Channel-billed Cuckoo	c							x	x					x	x	x		x			x
Eudynamys	scolopacea	Common Koel	c													x	x	x					
Centropus	phasianinus	Pheasant Coucal	c													x	x	x		x			
Ninox	rufa meesi	Rufous Owl	r													x		x					
Ninox	novaeseelandiae	Southern Boobook Owl	a										x	x	x	x	x	x					
Tyto	alba	Barn Owl	r													x		x					
Podargus	strigoides	Tawny Frogmouth	a		x								x		x	x	x	x	x	x		x	x
Podargus	papuensis	Papuan Frogmouth	c				x			x						x	x	x		x			x
Aegotheles	cristatus	Australian Owlet-Nightjar	r											x		x	x	x					
Eurostopodus	mystacalis	White-throated Nightjar	c		x											x		x				x	
Caprimulgus	macrurus	Large-tailed Nightjar	c	x												x		x					
Apus	pacificus	Fork-tailed Swift	r													x		x					
Hirundapus	caudacutus	White-throated Needetail	r													x		x		x			
Alcedo	azurea	Azure Kingfisher	c							x	x	x				x		x					
Dacelo	novaeguinea	Laughing Kookaburra	c				x			x	x	x		x		x	x	x		x			
Dacelo	leachii kempi	Blue-winged Kookaburra	a		x	x							x	x	x	x	x	x		x			
Todiramphus	macleayii	Forest Kingfisher	a										x		x	x	x	x		x			
Todiramphus	sanctus	Sacred Kingfisher	c													x				x			x
Todirhamphus	chloris	Mangrove Kingfisher	r													x							x
Alcedo	pusilla	Little Kingfisher	r	x			x		x									x					
Merops	ornatus	Rainbow Bee-eater	a	x		x										x		x	x	x	x	x	x
Eurystomus	orientalis	Dollarbird	c													x		x		x		x	

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				A	B	C	D	E	F	G	H	I	J	K	L		Darwin Stringybark Open Forest	Riparian Gallery Forest/alluvial woodland	Vine Forest on bauxite	Paperbark Woodland and Wetland Swamps	Foreshores, Tidal Flats, Beach	Coastal Vine Forest	Mangrove and Estuary
Malurus	amabilis	Lovely Fairy-wren	r								x					x		x					
Malurus	melanocephalus	Red-backed Fairy-wren	c		x		x			x	x	x				x		x					
Pardolotus	striatus	Striated Pardalote	a	x	x	x	x		x	x	x		x	x	x	x	x	x		x			
Gerygone	laevigaster	Mangrove Gerygone	c													x							x
Gerygone	magnirostris	Large-billed Gerygone	r													x		x					
Gerygone	palpebrosa	Fairy Gerygone	c					x								x	x	x		x			
Smicrornis	brevirostris	Weebill	c													x		x					
Philemon	argenticeps	Silver-crowned Friarbird	r								x							x					
Philemon	corniculatus	Noisy Friarbird	a				x			x	x	x	x	x	x	x	x	x		x			
Philemon	citreogularis	Little Friarbird	a	x	x					x		x				x	x	x		x			
Entomyzon	cyanotis	Blue-faced Honeyeater	c		x									x		x	x	x					
Xanthotis	flaviventer	Tawny-breasted Honeyeater	c				x		x	x	x					x		x					
Meliphaga	notata	Yellow-spotted Honeyeater	c	x		x										x		x				x	
Meliphaga	gracilis	Graceful Honeyeater	c				x			x	x	x				x		x		x			
Meliphaga	unicolor	White-gaped Honeyeater	r													x							x
Lichenostomus	flavus	Yellow Honeyeater	c		x	x										x	x	x					
Conophila	rufogularis	Rufous-throated Honeyeater	r													x		x					
Myzomela	erythrocephala	Red-headed Honeyeater	c				x	x		x	x	x				x	x	x		x			
Melithreptus	albogularis	White-throated Honeyeater	a	x	x	x	x			x	x		x	x	x		x	x	x	x		x	x
Lichmera	indistincta	Brown Honeyeater	c													x				x			x
Ramsayornis	modestus	Brown-backed Honeyeater	r			x										x		x					
Ramsayornis	fasciatus	Bar-breasted Honeyeater	c													x				x			
Conopophila	albogularis	Rufous-banded Honeyeater	r									x				x		x					
Certhionyx	pectoralis	Banded Honeyeater	a			x										x	x	x		x			
Myzomela	obscura	Dusky Honeyeater	c													x		x					x

Genus	Species	Common Name	Relative Abundance in suitable habitat	Comprehensive Fauna Sites												Supplementary sites and Targeted surveys	Main Habitats						
				A	B	C	D	E	F	G	H	I	J	K	L		Darwin Stringybark Open Forest	Riparian Gallery Forest/alluvial woodland	Vine Forest on bauxite	Paperbark Woodland and Wetland Swamps	Foreshores, Tidal Flats, Beach	Coastal Vine Forest	Mangrove and Estuary
Eopsaltria	pulverulenta	Mangrove Robin	c							x	x												x
Poecilodryas	superciliosa	White-browed Robin	r													x				x			
Microeca	fascinans	Jacky Winter	c				x			x	x							x					
Microeca	flavigaster terraereginae	Lemon-bellied Flycatcher	a			x				x	x		x	x	x	x	x	x	x	x			x
Monarcha	trivirgatus	Spectacled Monarch	r													x		x					
Pomatostomas	temporalis	Grey-crowned Babbler	r										x				x						
Daphoenositta	chrysoptera striata	Varied Sittella	r													x	x	x					
Pachycephala	simplex	Grey Whistler	r				x	x				x					x	x		x			
Pachycephala	rufiventris	Rufous Whistler	a		x				x		x		x	x	x	x	x	x		x			
Colluricincla	megarhyncha	Little Shrike-thrush	c											x		x	x	x					
Myiagra	ruficollis	Broad-billed Flycatcher	c				x			x								x		x			
Myiagra	rubecula	Leaden Flycatcher	c			x							x	x		x	x			x			
Myiagra	alecto	Shining Flycatcher	c	x												x		x					x
Grallina	cyanoleuca	Australian Magpie-lark	c			x							x			x	x	x		x			
Rhipidura	rufifrons dryas	Rufous Fantail	c													x		x					x
Rhipidura	fuliginosa	Grey Fantail	c								x		x			x	x	x					
Rhipidura	rufiventris	Northern Fantail	r													x		x					
Rhipidura	leucophrys	Willy-wagtail	c				x			x	x					x	x			x			x
Dicrurus	bracteatus	Spangled Drongo	c			x					x					x	x	x	x	x		x	x
Coracina	novaehollandiae	Black-faced Cuckoo-shrike	a	x		x	x		x	x	x	x				x	x	x	x	x		x	x
Coracina	tenuirostris	White-bellied Cuckoo-shrike	a		x	x							x	x	x	x	x	x		x			
Lalage	sueurii	White-winged Triller	c			x										x		x					
Lalage	leucomela	Varied Triller	c	x												x	x	x					
Sphecotheres	viridis	Figbird	c						x							x		x	x	x		x	
Oriolus	flavocinctus	Yellow Oriole	r													x		x					x

Genus	Species	Common Name	Relative Abundance in suitable habitat	Comprehensive Fauna Sites												Supplementary sites and Targeted surveys	Main Habitats						
				A	B	C	D	E	F	G	H	I	J	K	L		Darwin Stringybark Open Forest	Riparian Gallery Forest/alluvial woodland	Vine Forest on bauxite	Paperbark Woodland and Wetland Swamps	Foreshores, Tidal Flats, Beach	Coastal Vine Forest	Mangrove and Estuary
Oriolus	sagittatus	Olive-backed Oriole	r													x		x					
Artamus	leucorhynchus	White-breasted Woodswallow	r													x					x		x
Artamus	minor	Little Woodswallow	c						x		x					x		x	x				
Cracticus	quoyi	Black Butcherbird	c	x			x	x		x		x				x		x	x	x		x	x
Cracticus	mentalis	Black-backed Butcherbird	a		x								x	x	x	x	x	x		x			
Cracticus	nigrogularis	Pied Butcherbird	c		x	x										x	x	x					
Corvus	orru	Torresian Crow	c			x			x				x		x	x	x	x	x				
Chlamydera	nuchalis	Great Bowerbird	c	x												x	x	x	x			x	
Ptiloris	magnificus	Magnificent Riflebird	r													x						x	
Hirundo	nigricans	Tree Martin	r				x			x						x				x			
Hirundo	ariel	Fairy Martin	c	x		x										x		x		x			
Anthus	novaeseelandiae	Richards Pipit	r													x							x
Cinclorhamphus	mathewsi	Rufous Songlark	r													x		x					
Cisticola	juncidus	Zitting Cisticola	r													x				x			
Cisticola	exilis	Golden-headed Cisticola	c													x				x			
Lonchura	castaneothorax	Chestnut-breasted Mannikin	r													x		x		x			
Taeniopygia	bichenovii	Double-barred Finch	r													x		x					
Nectarinia	jugularis	Yellow-bellied Sunbird	c						x		x					x	x	x	x	x		x	x
Dicaeum	hirundinaceum	Mistletoebird	c			x							x	x	x	x	x	x				x	
Zosterops	luteus	Yellow White-eye	r													x							x
Mammals	**184**																						
Isoodon	macrourus	Northern Brown Bandicoot	r													x							
Petaurus	breviceps	Sugar Glider	r											x		x		x				x	
Trichosurus	vulpecula	Common Brushtail Possum	r													x					x		
Sminthopsis	v. virginiae	Red-cheeked Dunnart	r				x			x								x					

Genus	Species	Common Name	Relative Abundance in suitable habitat	Comprehensive Fauna Sites												Supplementary sites and Targeted surveys	Main Habitats						
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Macropus	agilis	Agile Wallaby	c			x		x						x		x	x	x		x			x
Macropus	antilopinus	Antilopine Wallaroo	r			x							x			x	x	x					
Macropus	giganteus	Eastern Grey Kangaroo	r										x				x						
Pteropus	alecto	Black Flying-fox	r													x				x			
Saccolaimus	flaviventris	Yellow-bellied Sheathtail-bat	c	x	x	x		x	x		x					x	x	x				x	
Saccolaimus	mixtus	Papuan Sheathtail-bat	?													?							
Chaerephon	jobensis	Northern freetail bat	c	x		x	x		x		x	x				x		x		x		x	
Mormopterus	beccarii	Beccari's Freetail-bat	c	x		x		x	x		x					x	x	x	x			x	
Minopterus	schreibersii	Common Bentwing-bat	r													x		x					
Chalinolobus	nigrogriseus	Hoary Wattled Bat	c		x		x	x		x	x					x	x	x					
Pipistrellus	adamsi	Cape York Pipistrelle	c			x			x							x	x					x	
Pipistrellus	westralis	a pipistrelle bat	r													x	x						
Nyctophilus	bifax	Northern long-eared bat	r													x				x			
Scotorepens	sanborni	Northern Broad-nosed Bat	c		x	x		x	x	x		x				x	x	x	x	x			
Melomys	burtoni	Grassland Melomys	r			x										x		x					
Melomys	capensis	Cape York Melomys	r	x		x			x					x		x	x	x	x				
Rattus	sordidus	Canefields Rat	r			x												x					
Pseudomys	delicatulus	Delicate Mouse	r				x			x								x					
Uromys	caudimaculatus	Giant White-tailed Rat	r													x		x					
Sus	scrofa	feral Pig*	a			x							x			x	x	x	x	x	x	x	x
Bos	taurus	Cattle*	r													x	x						
Equus	caballus	Horse*	r													x	x	x		x			x
Canis	lupus dingo	Dingo*	r													x	x	x		x	x		x
Felis	catus	Feral Cat*	a										x			x	x	x		x			

* Introduced species

Environmental Impact Statement

for South of Embley Project

Section 8
Appendix

APPENDIX 8A

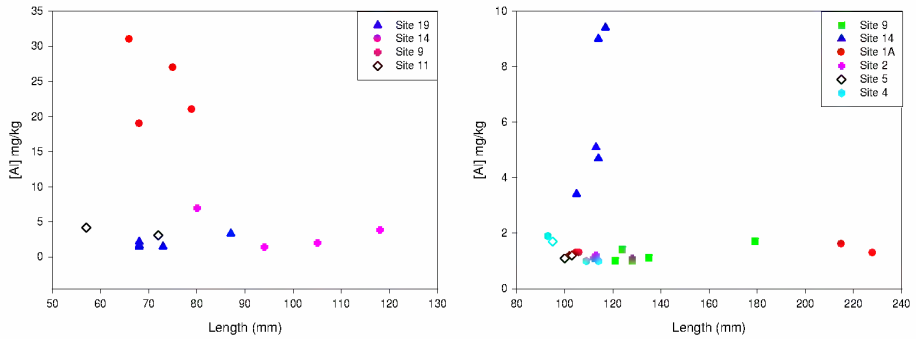
FISH AND MACRO CRUSTACEA SITE SURVEY EFFORT

Catchment	Subcatchment	Sites	Survey / Sampling Method						
			Gill Netting	Large Fyke Net	Electrofishing	Bait Trapping	Crab Trapping	Targeted Angling	Visual Observations
Norman Creek Freshwater	Eastern Branch	1A	120m^2 x ~17hrs	~17 hrs	~1hr	~85 hrs	NA	~2hrs	~11hrs
		5A	120m^2 x ~17hrs	~17 hrs	~1hr	~85 hrs	NA	~2hrs	~11hrs
		7A	NA	~17 hrs	~1hr	~85 hrs	NA	NA	~11hrs
	Northern Branch	2A	120m^2 x ~17hrs	~17 hrs	~1hr	~85 hrs	NA	NA	~11hrs
		3	NA	0	~1hr	~85 hrs	NA	NA	~4hrs
		4	60m^2 x ~17hrs	~17 hrs	~1hr	~85 hrs	NA	NA	~9hrs
	North east Tributary	11	NA	~17 hrs	~1hr	~85 hrs	NA	NA	~11hrs
Norman Creek Estuarine	Northern Branch	10A	120m^2 x ~4hrs	NA	NA	0	0	~4hrs	~6hrs
	Total Catchment	12	120m^2 x ~10hrs	NA	NA	~50 hrs	~50 hrs	~4hrs	~10hrs
Ward River Freshwater	Coconut Ck	14	120m^2 x ~17hrs	~17 hrs	~1hr	~85 hrs	NA	NA	~9hrs
	Upper Ward	22	NA	NA	~1hr	~85 hrs	NA	NA	~9hrs
		25A	120m^2 x ~17hrs	~17 hrs	~1hr	~85 hrs	NA	~2hrs	~11hrs
		20	120m^2 x ~10hrs	~17 hrs	~1hr	~85 hrs	NA	~4hrs	~7hrs
	Local Tree Swamp	32	90m^2 x ~17hr	~17 hrs	~1hr	~85 hrs	NA	NA	~9hrs

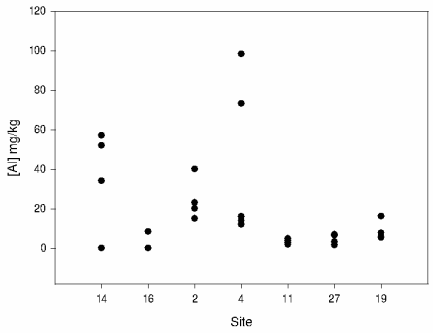
Ward River Estuarine	Upper Ward	28	120m^2 x ~10hrs	NA	NA	~50 hrs	~50 hrs	~4hrs	~9hrs
		29	120m^2 x ~10hrs	NA	NA	~50 hrs	~50 hrs	~4hrs	~9hrs
	Total Catchment	30	120m^2 x ~10hrs	NA	NA	~50 hrs	~50 hrs	~4hrs	~9hrs
Winda Winda Creek Freshwater	Northern Tributary	19	120m^2 x ~17hr	~17 hrs	~1hr	~85 hrs	NA	NA	~7hrs
	Winda Winda	9A	120m^2 x ~17hr	~17 hrs	~3hr	~85 hrs	NA	~2hrs	~9hrs
Winda Winda Creek Estuarine	Total Catchment	21	120m^2 x ~10hrs	NA	NA	0	0	~4hrs	~10hrs
Hey Point Tree swamp Freshwater	Local Tree Swamp	27	60m^2 x ~17hrs	~17 hrs	~1hr	~85 hrs	NA	NA	~9hrs
Pera Head Lagoon Freshwater	Local Tree Swamp	16A	90m^2 x ~17hr	~17 hrs	~1hr	~85 hrs	NA	NA	~9hrs
Ina Creek Freshwater	Ina Creek	26	60m^2 x ~17hr	~17 hrs	~1hr	~85 hrs	NA	NA	~9hrs
		36	0	0	0	0	NA	~2hrs	~4hrs
Ina Creek Estuarine		37	0	NA	NA	0	0	~6hrs	~6hrs

APPENDIX 8B

BIOTA TISSUE METAL RESPONSE



(b)



(c)

Figure 8B-1 Aluminium concentrations by site in (a) *Melanotaenia splendida* flesh samples; (b) *Neosilurus hyrtlii* gill samples; and (c) whole Dytiscid samples

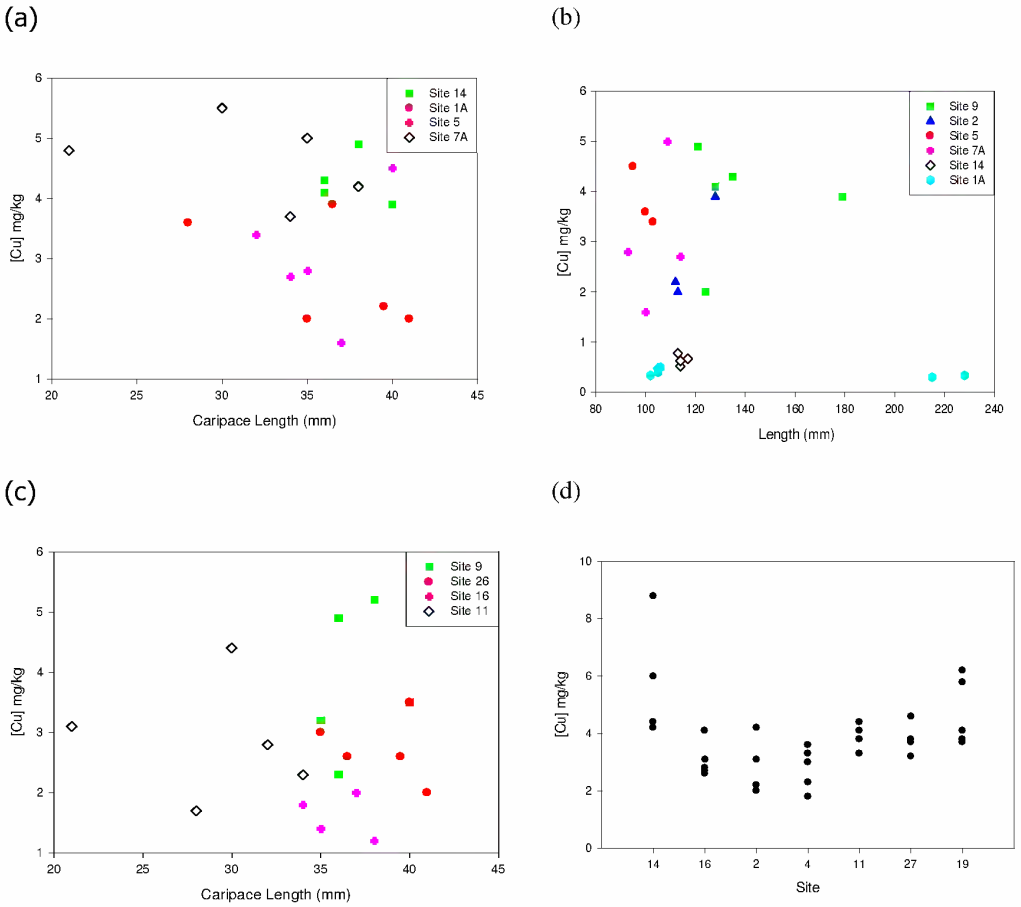


Figure 8B-2 Copper concentrations by site in (a) *Cherax quadricarinatus* tail samples; (b) *Neosilurus hyrtlii* hind samples; (c) *Cherax sp.1* tail samples; and (d) whole Dytiscid samples

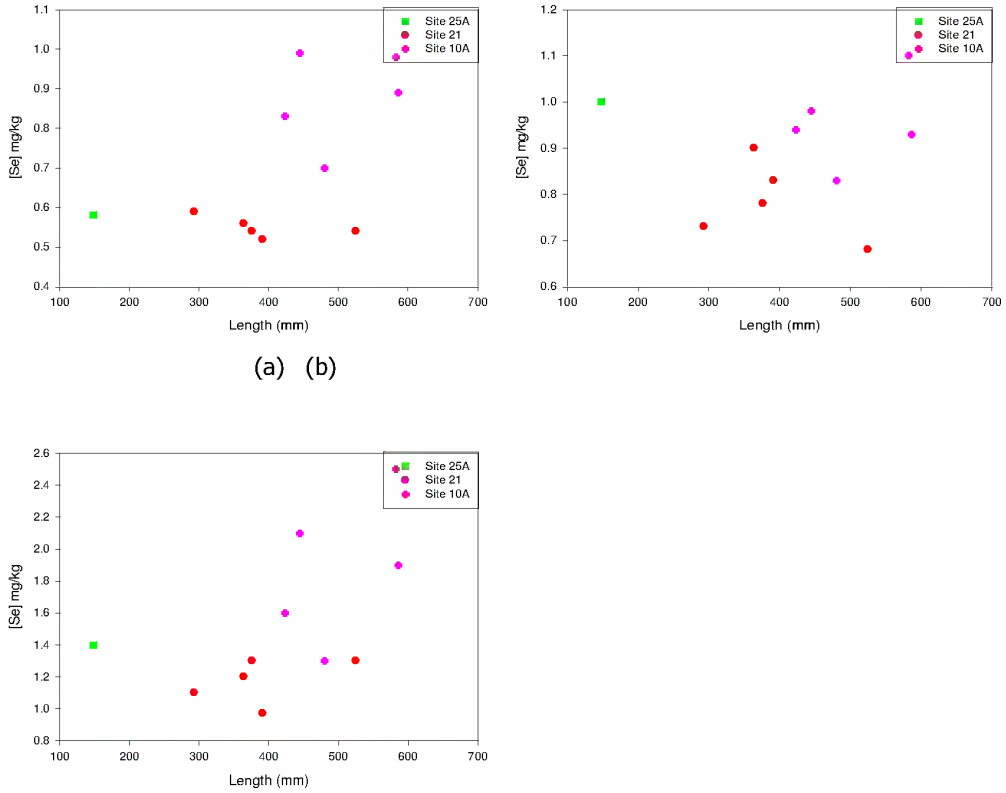
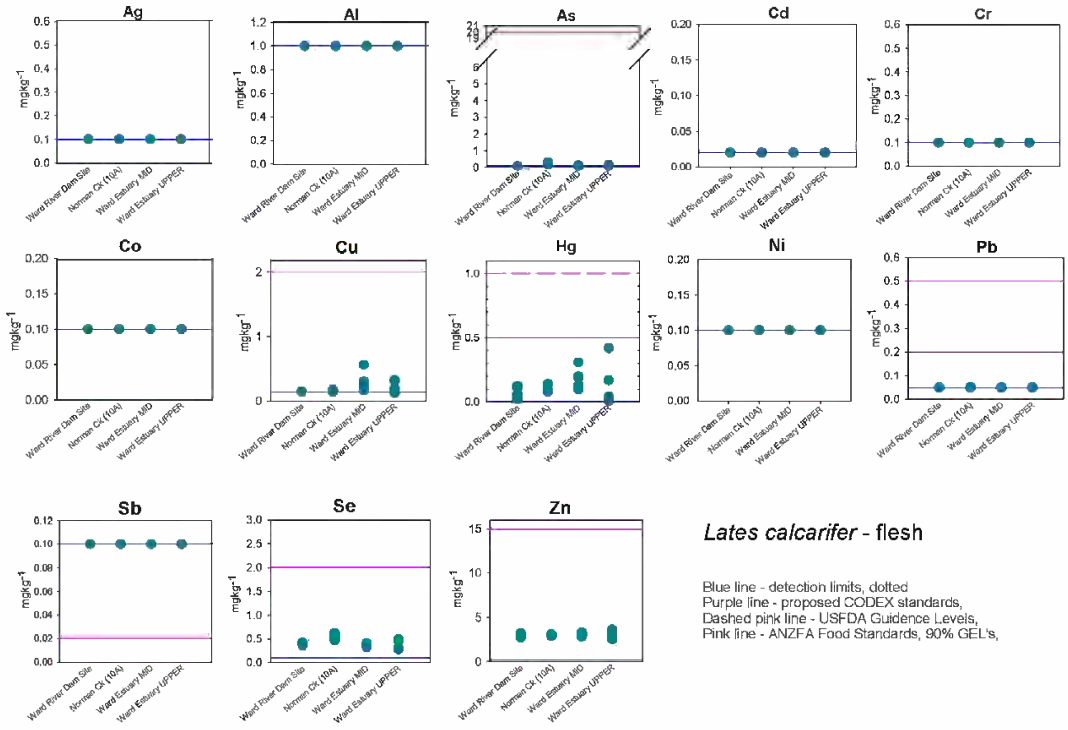
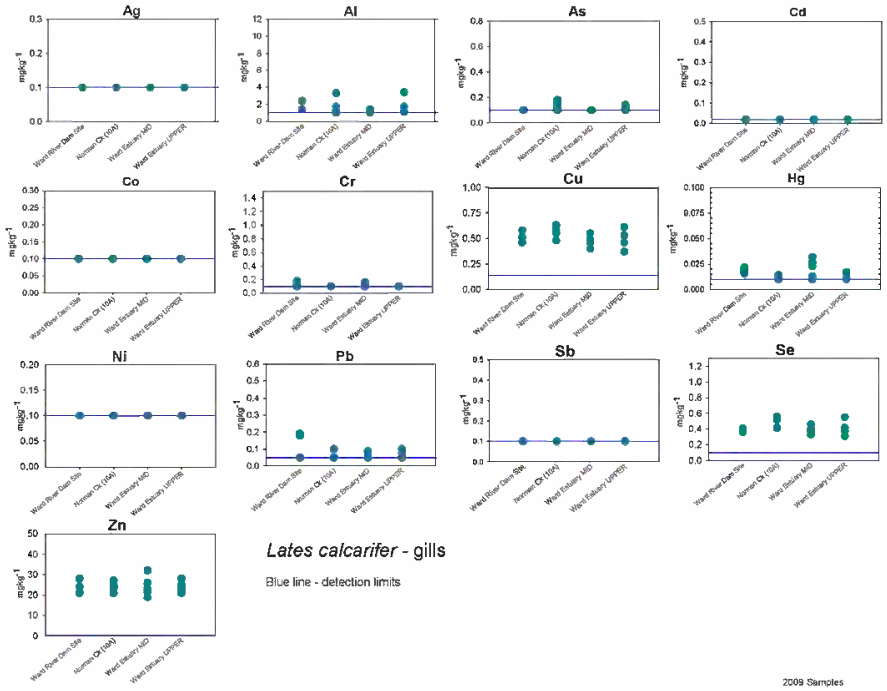
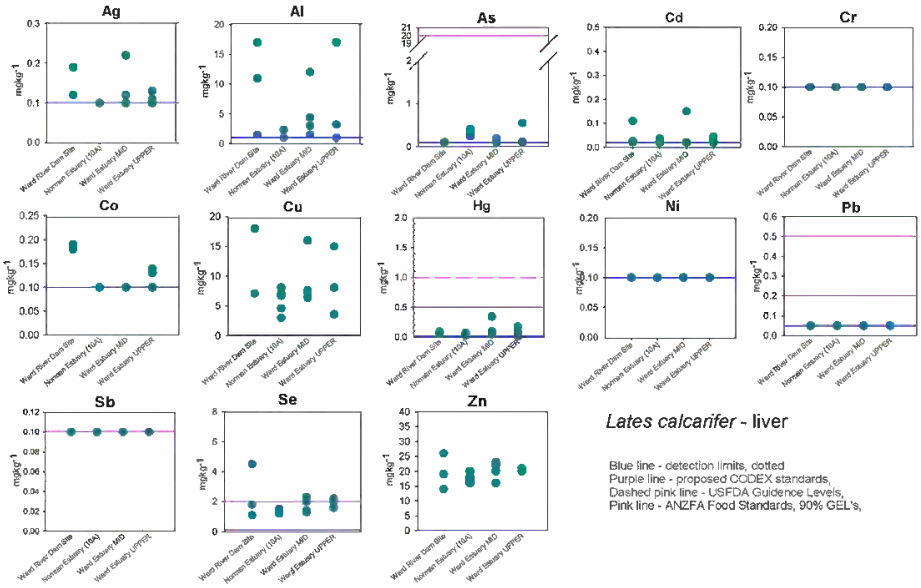


Figure 8B-3 Selenium concentrations by site in (a) *Lates calcarifer* flesh samples; and (b) *Lates calcarifer* gill samples; and (c) *Lates calcarifer* liver samples


Ag
Al
As
Cd
Cr
Co
Cu
Hg
Ni
Pb
Sb
Se
Zn
mgkg-1
Ward River Dam Site
Norman Ck (10A)
Ward Estuary MID
Ward Estuary UPPER
Lates calcarifer - flesh
Blue line - detection limits, dotted
Purple line - proposed CODEX standards,
Dashed pink line - USFDA Guidence Levels,
Pink line - ANZFA Food Standards, 90% GEL's,

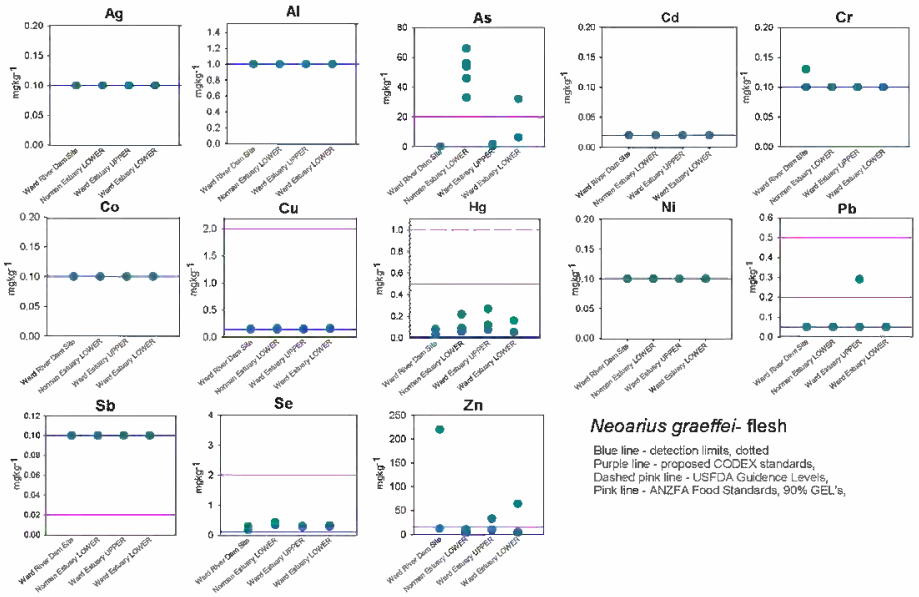

Ag
Al
As
Cd
Co
Cr
Cu
Hg
Ni
Pb
Sb
Se
Zn
mg/kg-1
Ward River Dam Site
Norman Ck (16A)
Ward Estuary MID
Ward Estuary UPPER
Lates calcarifer - gills
Blue line - detection limits
2009 Samples

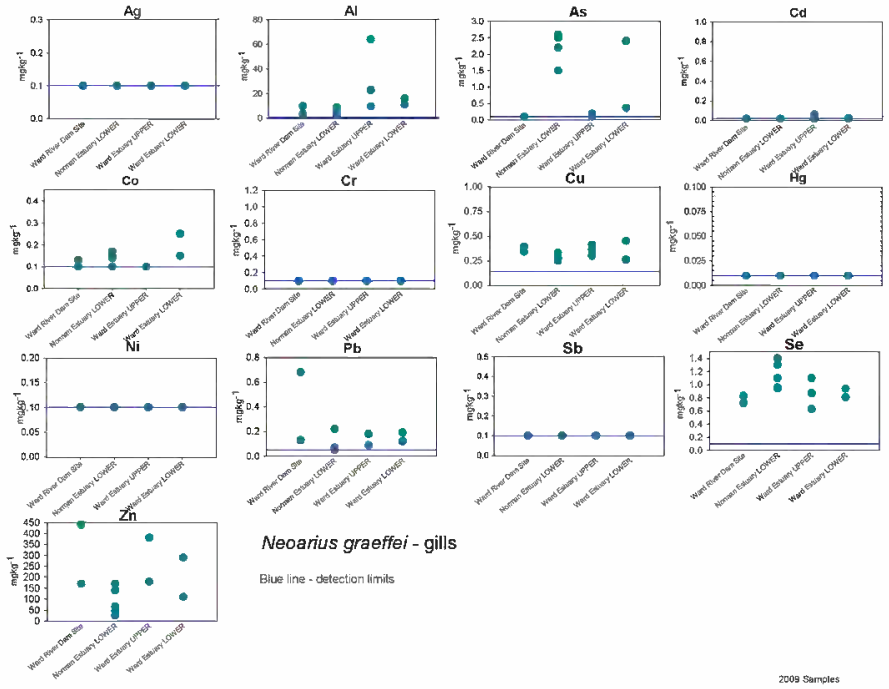


Lates calcarifer - liver

Blue line - detection limits, dotted
Purple line - proposed CODEX standards,
Dashed pink line - USFDA Guidence Levels,
Pink line - ANZFA Food Standards, 90% GEL's,

2009 Samples


Ag
Al
As
Cd
Cr
Co
Cu
Hg
Ni
Pb
Sb
Se
Zn
mg/kg-1
Ward River Dam Site
Norman Estuary LOWER
Ward Estuary UPPER
Ward Estuary LOWER
Neoarius graeffei- flesh
Blue line - detection limits, dotted
Purple line - proposed CODEX standards,
Dashed pink line - USFDA Guidence Levels,
Pink line - ANZFA Food Standards, 90% GEL's,
2009 Samples


Ag
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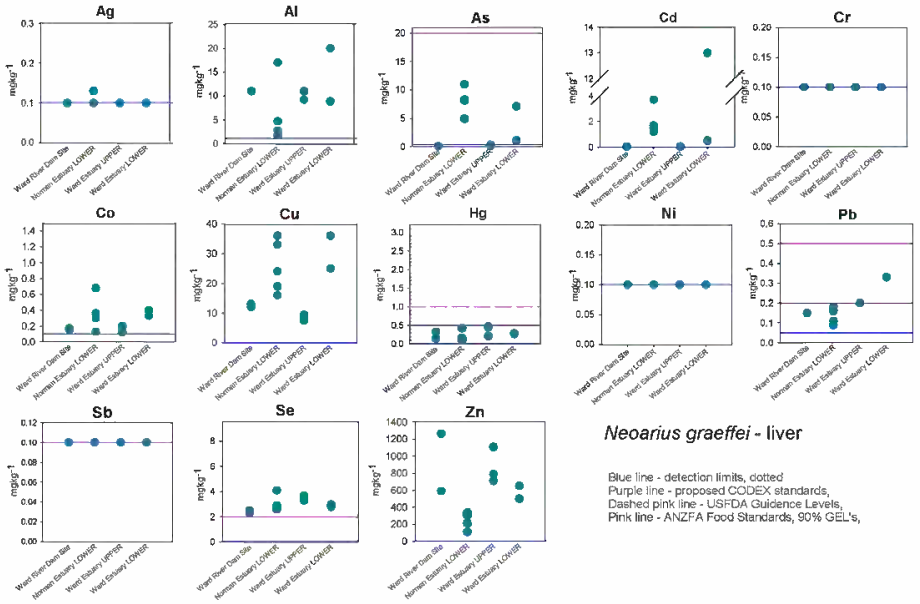
mg/kg-1
Ward River Dam Site
Norman Estuary LOWER
Ward Estuary UPPER
Ward Estuary LOWER
Neoarius graeffei - gills
Blue line - detection limits
2009 Samples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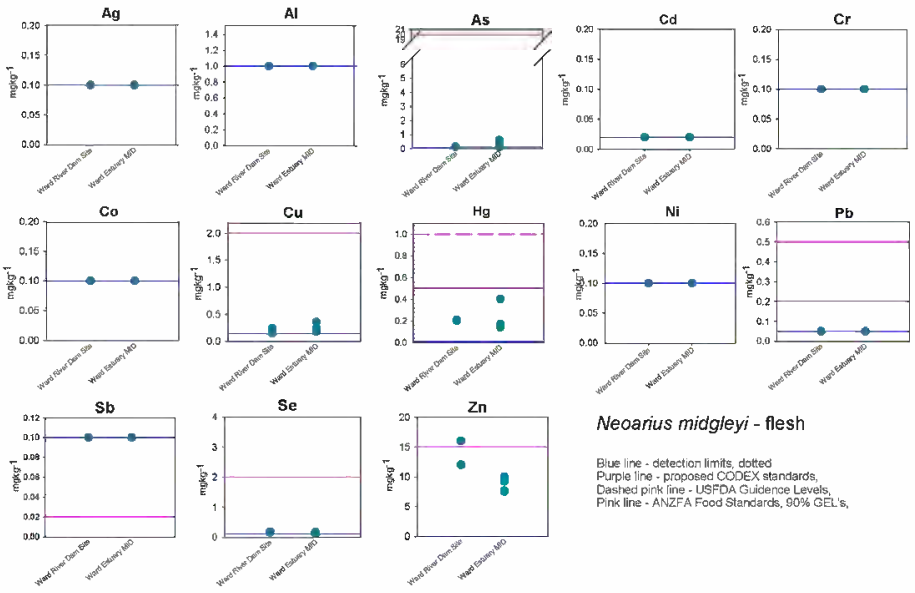
Ward River Dam Site
Norman Estuary LOWER
Ward Estuary UPPER
Ward Estuary LOWER
Neoarius graeffei - liver
Blue line - detection limits, dotted
Purple line - proposed CODEX standards,
Dashed pink line - USFDA Guidence Levels,
Pink line - ANZFA Food Standards, 90% GEL's,
2009 Samples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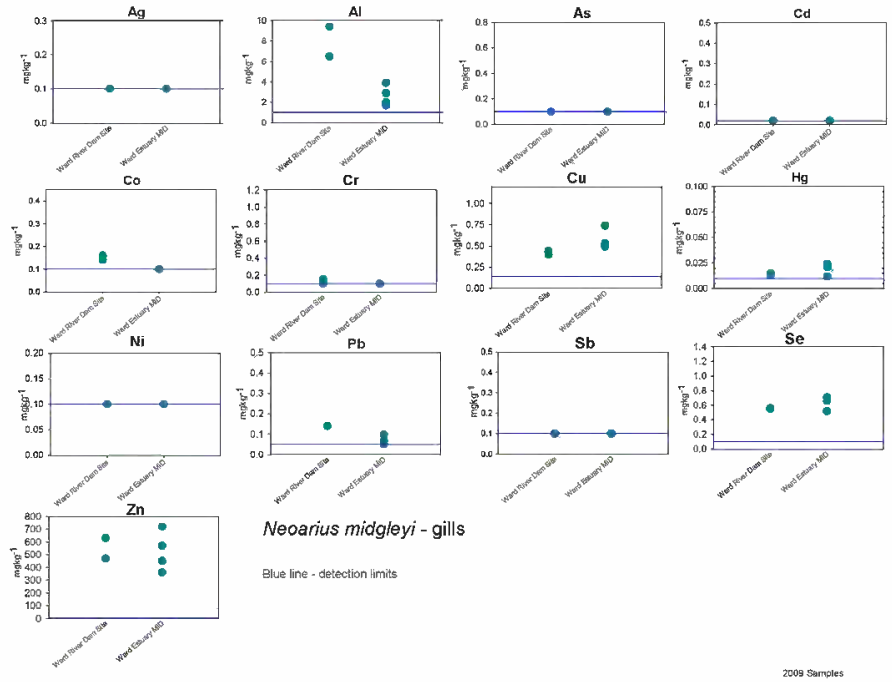
mg/kg-1
Ward River Dam Site
Ward Estuary MID
Neoarius midgleyi - flesh
Blue line - detection limits, dotted
Purple line - proposed CODEX standards,
Dashed pink line - USFDA Guidence Levels,
Pink line - ANZFA Food Standards, 90% GEL's,
2009 Samples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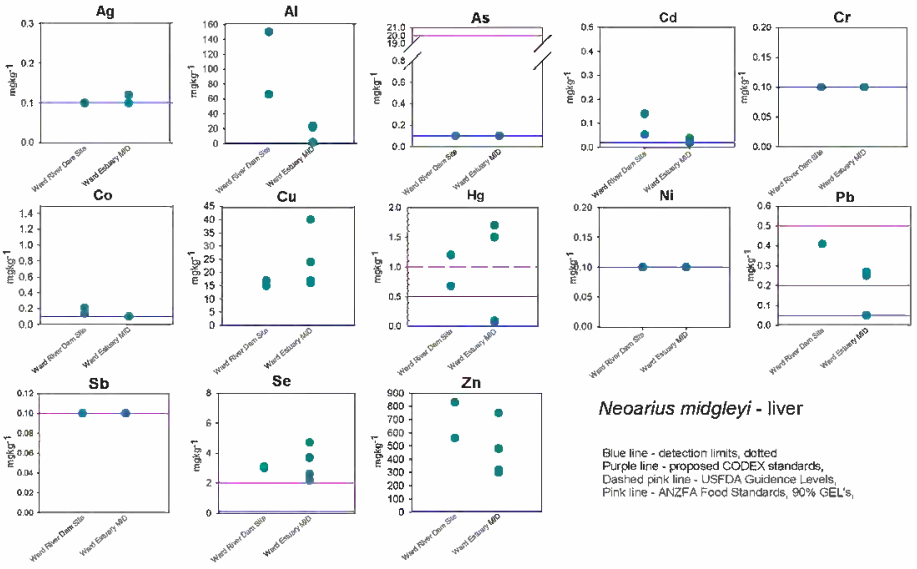
Ward River Dam Site
Ward Estuary MID
Neoarius midgleyi - gills
Blue line - detection limits
2009 Samples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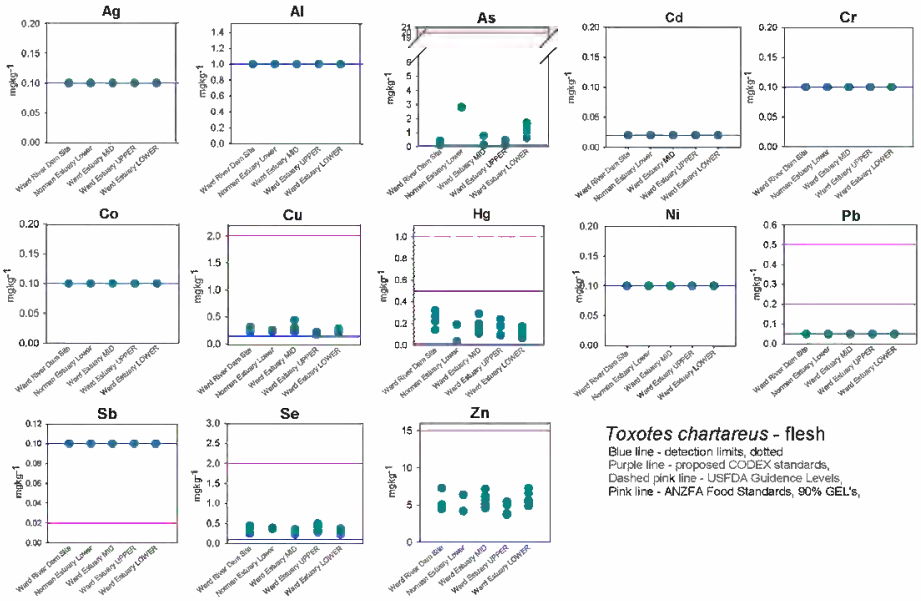
mg/kg-1
Ward River Dam Site
Ward Estuary MID
Neoarius midgleyi - liver
Blue line - detection limits, dotted
Purple line - proposed CODEX standards,
Dashed pink line - USFDA Guidence Levels,
Pink line - ANZFA Food Standards, 90% GEL's,
2009 Samples


Ag
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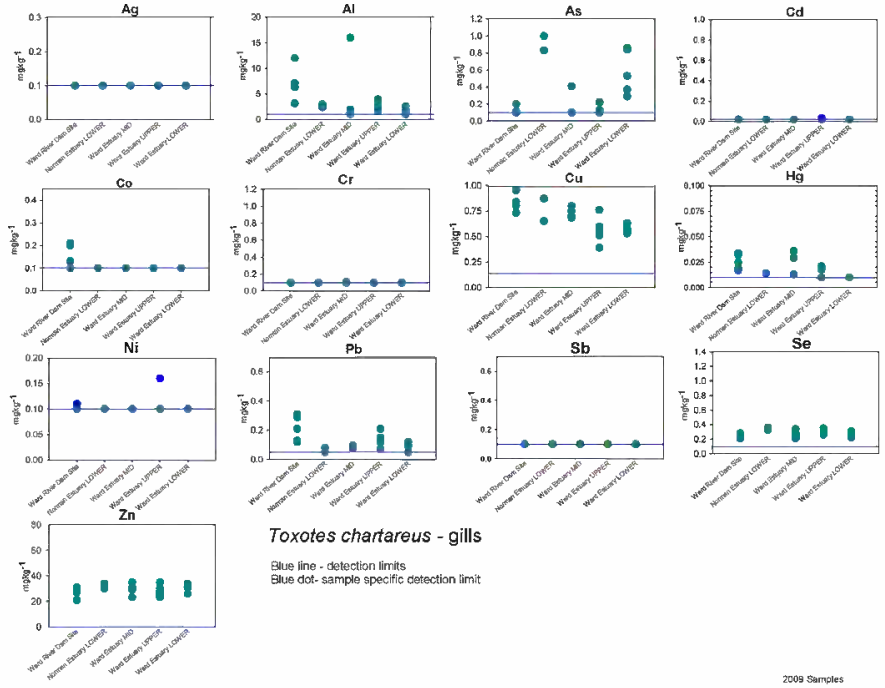
mg/kg-1
Ward River Dam Site
Norman Estuary Lower
Ward Estuary MID
Ward Estuary UPPER
Ward Estuary LOWER
Toxotes chartareus - flesh
Blue line - detection limits, dotted
Purple line - proposed CODEX standards,
Dashed pink line - USFDA Guidence Levels,
Pink line - ANZFA Food Standards, 90% GEL's,
2009 Samples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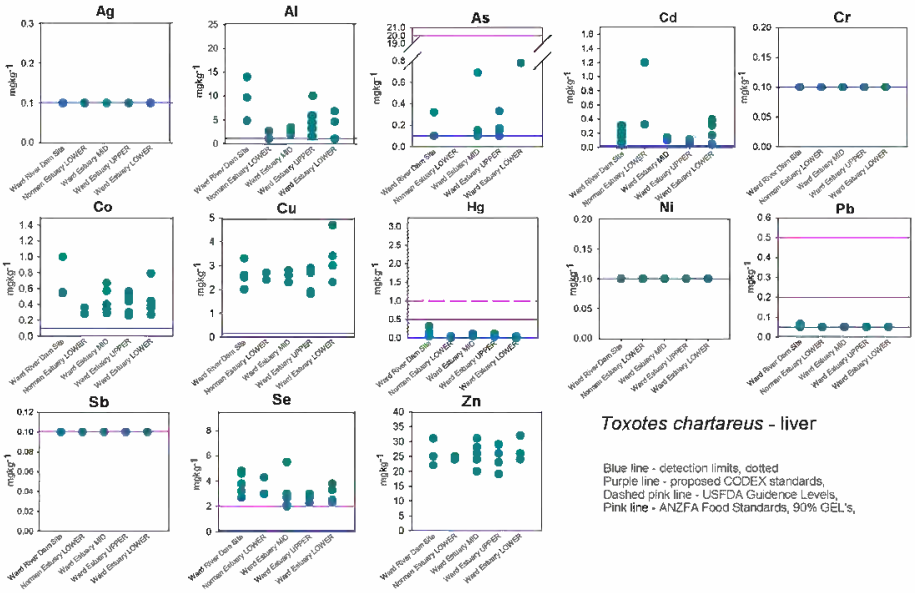
mg/kg-1
Toxotes chartareus - gills
Blue line - detection limits
Blue dot- sample specific detection limit
2009 Samples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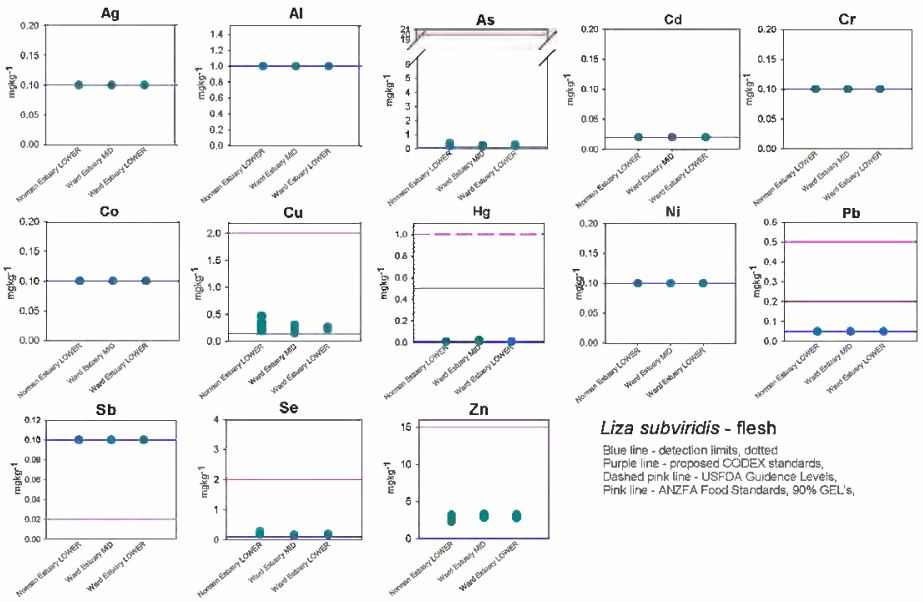
mg/kg-1
Ward River Dam Site
Norman Estuary LOWER
Ward Estuary MID
Ward Estuary UPPER
Ward Estuary LOWER
Toxotes chartareus - liver
Blue line - detection limits, dotted
Purple line - proposed CODEX standards,
Dashed pink line - USFDA Guidence Levels,
Pink line - ANZFA Food Standards, 90% GEL's,
2009 Samples


Ag
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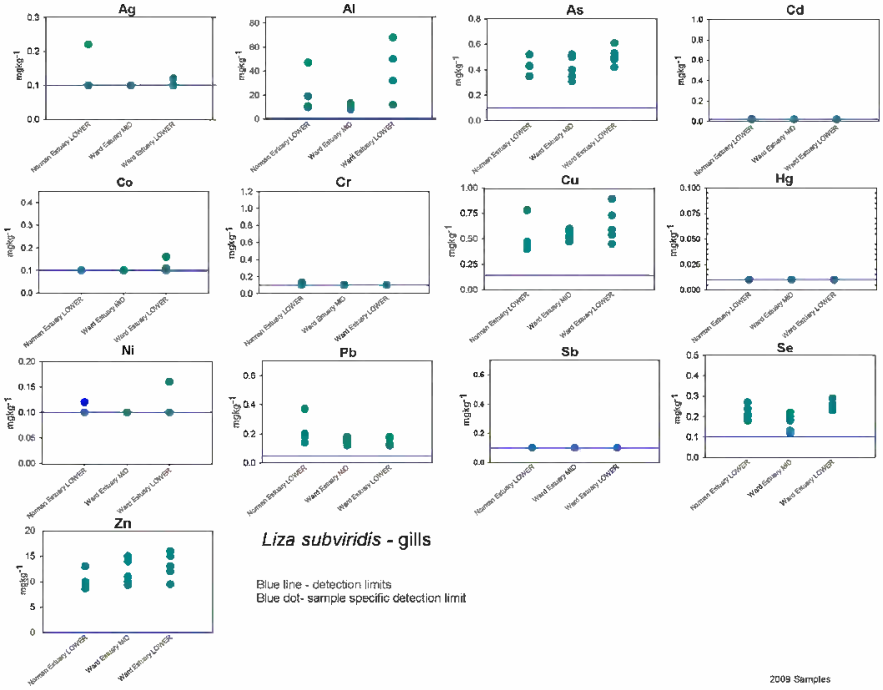
mg/kg-1
Norman Estuary LOWER
Ward Estuary MID
Ward Estuary LOWER
Liza subviridis - flesh
Blue line - detection limits, dotted
Purple line - proposed CODEX standards,
Dashed pink line - USFDA Guidence Levels,
Pink line - ANZFA Food Standards, 90% GEL's,
2009 Samples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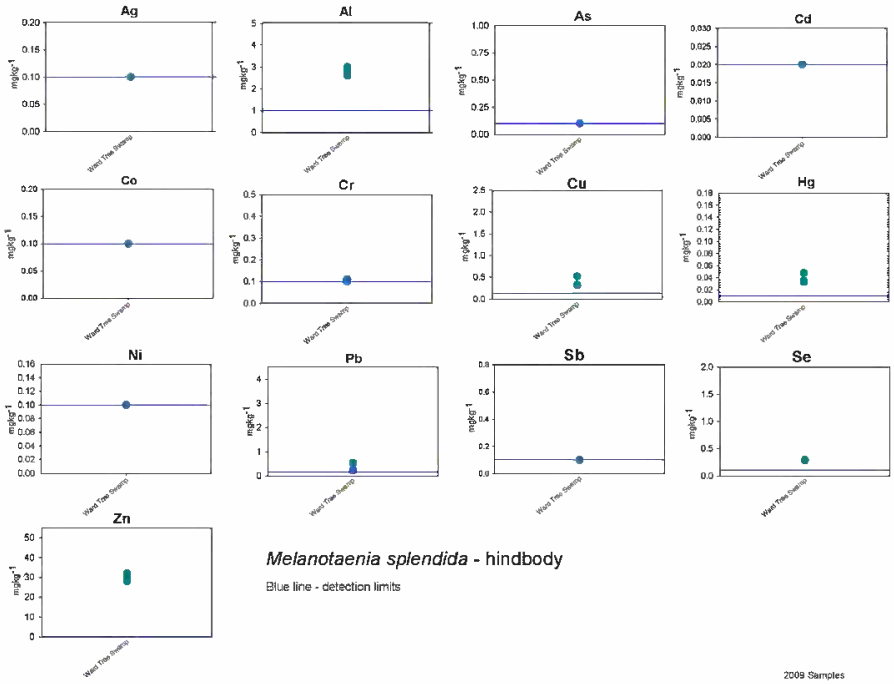
mg/kg-1
Norman Estuary LOWER
Ward Estuary MID
Ward Estuary LOWER
Liza subviridis - gills
Blue line - detection limits
Blue dot- sample specific detection limit
2009 Samples


Ag
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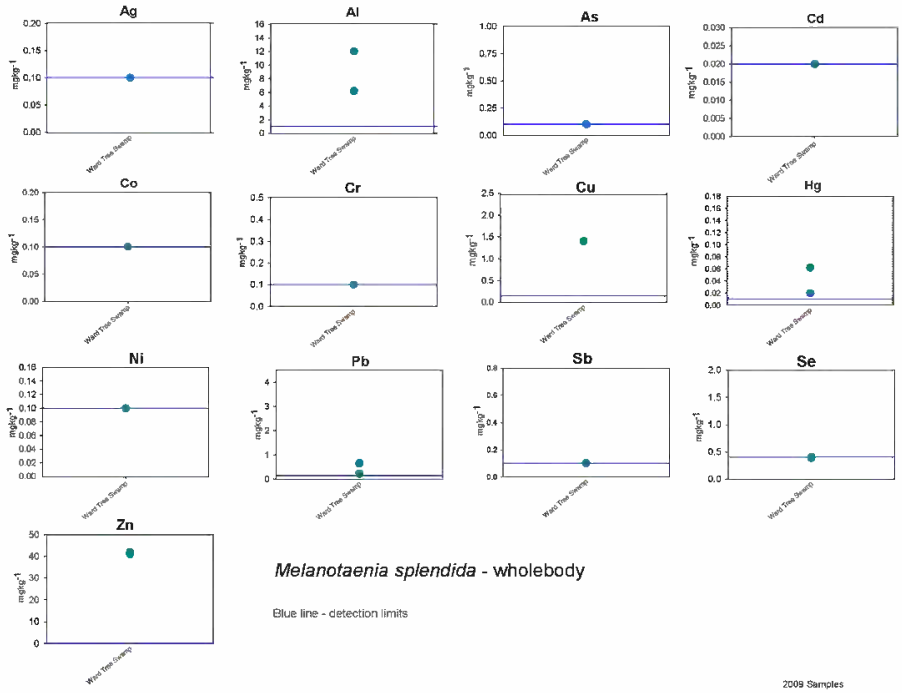
Ward Tree Swamp
Melanotaenia splendida - hindbody
Blue line - detection limits
2009 Samples


Ag
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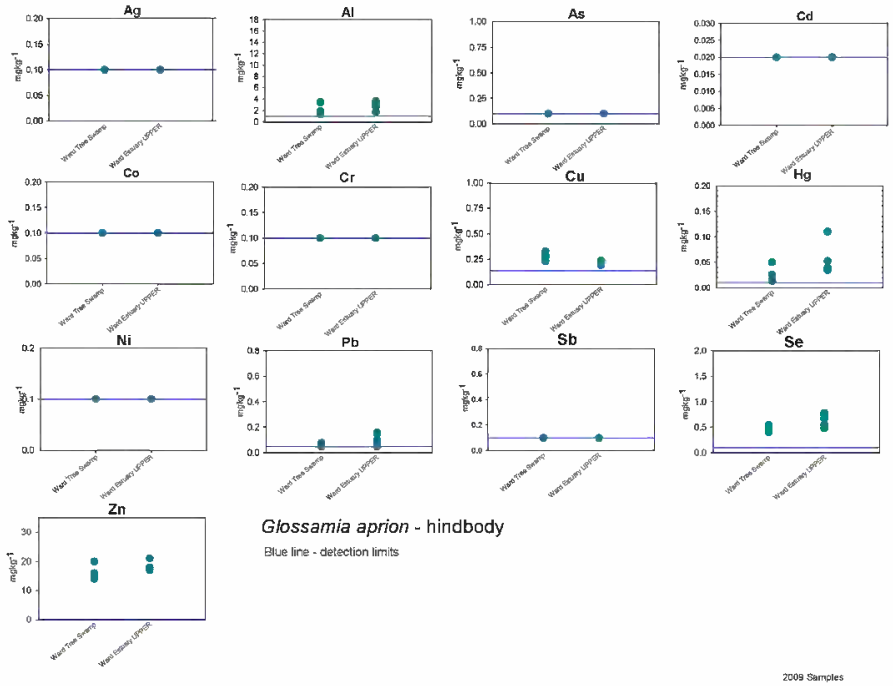
mg/kg-1
Ward Tree Swamp
Melanotaenia splendida - wholebody
Blue line - detection limits
2009 Samples


Ag
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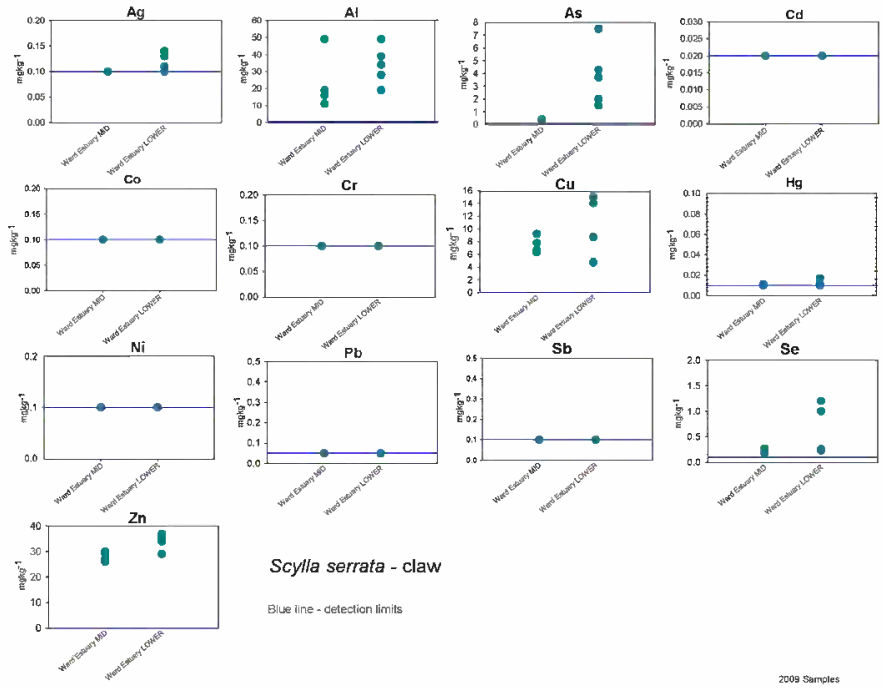
mg/kg-1
Ward Tree Swamp
Ward Estuary UPPER
Glossamia aprion - hindbody
Blue line - detection limits
2009 Samples


Ag
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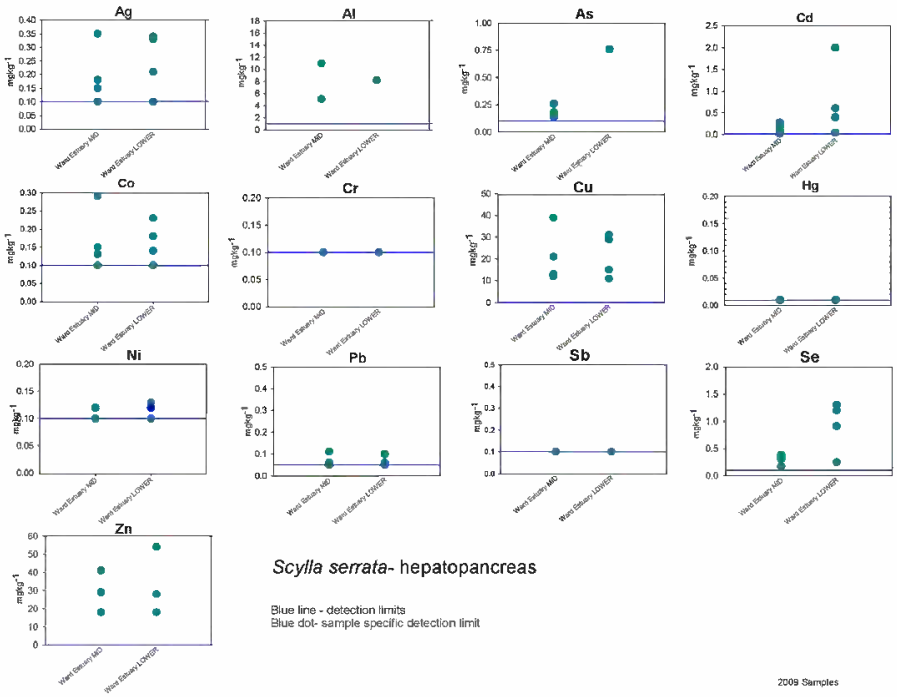
mg/kg-1
Ward Estuary MID
Ward Estuary LOWER
Scylla serrata - claw
Blue line - detection limits
2009 Samples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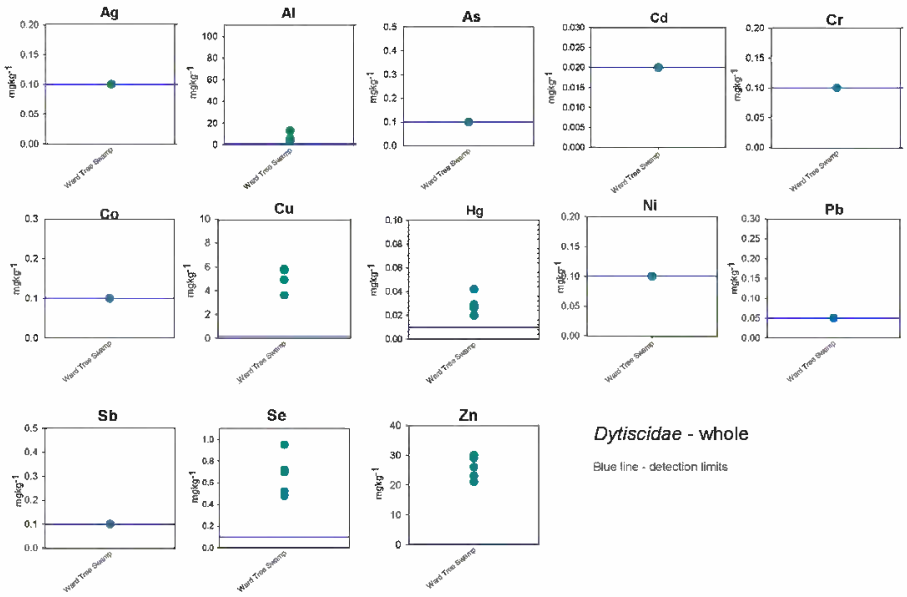
mg/kg-1
Scylla serrata- hepatopancreas
Blue line - detection limits
Blue dot- sample specific detection limit
2009 Samples


Ag
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Co
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Ni
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Zn
mg/kg-1
Ward Tree Swamp
Dytiscidae - whole
Blue line - detection limits
2009 Samples

APPENDIX 8C

RESPONSE TO DSEWPAC COMMENTS ON THREATENED ELASMOBRANCH SPECIES

econcern

environmental consultancy
'local to global – catchment to coastal'

Econcern
56 McPhails Road
Huonbrook NSW 2482
Phone: (02) 66840330
Mobile: 0418982426
Email: econcern@bigpond.com
A.B.N. 99 607 411 256

To: Fiona Talbot, Technology and Innovation Principal Advisor – Environment Rio Tinto

From: Jim Tait Senior Environmental Scientist Econcern

Subject: Response to DESEWPaC Comments on South of Embley EIS concerning threatened elasmobranch species

Date: 1st April 2011

Based on a brief assessment of the comments of DESEWPaC reviewers of the SOE Project EIS, there would appear to be several generic issues of concern regarding threatened elasmobranch species in the project area. These issues are addressed in turn under four collective headings below;

1. ADEQUACY OF EXISTING SURVEYS.

Survey efforts for fishes in the project area were subject to a number of constraints associated with sampling efficiency, access and safety. Within the estuary proper, large populations of estuarine crocodiles limited night work due to safety concerns for samplers associated with potential crocodile attack and with the removal of enmeshed crocodiles from gill nets (which still occurred albeit at a manageable level during daylight hours). For this reason gill nets were set for standard 4 hr periods either in the early post morning or late afternoon pre dusk period when many fish species are known to be active.

In the highly seasonal freshwater reaches of tributary stems flowing to the estuary overnight net sets were employed at a range of sites upstream of the proposed impoundment and in adjoining tributary systems. Sampling was conducted in the post wet season run off period (May) as this presented the optimal site conditions for sampling. During the wet season stream reaches could not be sampled due to the inaccessibility of sites due to wet season inundation of the landscape and due to the debris laden high flows that prevent the safe and effective deployment of sampling gear. During the dry season, freshwater habitats upstream of the impoundment area were reduced to small residual pools that were too small to deploy gill nets and lacked flow for effective use of fyke nets.

In addition to gill netting other survey methods employed were backpack electrofishing, bait trapping, fyke netting, targeted angling and visual observation (highly effective in the ultra clear freshwater habitats of the project area. This represents as comprehensive a suite of methods as could possibly be employed within the available freshwater habitats.

2. SUITABILITY OF HABITAT FOR EPBC LISTED ELESMOBRANCH SPECIES

Freshwater streams of the project area have ultra low conductivity as a consequence of draining highly weathered bauxite landscapes which do not contribute salts. To put it into context, it should be recognised that recorded conductivity values approach those of distilled water. As discussed in the EIS, a hypothesis of the fish biologist involved in these surveys is that these ultra low conductivity values present an osmoregulation constraint on the freshwater fish community that occur in these systems evidenced by the complete absence of records for

otherwise ubiquitous families, genera and species of freshwater fishes found throughout tropical Australia including in adjoining river systems of the region. Examples include a complete lack of gobies, theraponids, gerrids and mullets. The only catadromous (estuarine breeding) freshwater species found in the project area were Tarpon, Barramundi and Mangrove Jack the latter two only in tidally influenced freshwater reaches downstream of the proposed impoundment site and in the lowermost freshwater reaches of adjoining tributary systems. It should be noted that all regional freshwater/inland records for Freshwater sawfish *Pristis microdon* come from larger perennial river systems (as opposed to small seasonal creeks NB: Norman creek has a channel width of approximately 4m and a maximum depth of approximately 1.5m at the proposed impoundment site) which have conductivities typically of several hundred microsiemens and which are typically co inhabited by a full complement of the catadromous, amphidromous and estuarine vagrant species noticeably absent from the freshwater reaches of Norman Creek. It is suggested that the ultra low conductivities of the project areas freshwaters would present an equal or greater osmoregulation constraint on elasmobanch fishes which poss a more primitive osmorregulation capacity than modern ray finned fishes.
Based on EIS survey results, know records for *Pristis spp.* and *Glyphis spp.* and anecdotal information obtained from Traditional Owner informants it is firmly believed that while the estuarine and possibly lower tidally influence freshwater reaches of the Norman Creek system do provide potentially suitable habitat for *Pristis spp.* and *Glyphis spp* the seasonal freshwater reaches upstream of the proposed impoundment site do not. This assessment does not only rest on the described water quality constraints but also on the small size and seasonality of the systems concerned.

3. MITIGATION MEASURES

The principle mitigation measure proposed to address concerns surrounding potential breaks in aquatic habitat connectivity associated with the proposed impoundment wall is a low gradient fishway of a 'rock ramp' style, to be incorporated in the spillway overflow of the proposed impoundment. It is believed that this measure will facilitate passage of all upstream migrating species that access freshwater habitats of Norman Creek upstream of the proposed impoundment wall. This belief is underpinned by several factors including:

- The proven success of rock ramp style fishways for facilitating the passage of the targeted catadromous species in other regions of Queensland i.e. lower Fitzroy coastal catchments.
- The successful upstream passage of at least one of the targeted catadromous species (Tarpon) up the flow dissipating spillway bypass (not specifically designed for fish passage) of an impoundment (Ely Dam) constructed in an equivalent environment north of Weipa in the Pine River catchment.
- The presence of high gradient riffle run sequences downstream of the proposed impoundment wall that present hydraulic environments that will be at least matched in terms of fish passage ability by the low gradient fishway planned to be incorporated at the proposed impoundment wall.

As noted in the preceding discussion point (above) it is firmly believed that Freshwater sawfish *Pristis microdon* do not currently utilise the small seasonal stream reaches upstream of the proposed impoundment wall. However, the proposed impoundment will create a permanent lacustrine freshwater habitat suitable for most if not all freshwater species that currently inhabit the impoundment reach. The size and perenniality of this habitat may also present opportunities for species not commonly encountered in the impoundment reach (possible including Freshwater sawfish *Pristis microdon)* to occur there post impoundment construction. To that end it is argued that the level of connectivity to the impoundment that will be available to migratory species will be at least equivalent to that presented by the higher gradient stream reaches downstream of the impoundment wall site.

4. SCALE OF IMPACT

Issues raised concerning the loss of mangrove habitat and channel dredging associated with the barge and ferry infrastructure need to be placed in the broader context of the extensive estuarine habitat mosaic present in the Embley River estuary. Intertidal areas devoid of mangrove cover and deeper channel areas form part of the broader habitat mosaic of this system and it is suggested that the modified habitat that result from these activities i.e. dredged deeper channels and cleared mangrove areas fall within the range of natural habitat variability of the system, and will remain productive habitats that can be utilised or at least traversed by threatened *Pristis spp*. and *Glyphis spp*. When the area of habitat disturbance associated with dredging or mangrove clearing is put into the context of the area of mangrove and shallow estuarine channel available within the broader Embley River estuarine habitat complex, the claim that these disturbances do not represent a significant loss of habitat for these is readily substantiated.

Norman Creek at the site of the proposed impoundment wall May 2009.

High gradient bedrock reach of Norman Creek downstream of the proposed impoundment wall.

Upper estuarine/freshwater gill net sampling highlighting very real safety contraints to night time sampling.

Spillway bypass at Ely Dam north of Weipa highlighting potential for incorporation of dedicated low gradient 'rock ramp' fishways in

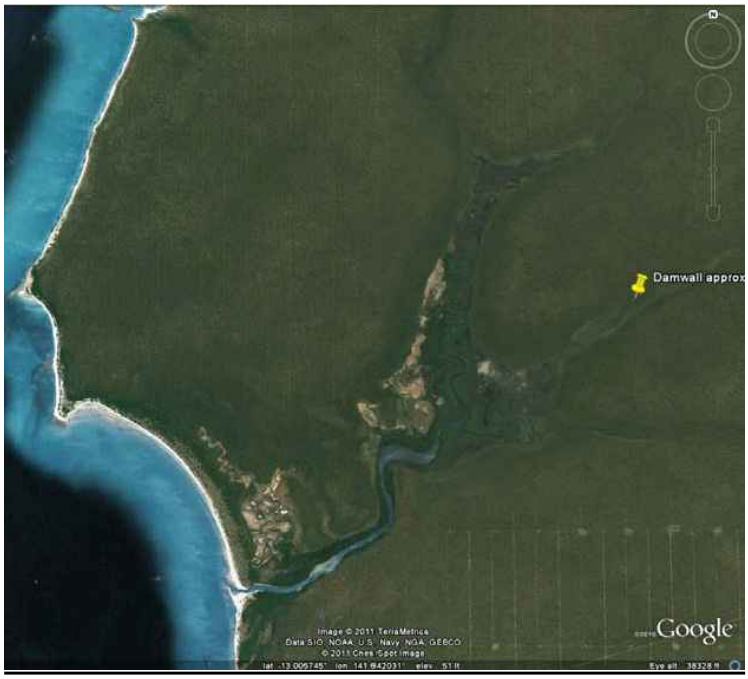
Weipa Region impoundments.

Potentially suitable *Pristis spp*. and *Glyphis spp*. habitat downstream of proposed impoundment site though habitat suitability still likely to be limited by low water conductivity.

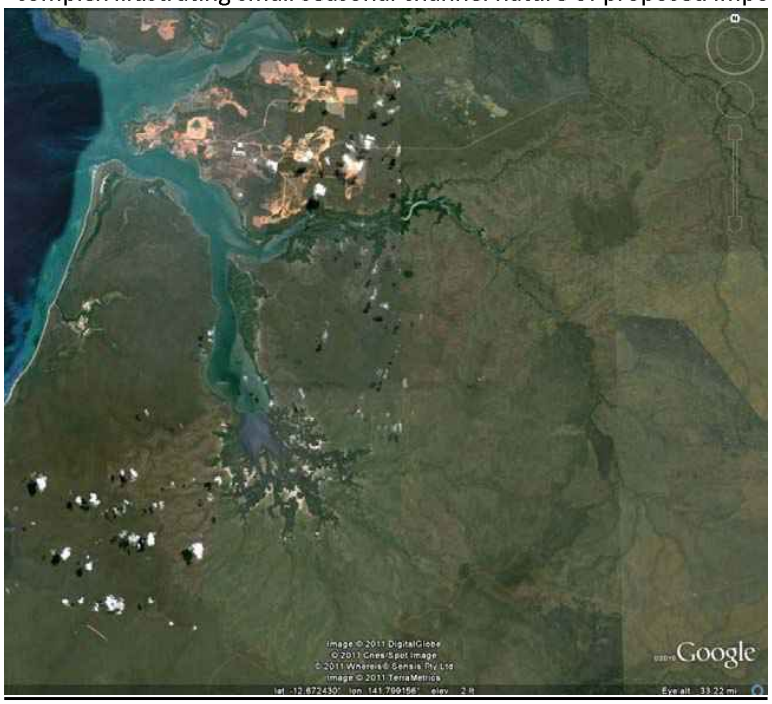
Potentially suitable *Pristis spp*. and *Glyphis spp*. habitat on tributary stem north of proposed impoundment catchment, though habitat suitability still likely to be limited by low water conductivity.

Lower Norman Creek freshwater reach perennial freshwater habitat upstream of impoundment site during early dry season August 2007.

Lower Norman Creek freshwater reach perennial freshwater habitat upstream of impoundment site during early dry season August 2007.



Location of proposed impoundment wall in relation to broader Norman Creek wetland habitat complex illustrating small seasonal channel nature of proposed impoundment site.



Overview image of Embley River estuarine habitat complex to provide scale context to proposed mangrove removal and channel dredging habitat impacts.

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Environmental Impact Statement

for South of Embley Project

Section 15
Appendix

APPENDIX 15A

SOUTH OF EMBLEY PROJECT NEWSLETTERS

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Rio Tinto Alcan

WEIPA SOUTH OF EMBLEY PROJECT

Newsletter 3 • December 2010

Project update

Rio Tinto Alcan is conducting a feasibility study to extend its Weipa bauxite mine in an area south of the Embley River. The South of Embley (SoE) Project would extend the Weipa mine life by approximately 40 years depending on production rates.

The SoE Project will progressively replace depleted bauxite reserves at the East Weipa and Andoom mining areas, maintain continuity of supply to Rio Tinto Alcan's two Gladstone alumina refineries and continue to generate employment and other economic benefits on the Western Cape.

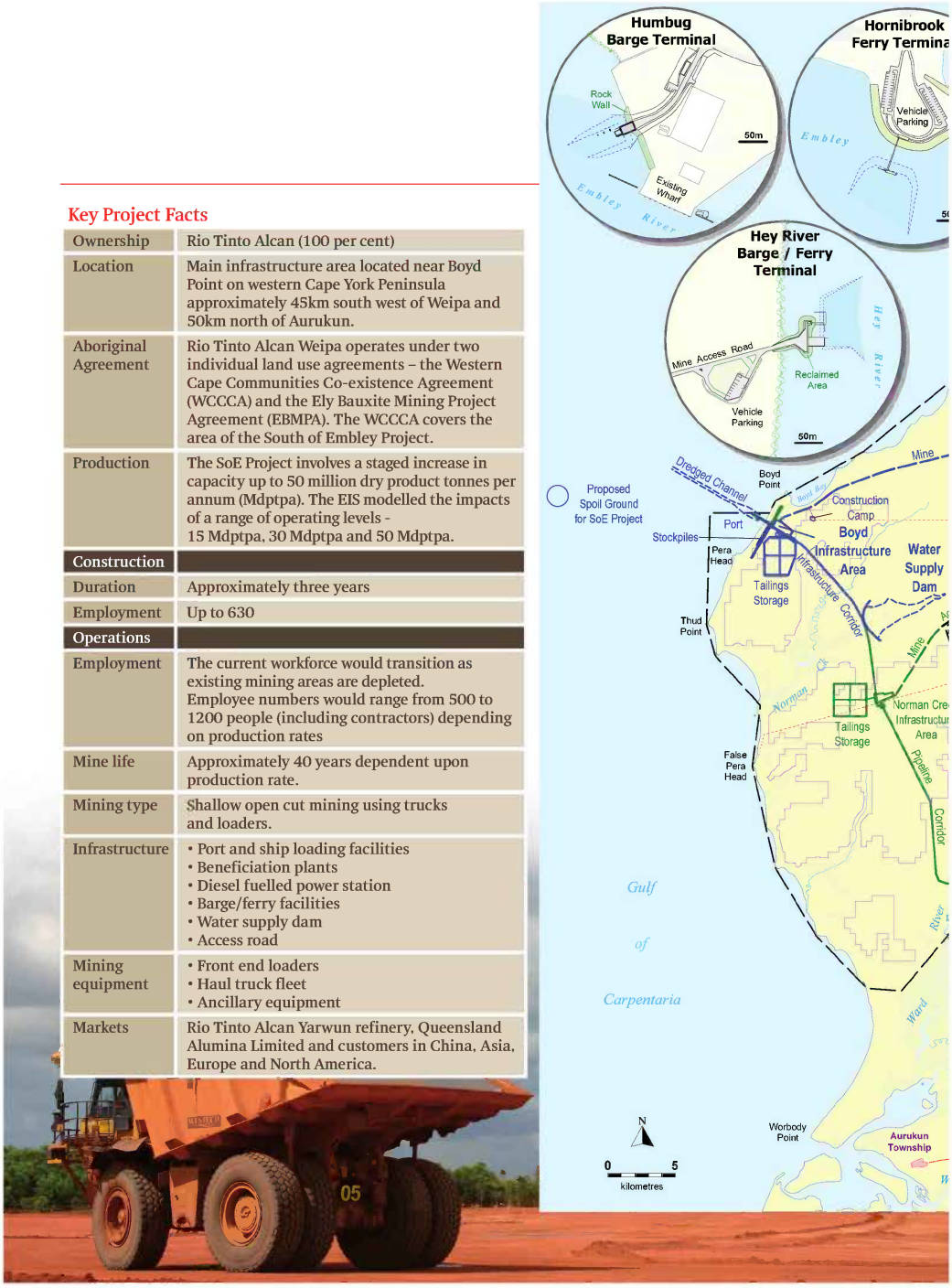
Rio Tinto Alcan has assessed the project over the last two years and through a series of social and environmental studies and in consultation with key stakeholders. This information was used to prepare an Environmental Impact Statement (EIS) which will be available for public review and comment early in 2011.

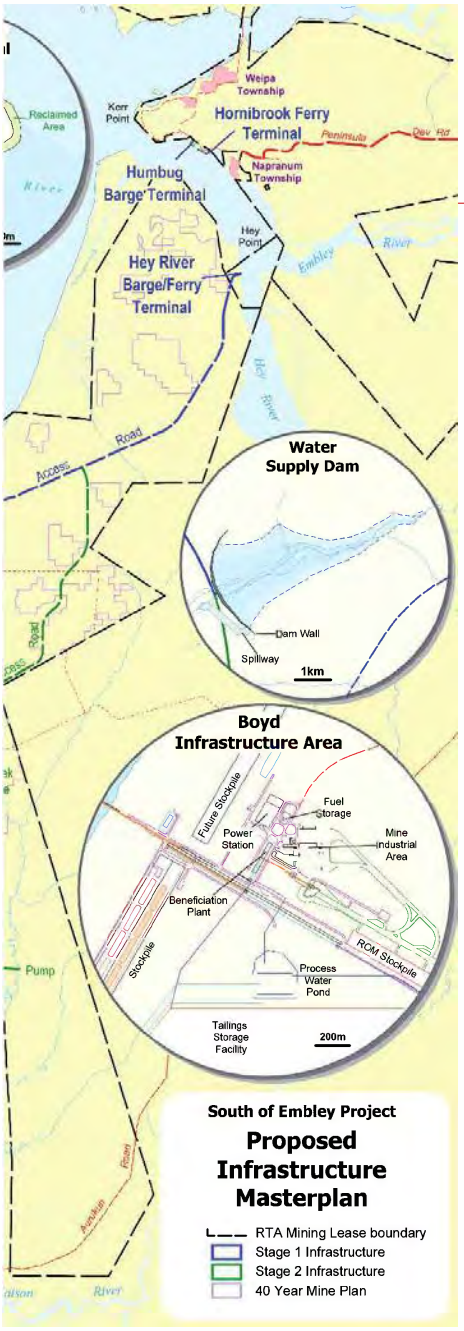
The SoE Project involves a staged increase in capacity up to a possible 50 million dry product tonnes per annum (Mdptpa). The EIS modelled the impacts of a range of operating levels – 15 Mdptpa, 30 Mdptpa and 50 Mdptpa. The initial capacity is subject to feasibility studies and market conditions – RTA is currently targeting initial capacity from the SoE Project of up to 22.5 Mdptpa. The SoE Project includes new mining areas, construction of new infrastructure including beneficiation plants, power station, warehouses, workshops, barge and ferry facilities, ship loading facilities, and an access road. Construction could start in 2012, depending on regulatory and internal approvals.

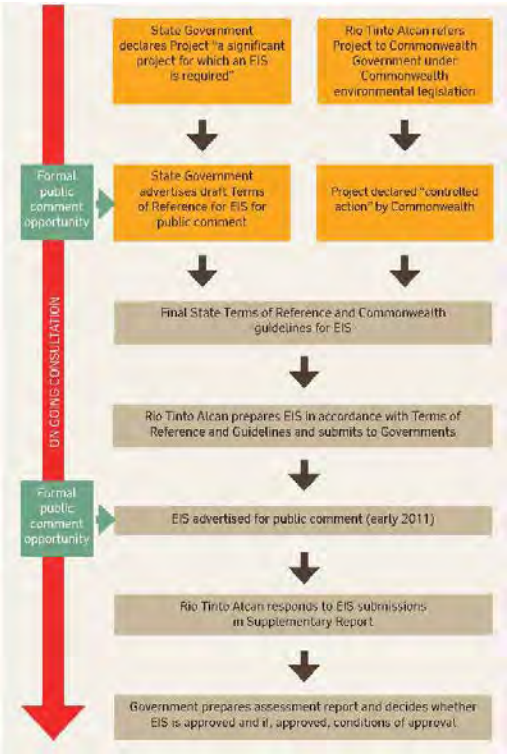
A construction workforce will be accommodated in a temporary construction village on site and, once operational, employees would commute daily to the mine.

Key Project Facts

Ownership	Rio Tinto Alcan (100 per cent)
Location	Main infrastructure area located near Boyd Point on western Cape York Peninsula approximately 45km south west of Weipa and 50km north of Aurukun.
Aboriginal Agreement	Rio Tinto Alcan Weipa operates under two individual land use agreements – the Western Cape Communities Co-existence Agreement (WCCCA) and the Ely Bauxite Mining Project Agreement (EBMPA). The WCCCA covers the area of the South of Embley Project.
Production	The SoE Project involves a staged increase in capacity up to 50 million dry product tonnes per annum (Mdptpa). The EIS modelled the impacts of a range of operating levels - 15 Mdptpa, 30 Mdptpa and 50 Mdptpa.
Construction	
Duration	Approximately three years
Employment	Up to 630
Operations	
Employment	The current workforce would transition as existing mining areas are depleted. Employee numbers would range from 500 to 1200 people (including contractors) depending on production rates
Mine life	Approximately 40 years dependent upon production rate.
Mining type	Shallow open cut mining using trucks and loaders.
Infrastructure	• Port and ship loading facilities • Beneficiation plants • Diesel fuelled power station • Barge/ferry facilities • Water supply dam • Access road
Mining equipment	• Front end loaders • Haul truck fleet • Ancillary equipment
Markets	Rio Tinto Alcan Yarwun refinery, Queensland Alumina Limited and customers in China, Asia, Europe and North America.







Environmental Impact Statement (EIS) process

The EIS describes the environmental, social and economic benefits and impacts of the Project and proposes measures to mitigate any potential adverse impacts.

It includes an assessment of Project impacts on water, land use, plants, animals (including reptiles, and marine animals), noise, dust, health and safety and traffic. The EIS also discusses predicted impacts of the Project on cultural heritage and the socio-economic conditions of the region.

The EIS is being finalised and will be available for public comment in early 2011. Information about the public comment period and how to make a submission will be advertised in advance.

Rio Tinto Alcan may then be asked to prepare a Supplementary Report to address any issues raised in submissions from Government departments, other organisations or individuals.

Together, the EIS and Supplementary Report will be assessed by the Queensland and Commonwealth Governments who must both approve the Project before it can be developed.

In addition to the formal process, you can contact Rio Tinto Alcan directly on freecall 1800 308 938 or email *external.affairs@riotinto.com* if you would like more information about the Project or the EIS process.

Community consultation

Community participation and feedback was a key consideration for Rio Tinto Alcan as it developed the EIS.

Since the feasibility study began in 2008, Rio Tinto Alcan has consulted with a wide range of stakeholders including Traditional Owners; of Weipa, Aurukun, Napranum and Mapoon; government agencies and service providers; local Councils; business and industry leaders; pastoral landholders and managers; community organisations and employees living on Western Cape York.

In particular, Rio Tinto Alcan has undertaken an intensive consultation process with Traditional Owners.

The Western Cape Communities Co-existence Agreement (WCCCA) between Traditional Owners, Community Councils, Cape York Land Council, Rio Tinto Alcan and the Queensland Government recognises and provides the framework for the coexistence of Indigenous rights and mining in the region.

In keeping with the guidelines and spirit of the WCCCA, a Project Sub Committee was established in early 2009 to provide a forum for Traditional Owners and Rio Tinto Alcan to discuss and make recommendations on the Project.

The Sub Committee is regularly briefed on Project developments and was provided with draft chapters of the EIS for review as they became available.

This process has not only facilitated greater understanding and information sharing about the Project and potential impacts, but also allowed early identification of community, social and/or cultural heritage issues for Rio Tinto Alcan.

For example, this consultation process identified Traditional Owner concerns about the potential impacts of a dam planned on the Ward River. In response, Rio Tinto Alcan project staff reassessed water storage requirements and redesigned the Project to remove the need for the Ward River dam. Only one water supply dam, will now be built (on a tributary of Norman Creek), to supply the Project.

Consultation with Traditional Owners and the broader community will continue throughout the EIS process, into Project construction and operations.

Traditional Owner meeting on country at Boyd Bay.

For more information about the South of Embley Project contact:
Freecall: 1800 308 938 • Email: external.affairs@riotinto.com • Website: www.riotinto.com/riotintoalcan

Please be advised that this newsletter may contain images of and / or reference to deceased persons.

WEIPA

SOUTH OF THE EMBLEY PROJECT

Newsletter 2 • March 2009

Rio Tinto Alcan

Project overview

Rio Tinto Alcan has started a feasibility study and Environmental Impact Statement (EIS) to extend the Weipa bauxite mine in an area south of the Embley River. This new mining area would extend the life of the Weipa mine by approximately 40 years, depending on production rates.

Mining in this area would require construction of new infrastructure (including a beneficiation plant, power station, warehouses, workshops, barge and ferry facilities, and port and ship loading facilities). A construction workforce of approximately 350 people would be accommodated at a temporary construction camp at the site for the three year construction period. The operational workforce would commute between Weipa and the mine on a daily basis.

The feasibility phase will review the technical and financial aspects of the operation and possible impacts and consequences of mining in this area. A decision to proceed with the development will depend upon Rio Tinto Alcan obtaining regulatory and internal approvals.

Community asked for input

Last year South of the Embley (SoE) project team members and the Social Impact Assessment consultants met with Traditional Owners, local government representatives, business people, service providers and other members of the community to discuss potential impacts of the South of the Embley project. Information was provided to these groups and the wider community through individual meetings, public information sessions, newsletters, displays and other interactions. The following were some of the questions raised by the community.

1. What are the opportunities for local businesses in Aurukun and Weipa?
2. How can the coastline and other areas of significance be protected?
3. What are the Indigenous employment opportunities during construction and operations?
4. What will be the social impacts on the communities of Weipa, Napranum and Aurukun?
5. What are the potential impacts of shipping activities on charter, commercial and recreational fishing and land/coastline access?
6. How will the community gain access to the lease during construction and operations?
7. How will planning and coordination of regional emergency and health services occur?
8. What will be the environmental impacts on Norman Creek?
9. How will the logistical issues of the workforce commuting to the proposed mine be managed?
10. What are the benefits and potential risks of public use of the proposed mine road and ferry/barge service?

Project team responses to these issues will be addressed in the EIS and summarised in the next Community Newsletter. Another round of public information sessions will be held when the EIS is available for public comment mid 2009.

Rio Tinto Alcan Weipa Community Relations employees talk to Vera Koomeeta, Aurukun Family Responsibilities Commissioner, about the proposed infrastructure for the South of the Embley Project.

Issues in focus

Two issues in particular were raised by a number of different business and community groups in Weipa, Aurukun and Napranum.

Coastline protection
Protection of the coastline was a key issue for a number of groups including Traditional Owners, local businesses, the Weipa Chamber of Commerce and members of the community. People said they wanted more information about how the proposed mining and port activity would impact the coastline and waters near the proposed port. They also asked how Rio Tinto Alcan Weipa would manage access to the coastline for traditional, commercial and recreational purposes to minimise adverse impact on the environment. In addition to environmental impacts, the community wanted to know how Rio Tinto Alcan's activities south of the Embley River would impact their current recreational or commercial activities.

Business opportunities
Business groups, local government representatives and members of the community were very interested in the broad range of opportunities the project could generate for local non Indigenous and Indigenous businesses. The community wanted to know about the business opportunities generated directly by the construction and operations activity, such as earthmoving. They were also interested in the indirect business opportunities (such as ecotourism) potentially generated by the flow on impact of the project on employment, population growth, house prices and regional services.

Rio Tinto Alcan's response to these issues will be addressed in the EIS due for release mid 2009. In the meantime, community members are encouraged to contact the project team for more information about the South of the Embley project.

Wik Projects Board Members, Wik Waya Traditional Owners and Advisors participate in a two day workshop as part of the Social Impact Assessment consultation.

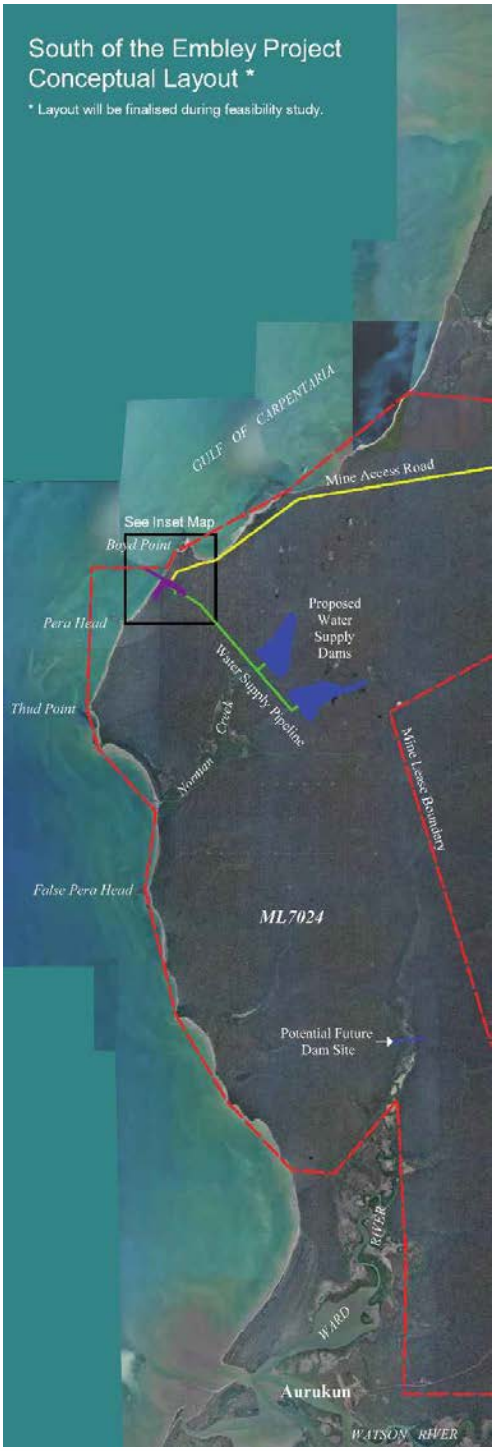
From General Manager Weipa operations

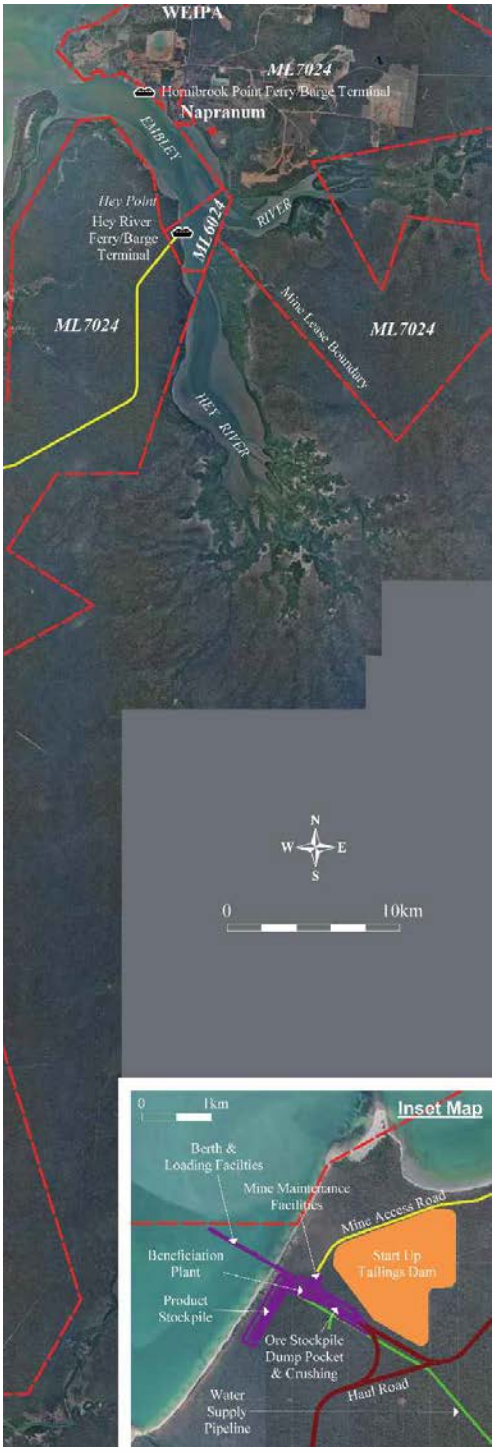
Our Weipa operations are a vital cornerstone of Rio Tinto Alcan's global aluminium business. The South of the Embley project would, if approved, eventually replace our existing East Weipa mine and allow us to extend the life of our bauxite mining operations for approximately 40 years. We understand Rio Tinto Alcan has a significant impact on the communities of the Western Cape and it is very important the community understands our plans and has an opportunity to comment.

Last year members of the South of the Embley project team started working on assessments to determine the possible impacts of our proposed mine on the local environment and community. These included surveys of the proposed mine area to identify flora and fauna and areas of cultural significance to Traditional Owners. Team members also talked to local government, community groups and individuals about the project and what it would mean in terms of employment opportunities and the impact on the community, businesses and services in the region. Engineers are still working to determine the best configuration of the mine areas and associated infrastructure. The outcome of all of this activity will be presented in the EIS available for public comment mid 2009.

We plan to build a mining operation that continues to generate benefits for the community well into the future so it is very important the community provides input. There are a number of opportunities for the community to provide formal comment through the EIS process. However, project team members are available, at any time, to talk through the project or our feasibility process and can be contacted on email: *infoEIS@riotintoalcan.com* or freecall 1800 308 938. Alternatively, you can use the feedback form included with this newsletter to make a comment.

Jo-Anne Scarini
General manager Weipa operations





PROJECT FACTS

Ownership	Rio Tinto Alcan (100 per cent).
Location	The main infrastructure area of the South of the Embley project is located near Boyd Point on the western Cape York Peninsula, approximately 45 km south of Weipa and 50 km north of Aurukun.
Production	We estimate the mine would initially be capable of producing between 15 million and 30 million dry product tonnes per year. It would be capable of expansion to 50 million dry product tonnes per year in the future.
Feasibility phase	One to two years.
CONSTRUCTION	
Duration	Depending upon approvals, construction could start as early as 2010, and would take approximately three years.
Employment	The project construction workforce is estimated to be around 350 people.
OPERATIONS	
Duration	The South of the Embley operations would have a mine life of approximately 40 years, depending on production rate.
Employment	The current workforce would transition to the new location as existing mining areas are depleted.
Mining type	Open cut mining using trucks and loaders.
Infrastructure	• Port and ship loading facilities • Beneficiation plant • Diesel fuelled power station • Barge / ferry facilities • Water storage dams
Mining equipment	• Loaders or excavators • Truck fleet (number and size to be determined) • Ancillary equipment
Markets	Rio Tinto Alcan Yarwun refinery, Queensland Alumina Limited and customers in China, Asia, Europe and North America.

Flatback turtle hatchlings.

Marine turtles in vicinity of South of Embley Project

As part of the environmental studies, a survey of marine turtles was conducted from Boyd Bay to Norman Creek. The survey found that scattered turtle nesting occurred, but concentrated nesting did not. Based on the inspection of tracks, the most common nesting species was the flatback turtle. Lesser numbers of tracks from other species were seen. While identification from tracks is not precise, these other species are likely to be hawksbill, green and/or Olive Ridley turtles, all of which are known to occur in the Western Cape region. All these marine turtles are protected under Commonwealth and State legislation.

The EIS will assess the potential impact on marine turtles from the proposed port south of Boyd Point and examine possible mitigation measures. Rio Tinto Alcan is providing assistance to Environmental Protection Agency turtle researchers at the South of Embley project site by deploying sand temperature loggers, which will contribute to understanding the biology of marine turtles.

An adult flatback turtle laying eggs.

Environment surveys

Environmental consultants monitor waterways during the wet season as part of the South of the Embley project environmental survey programme.

A number of environmental surveys have been conducted on the section of Rio Tinto Alcan's lease proposed for development. As part of the EIS process formal environmental surveys are completed to understand the state of the natural environment before development and to predict the impact the proposed development is likely to have. The surveys were undertaken by independent environmental consultants between late 2007 and 2008 to allow for the changes to the natural environment with the wet and dry seasons.

Surveys were conducted to identify what species of flora and fauna (including fish, insects, birds, frogs, reptiles, bats and other mammals) can be found in the proposed development area. The surveys recorded a wide array of species in woodland, vine forest, swamp, stream and riparian habitats including some plant and animals that are classified by the Commonwealth and State Governments as endangered, vulnerable or rare (known as EVR). The habitats and flora and fauna of the area were found to be very similar to those occurring in and around Weipa.

Most of the EVR flora and fauna were found in swamp and riparian habitats including epiphytic orchids, the insectivorous pitcher plant and the Black-necked Stork.

The impact of the proposed project on the surface and groundwater was also studied, specifically the quality of the shallow aquifer and the potential impact of constructing dams. Further engineering work has confirmed that two dams are highly likely to be built on the upper tributaries of Norman Creek and one dam on the Ward River. The impact of building and running a port, including dredging operations, in the Boyd Point region and on nearby coral reefs was also surveyed.

The consultants studied the existing Lorim Point wharf facilities and beneficiation plant to build a picture of how the new facilities might impact in terms of noise, dust and visual amenity. Other studies were conducted on the soil and sediment of the proposed mine and port sites, and to determine the impact of the new operation on traffic and transport.

The detailed findings of all the studies will be included in the EIS document, which is due for release for community comment in mid 2009.

Cultural heritage surveys

Wik Waya Traditional Owners worked with Rio Tinto Alcan heritage archaeologists to conduct a comprehensive archaeological survey of proposed drill lines inland from Boyd Bay.

The surveys took six weeks and identified a number of sugarbag and Woomera scarred trees that are of cultural significance to Traditional Owners. The scarred trees are also archaeologically important as they can provide valuable information about past patterns of human land use. Rio Tinto Alcan will work with Traditional Owners to ensure important sites are preserved and, if necessary, significant trees will be relocated.

Further cultural heritage work with Traditional Owners will be undertaken later this year to record shell middens and scarred trees in the vicinity of Norman Creek and around the proposed plant facilities.

Norman Kerindun and Henry Kelinda participated in cultural heritage surveys of the site.

Aurukun residents join Rio Tinto Alcan representatives at the Destinations Programme selection workshop in August 2008.

Destinations Programme

Approximately 30 Aurukun residents participated in the Destinations Programme selection workshop held in Aurukun in August 2008.

Rio Tinto Alcan is committed to increasing the participation of local Aboriginal people in its workforce by helping people prepare for work and creating a workplace culture that is supportive of Aboriginal people and values their contribution.

Rio Tinto Alcan developed the Destinations Programme in 2007 to specifically address recruitment and retention issues of Aurukun people at its Weipa operations. It is focused on developing a new and innovative approach to transitioning people from the community into the workforce.

The Destinations Programme was designed after extensive consultation with Traditional Owners, current and previous employees from Aurukun, government departments and employment agencies and using the experience Rio Tinto has gained from other operations.

The programme has three stages:

Stage 1: Pre-vocational training programme conducted by Myuma Pty Ltd, at Camooweal (13 weeks)

Stage 2: Work sampling programme at Rio Tinto Alcan Weipa (16 weeks)

Stage 3: Fixed term contract at Rio Tinto Alcan Weipa (16 weeks)

Five new participants (Delwyn Blowhard, Ross Koonutta, Kenneth Pamtoonda, Alistair Pamtoonda and Ronnie Ngalametta) were selected in February 2009 and are the fourth intake in the two year pilot programme. There are currently nine people in various stages of the Destinations Programme and all participants who successfully complete all three stages will be placed into permanent full time employment at the Weipa operations.

Spending time outside their community is a new approach for people undertaking this type of pre-vocational training. Rio Tinto Alcan believes this approach will provide a supportive pathway for people living in Aurukun progressing from Community Development Employment Projects to full time work in the mining industry.

While only in its early stages, the Destinations Programme is showing some positive results. Rio Tinto Alcan will continue to work closely with programme partners Myuma Pty Ltd and Wik Projects Ltd to monitor the programme and support the participants. The Queensland Department of Employment and Industrial Relations and the Commonwealth Government Department of Education, Employment and Workplace Relations have also provided financial support for the two year pilot programme.

If successful, the Destinations Programme will provide the framework to increase the skill level and employment opportunities for the Aurukun community into the future.

Managers meet in Aurukun

Rio Tinto Alcan Weipa's management team held one of their monthly meetings in Aurukun in August last year. The management team meet in each Western Cape community once a year, as a way of visiting the communities and helping community members understand more about Rio Tinto Alcan's operations.

In addition to their usual business, the managers received an update from Gina Castelain and Richard Ornyengaia about the work of Wik Projects Ltd. They provided a summary of the range of current and future business opportunities developed by Wik Projects Ltd including earthmoving, eco-tourism, timber harvesting, employment and training programmes, cultural heritage and coastal management.

Colin Saltmere of Myuma Pty Ltd was also present at the meeting and spoke to the managers about the pre-vocational training stage of the Destinations Programme he hosts in Camooweal. He spoke specifically about the strategies being implemented by Myuma to support the transition of participants from the community to work in the mining industry.

Wik Project's Gina Castelain and Richard Ornyengaia and Myuma Pty Ltd's Colin Saltmere (third from left) addressed Rio Tinto Alcan Weipa's management team at the meeting in Aurukun.

EIS process

State and Commonwealth Governments require Rio Tinto Alcan to prepare an EIS which they assess before approving the project. The EIS is a document that describes the impacts of a proposed project and includes assessment of the environmental, social and economic impacts. Information is also included on plans to mitigate any impacts from the proposed project. The process for preparing the EIS is managed by the Queensland Government and includes opportunities for formal public comment.

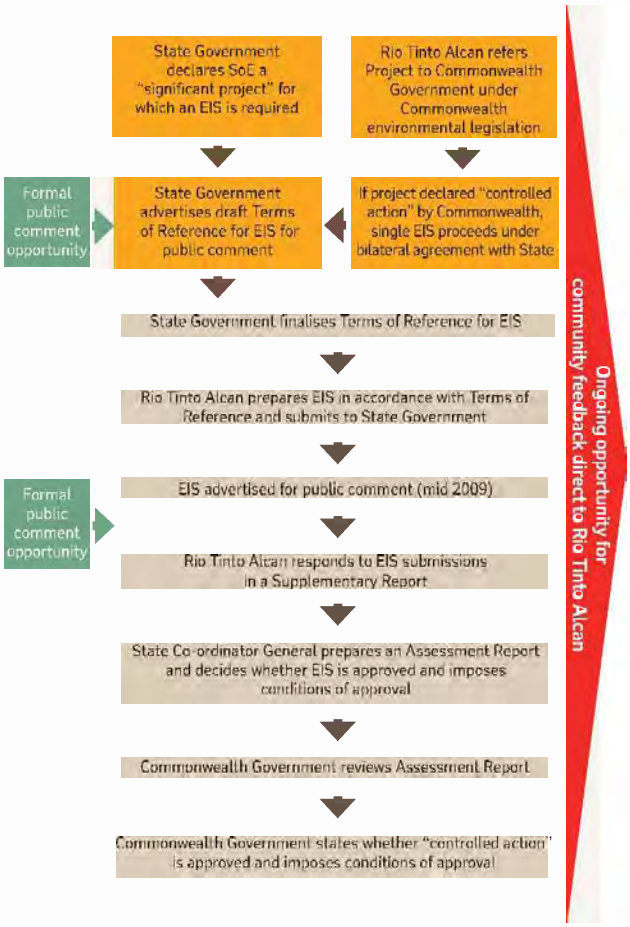
Where are we up to?

The Commonwealth Government's Department of Environment, Water, Heritage and the Arts has declared the South of the Embley project a "controlled action" under the *Commonwealth Environment Protection and Biodiversity Conservation Act*. This means Rio Tinto Alcan will require approval from the Commonwealth Government, as well as the Queensland Government, before it can proceed. However, Rio Tinto Alcan only needs to produce one EIS document for both government processes.

The **Terms of Reference** is a document prepared by the Queensland Government which outlines what issues Rio Tinto Alcan must address in the EIS. The Queensland Government released a draft Terms of Reference on 17 January 2009 for public comment. The Terms of Reference is now being finalised by the Queensland Government. A final version will be available to the public when it is complete.

What's next?

Once the draft Terms of Reference have been finalised, Rio Tinto Alcan will produce an **EIS** document which will be available for comment by government agencies and the public. Any submissions on the EIS will be addressed in the **Supplementary Report** which is then assessed by the Queensland Government. The Queensland Government will then produce an Assessment Report and decide if the EIS is approved including any specific conditions of approval. The Commonwealth Government will then review the State Assessment Report and decide whether the "controlled action" is approved and imposes any conditions of approval.



Need more information?

South of the Embley project team members are available via email: *infoEIS@riotintoalcan.com* or freecall 1800 308 938 to provide more information about the project or to discuss issues of concern. Or you can complete and post the feedback form on the back of this newsletter.

QUESTIONS

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or email infoEIS@riotintoalcan.com

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WEIPA

SOUTH OF THE EMBLEY PROJECT

Newsletter 1 • June 2008

Rio Tinto Alcan

Project overview

Rio Tinto Alcan has started a feasibility study and environmental impact assessment to extend our Weipa mine in an area south of the Embley River. With an initial operating capacity of 15 million tonnes per year, we estimate this new mining area will extend the life of Weipa mine by approximately 40 years, depending on production rates.

As Comalco (now Rio Tinto Alcan) we began mining bauxite at Weipa in 1961 and the mine is a core asset and vital part of our growing aluminium business. Current mining operations at East Weipa and Andoom produce 18 million tonnes per year, and we plan to exceed 21 million tonnes per year in 2008.

International demand for bauxite remains strong, and Rio Tinto Alcan is now examining the viability of mining south of the Embley River on part of our existing mining lease. Over the next two years a feasibility study and Environmental Impact Statement (EIS) process will look at the technical and financial aspects and possible impacts and consequences of mining this area. A decision to proceed with the development will depend on Rio Tinto Alcan obtaining internal and regulatory approvals.

Mining in this part of the lease would require construction of new infrastructure, including a beneficiation plant (that washes the bauxite before we load it onto ships), power station, warehouses, workshops, barge and ferry facilities and a port and ship loading facilities. Rio Tinto Alcan is planning to have our operational workforce remain based in Weipa and they would commute to site on a daily basis.

We anticipate the mine extension would take three years to construct, and we estimate more than 350 jobs would be created during construction. Production at the South of the Embley operation would replace production from the depleted East Weipa reserves. The operational workforce would transition across as production increases at South of the Embley.

RTA will undertake extensive community consultation about the project, distribute information and respond to feedback. Comprehensive environmental and social studies will take place, to minimise impacts of the project.

From GM Operations – Weipa

The South of the Embley project is an important part of Weipa's future. The reserves at East Weipa and Andoom will gradually be depleted over the next few decades, and we estimate this project would provide for approximately 40 years of mining. But more importantly, the project is a vote of confidence in our community, and would ensure we can continue to play a large role in the region for generations to come.

During construction, there would be job opportunities for local residents. The project team, through the feasibility study period, will be working hard to maximise the benefits for the community.

Our focus on safety is not just at an operational level. The project team will be looking at designing a mine that is safe for our people, the community and the environment.

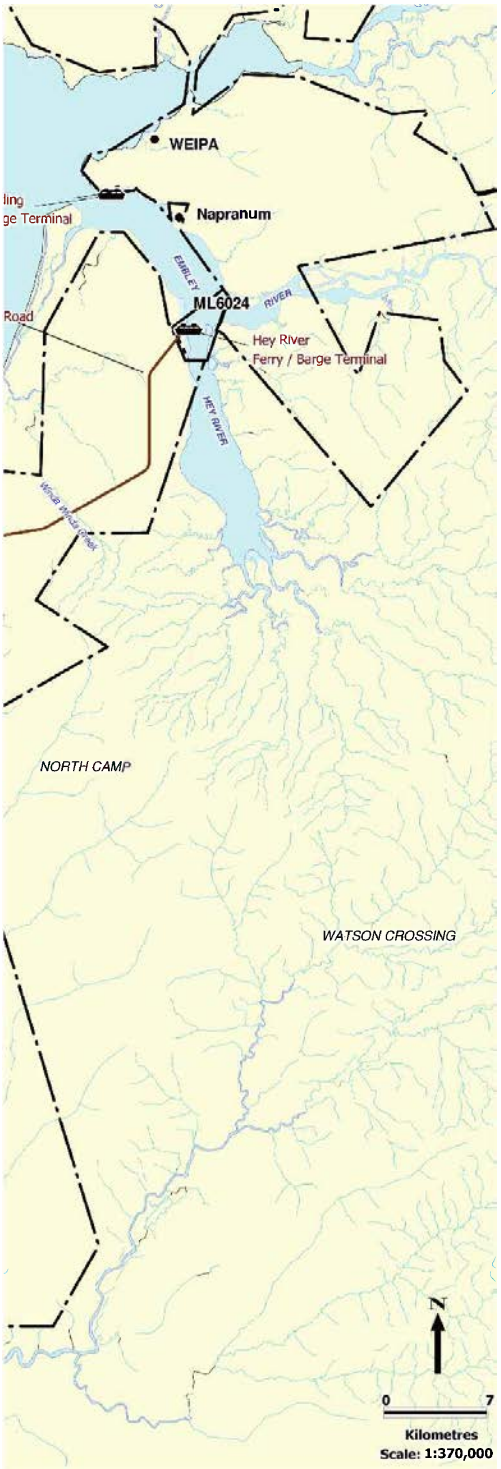
All of our mining activities at Weipa take place on Aboriginal land, subject to mining leases granted to Rio Tinto Alcan. The Western Cape Communities Co-existence Agreement (WCCCA) and the Ely Bauxite Mining Project Agreement (EBMPA) have underpinned our relationships with the Traditional Owners of the land on which we operate. Like all other mining, any activity at the southern part of our lease would continue to adhere to the WCCCA.

Our Weipa bauxite mine is very important for the Rio Tinto Alcan business, and this project is vital for Weipa's and Rio Tinto Alcan's long term future.

If you have any questions about the project, and any of its impacts, please email infoEIS@riotintoalcan.com or telephone 1800 308 938.

I look forward to seeing this exciting project develop over coming years.

Rob Atkinson
General Manager Operations
Weipa



PROJECT FACTS

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Location	The main infrastructure area of the South of the Embley project is located near Boyd Point on the western Cape York Peninsula, approximately 45 km south of Weipa and 50 km north of Aurukun
Production	We estimate the mine would initially be capable of producing between 15 million and 30 million dry product tonnes per year. It would be capable of expansion to 50 million dry product tonnes per year in the future
Feasibility phase	1 to 2 years
CONSTRUCTION	
Duration	Construction could commence as early as 2010, and would take approximately 3 years
Employment	The Project construction workforce is estimated to be around 350
OPERATIONS	
Duration	The South of the Embley operations would have a mine life of approximately 40 years, depending on production rate
Employment	The current workforce would transition to the new location as existing mining areas as depleted
Mining type	Open cut mining using truck and loaders
Infrastructure	Port and ship loading facilities Beneficiation plant Diesel fuelled power station Barge / ferry facilities
Mining equipment	Loaders or excavators Rear dump truck fleet (number and size to be determined) Ancillary equipment
Markets	Rio Tinto Alcan Yarwun refinery, Queensland Alumina Limited and customers in China, Europe and North America

Mining bauxite

The first step in the production of aluminium is to mine the ore used to make aluminium, called bauxite. Bauxite is formed by the natural weathering of sedimentary rocks which contain a high proportion of aluminium bearing metals. It is named after the French district of Les Baux where it was first discovered in 1821. The most important use of bauxite is in the preparation of alumina for aluminium production.

The bauxite ore at Weipa is in the form of small, red pebbles, called pisolites, which average five millimetres in diameter. The bauxite is found in a layer three to four metres in thickness on average, beneath about half a metre of topsoil.

Mine planning is usually done five years in advance to allow for the development of haul roads and the preparation of the areas that are to be mined.

Samples of the bauxite are collected from a series of holes drilled by a drilling rig. Samples are analysed in our laboratory and the information gathered assists our mine planners decide where to mine.

Before mining vegetation is removed from the area and the topsoil is stripped and taken to an area awaiting revegetation. Front end loaders use a shallow, open cut technique to load the bauxite into trucks. The bauxite is relatively easy to dig and does not require blasting. The ore is taken to a dump station for transportation to the beneficiation plant.

The bauxite is screened and washed with water to remove fine particles at a beneficiation plant. It is then placed on stockpiles before being loaded onto ships.

What is an Environmental Impact Statement (EIS)?

An EIS is a document that describes the impacts of a proposed project. This includes assessing potential environmental, social and economic impacts. An EIS also provides a full description of the proposed project, and summarises public consultation undertaken during the preparation of the EIS. Information is included on plans to mitigate the impacts of the project.

The Queensland Government provides guidelines on how EIS should be undertaken, and requirements that should be met should the project proceed.

Health, safety, environment

Achieving and maintaining world class environment, health, safety and community standards is fundamental to the way Rio Tinto Alcan operates. Rio Tinto Alcan firmly believes all environmental and community incidents, injuries and occupational illnesses are preventable and are striving to eliminate them.

Rio Tinto Alcan's commitment to zero injuries, environmental and community incidents and occupational illnesses, and our approach is set out in our Health, Safety, Environment and Communities policy. It states "Our vision is to be the world's preferred aluminium supplier from mine to market. To create sustained value from our resources and relationships, we are committed to producing bauxite, alumina and aluminium in a way that is safe, environmentally responsible and respectful of local laws and customs. As a business we care about people and we care about the world in which we live".

Environmental Impact Statement

As part of feasibility studies for the South of the Embley project an Environmental Impact Statement (EIS) will be undertaken. Construction cannot begin until the EIS is approved by the Government. The studies involved in the EIS include:

- Flora and fauna
- Surface water and groundwater
- Marine ecology
- Soils and land use
- Air quality
- Noise
- Waste management
- Traffic and transport
- Cultural heritage
- Social and economic

Extensive community consultation will be included in the EIS, and there will be many opportunities for anyone who is interested in this project to provide input into the process.

The outcomes of the EIS will be used to optimise the design of the mine and the preparation of environmental management plans for construction and operation.

A full copy of the EIS will be available at www.riotinto.com/riotintoalcan when it is complete.

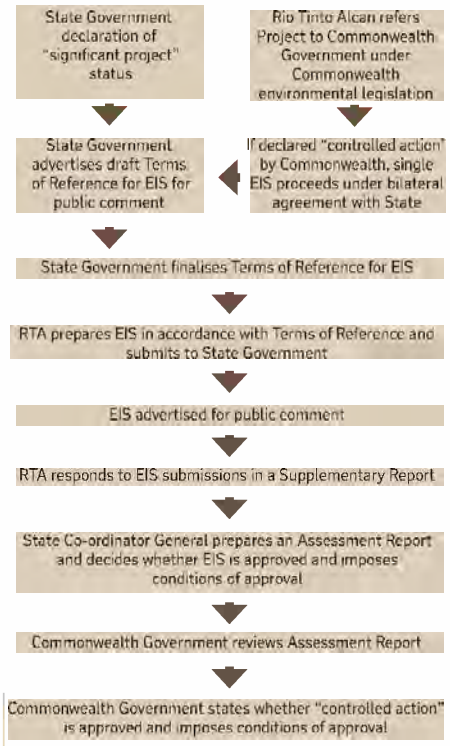
Environment

Throughout the design, construction and operation of the mine extension we will work hard to minimise impacts on the environment. An environmental management plan will guide all of our activities and respect for the environment will be central to our approach on this project.

The main environmental impacts of this project would be:

- Clearing of vegetation for activities associated with mining
- Development of dam sites for water supply
- Construction of a port facility near Boyd Point and associated dredging activities
- Construction of tailings dams to recycle water
- Construction of barge / ferry terminals at Evans Landing and Hey Point

EIS FLOWCHART - SOUTH OF EMBLEY PROJECT



Safety

At Rio Tinto Alcan we are committed to protecting our people from harm and seek to eliminate hazards, incidents and injuries from the workplace. Everyone's behaviour contributes to an injury and illness free workplace, set against the theme of "If it's not safe, don't do it that way".

Everyone involved with the South of the Embley project will be involved in our safety management programme, to achieve a goal of zero injuries. As it is with ongoing operations at Weipa, safety will be a core value at the South of the Embley project and we want to ensure all our employees return home safe and healthy at the end of each day.

Rio Tinto Alcan measures safety performance by tracking the number and severity of work injuries sustained. Safety statistics for the South of the Embley project will be made public each year, so the community can assess our performance.

Communities

The Weipa mine has developed very strong relationships with our neighbouring communities, contributing positively to the quality of life where we live and work, as well as promoting community growth and sustainability. It is important to Rio Tinto Alcan our local communities understand that as part of the EIS process, we will be looking closely at the impact our operations at the South of the Embley will have on them. Like all parts of the EIS, this will be made available for public comment.Activities over recent years have focused on contributing to social improvement and the economic conditions of our neighbouring community. We support a range of community initiatives including donations, training programmes, apprenticeships and scholarships.

These training programmes have provided many young people from the Western Cape with a positive start to their career, and there would be continued opportunities for training and skills development on the South of the Embley project.

The Western Cape Communities Co-Existence Agreement (WCCCA) was signed in 2001. The purpose of the agreement is to provide a comprehensive framework, which is legally binding, for Rio Tinto Alcan Weipa's relationships with the Traditional Owners, on whose land we operate, and facilitate ongoing operations.

The South of the Embley project would take place on an area covered by the WCCCA, however extensive consultation will occur throughout the feasibility study, EIS, as well as during construction and operations, to ensure the Traditional Owners fully understand and are involved in the activities that are taking place.

QUESTIONS

If you have any questions please phone freecall 1800 308 938.
or email infoEIS@riotintoalcan.com

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Environmental Impact Statement

for South of Embley Project

Section 18
Appendix

APPENDIX 18A

HSE MANAGEMENT SYSTEM OVERVIEW

Weipa | CLASSIC HSE Management System

Section 1 – HSE Management Procedures

HSE Management System Scope

This procedure provides a guide to the Health, Safety and Environment (HSE) Management System implemented at Rio Tinto Alcan Weipa.

Plan	1.01 Policy HSEC Policy
	1.02 Legal and Other Requirements HSE Obligations Register
	1.03 Hazard Identification and Risk Management Take 5, JSPs, Risk Register, SPs and SWs
	1.04 Improvement Planning HSE Improvement Plans – Site, MRU, Teams, Personal
Do	1.05 Organisational Resources and Accountabilities HSE Obligations Register, CLASSIC Appointments, Role Descriptions
	1.06 Training, Competency and Awareness Training needs analysis, training plans
	1.07 Supplier and Contractor Management Contractor management procedures
	1.08 Documentation and Document Control Requirements for ensuring HSE records and related data are maintained, accurate, current and where necessary secure
	1.09 Communication and Consultation HSE Committees, Team HSE Meetings, HSE Representatives, Innovations
	1.10 Operational Control Critical processes, plant and equipment
	1.11 Management of Change
	1.12 Disaster Management and Recovery DMR plan, training and scenario requirements, Emergency drills
Check	1.13 Measuring and Monitoring Health, Hygiene, Environmental and Safety monitoring and measuring.
	1.14 Non-Conformance Incident and Action Management Incidents, Actions, Banners
	1.15 Data and Records Management Requirements for data relating to 1.13
	1.16 Performance Assessment and Auditing Internal and external audits, Inspections – general requirements, Interactions.
Review	1.17 Management Review Methods used to review HSE performance

Section 2 - Safe Work

- 2.01 Isolation Procedure
- 2.03 Confined Space Entry Controls
- 2.04 Working at Heights
- 2.05 Control of Hot Work
- 2.06 Hazardous Substance Control
- 2.08 Control of Excavation
- 2.09 Mines Road Access
- 2.10 Accessing Electrical Equipment
- 2.11 Barricade Procedure
- 2.12 Scaffold Management
- 2.13 Working in the Vicinity of Overhead powerlines

Section 3 - Equipment

- 3.01 Motorised Equipment
- 3.02 Cranes and Lifting Equipment
- 3.03 Ladders, Working Platforms, Stairs and Walkways
- 3.04 Fire Protection Equipment
- 3.05 Pressure Vessels
- 3.06 Lighting
- 3.07 First Aid Equipment and Facilities
- 3.09 Machine Guarding
- 3.10 Work Environment
- 3.11 Electrical Work Systems
- 3.12 Tooling
- 3.13 Personal Protective Equipment
- 3.14 Fall Protection Equipment
- 3.15 HSE Guidelines for Purchase and Hire of Plant, Equipment and Services

Section 4 - Environment

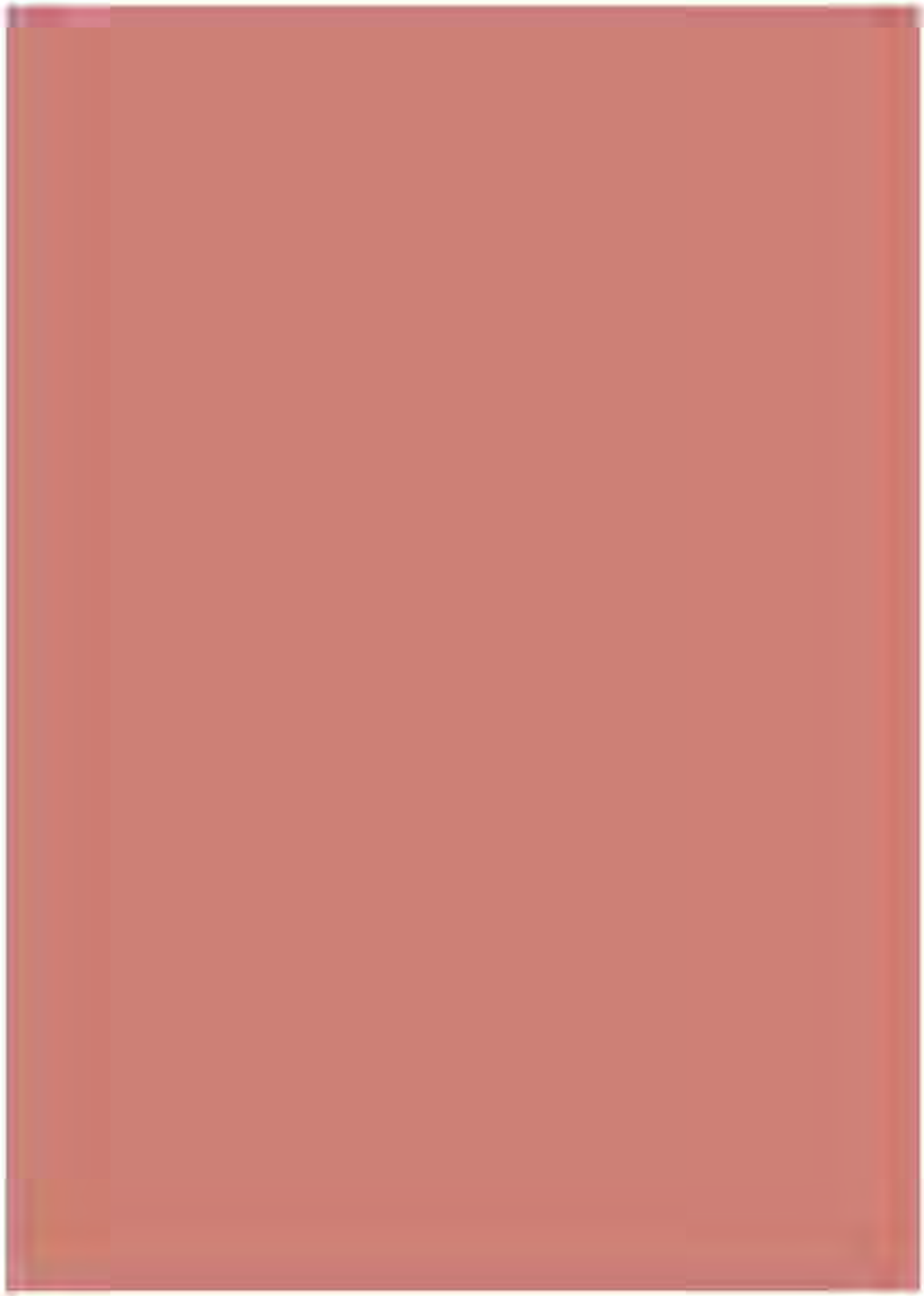
Under Development

Section 5 – Health and Hygiene

- 5.01 Particulate and Gas
- 5.02 Noise Management and Hearing Conservation
- 5.03 Manual Handling and Vibration
- 5.04 Radiation Management
- 5.05 Thermal Stress
- 5.06 Travel and Remote Site Health
- 5.07 Health Surveillance and Medicals

Environmental Impact Statement for South of Embley Project

Section 19 Appendix



APPENDIX 19A

PRELIMINARY PROJECT
HEALTH SAFETY AND ENVIRONMENT RISK REGISTER

Category	Hazard	Phase	Scenario Description	Relevant EIS Section describing Impacts and Mitigation Measures	Consequence	Likelihood	Risk classification
Environment	Biological	All	Sewage sludge from STP incorrectly disposed causing water/soil contamination (able to be remediated).	13 Waste	2-Medium	D-Unlikely	Low
Environment	Biological	All	Inefficient operation of the STP causing surface or groundwater contamination (able to be remediated).	13 Waste	3-Serious	C-Possible	High
Environment	Biological	All	Spread of significant weeds from mobile equipment.	7 Terrestrial Flora & Fauna	3-Serious	C-Possible	High
Environment	Biological	All	Introduction of marine pest species through inadequate ballast water management.	13 Waste	3-Serious	D-Unlikely	Moderate
Environment	Climatic/Natural Events	All	Cyclone causing environmental damage (e.g. hazardous substances spill, erosion, damage to rehabilitation).	19 Hazard and Risk	2-Medium	C-Possible	Moderate
	Climatic/Natural Events	All	Uncontrolled bushfire burns immature rehabilitation.	19 Hazard and Risk	3-Serious	D-Unlikely	Moderate
Environment	Land Use	All	Delays in scheduling of progressive rehabilitation causing impact to flora/fauna establishment.	3 Land	3-Serious	D-Unlikely	Moderate
Environment	Land Use	All	Poor soil handling techniques resulting in reduced soil quality for rehabilitation.	3 Land	3-Serious	D-Unlikely	Moderate
Environment	Land Use	All	Unauthorised disturbance of native vegetation, habitat or cultural heritage site.	7 Terrestrial Flora & Fauna 18 Social Impact Assessment	4-Major	D-Unlikely	High
Environment	Lighting	All	Port lighting disorienting marine turtles.	6 Marine	3-Serious	C-Possible	High
Environment	Sound/Vibration	All	Production of noise from mining activities cause community concern.	10 Noise	2-Medium	D-Unlikely	Low
Environment	Sound/Vibration	All	Noise generated from mining activities disturb fauna/breeding habitats or migratory species.	10 Noise	3-Serious	D-Unlikely	Moderate
Environment	Sound/Vibration	Construction	Underwater noise generated by piling causing impact to marine fauna.	10 Noise	3-Serious	D-Unlikely	Moderate
Environment	Substances	All	Ineffective operation of oily water separators causing hydrocarbon spill (able to be remediated).	13 Waste	2-Medium	C-Possible	Moderate
Environment	Substances	Operational	Contamination of water as a result of seepage from tailings dams (recoverable).	13 Waste	1-Minor	C-Possible	Low
Environment	Substances	Operational	Bauxite spill from the shiploader.	14 Traffic & Transport	2-Medium	C-Possible	Moderate
Environment	Substances	All	Discharge of hydrocarbons into the Hey or Embley River from fuel transfers causing contamination to land/water or impact to flora/fauna (able to be contained by booms and remediated).	19 Hazard and Risk	3-Serious	D-Unlikely	Moderate
Environment	Substances	All	Spill of hydrocarbons during use, storage or transfer on site causing contamination to land/water (able to be remediated).	19 Hazard and Risk	2-Medium	C-Possible	Moderate
Environment	Substances	Construction	Dredging and spoil disposal causing impact to marine or estuarine environment.	6 Marine	3-Serious	C-Possible	High
Environment	Substances	All	Suspended sediment or hydocarbons in runoff water from hardstand areas, roads, washdown bays, tailings dams or process water entering natural waterways (recoverable).	6 Marine 8 Freshwater Aquatic Ecology	2-Medium	C-Possible	Moderate
Environment	Substances	Operational	Air pollution caused by breakdown in generating unit exhaust system (on site impact only due distance to sensitive receptors).	9 Air Quality	2-Medium	D-Unlikely	Low
Environment	Substances	Operational	Dust emissions generated from mining or shiploading activities impact flora and fauna (recoverable).	9 Air Quality	2-Medium	D-Unlikely	Low
Environment	Vehicles and transport	All	Threatened species (i.e. cetacean, turtle, dugong) struck by bulk carrier, barge, ferry or other boat operated by RTA	6 Marine	3-Serious	D-Unlikely	Moderate
Environment	Waste	Operational	Tailings pipeline ruptures causing spill of tailings to land (able to be remediated).	13 Waste	2-Medium	C-Possible	Moderate
Environment	Waste	Operational	Overflow of tailings dam as a result of a major storm (able to be remediated/recoverable).	13 Waste	3-Serious	E-Rare	Moderate
Environment	Waste	All	Incorrect reuse or segregation of recyclables resulting in increased volumes of waste to landfill.	13 Waste	1-Minor	D-Unlikely	Low
Environment	Waste	All	Incorrect segregation of hazardous waste.	13 Waste	2-Medium	C-Possible	Moderate
Environment	Biological	All	Failure of water storage dam causes downstream physical damage to flora/fauna (recoverable).	5 Water	3-Serious	E-Rare	Moderate
Health	Biological	All	Medical staff exposed infectious disease from bodily fluids whilst treating a patient.	18 Health & Safety	3-Serious	E-Rare	Moderate
Health	Biological	All	Exposure to bacterial or infectious disease while working on / near sewage treatment facilities.	18 Health & Safety	3-Serious	E-Rare	Moderate
Health	Biological	All	Sting or bite from insect, spider, snake, dingo or crocodile.	18 Health & Safety	3-Serious	D-Unlikely	Moderate
Health	Biological	All	Inhalation of aerosols contaminated with legionella.	18 Health & Safety	3-Serious	E-Rare	Moderate
Health	Biological	Construction	Illness caused by bacteria in food.	18 Health & Safety	2-Medium	C-Possible	Moderate
Health	Biological	All	Illness caused by potable water not meeting drinking water criteria.	18 Health & Safety	2-Medium	D-Unlikely	Low
Health	Climatic/Natural Events	All	Exposure to smoke and fumes as a result of fire or gas leak.	18 Health & Safety	3-Serious	D-Unlikely	Moderate
Health	Electrical/Magnetic	All	Exposure to electromagnetic fields.	18 Health & Safety	2-Medium	E-Rare	Low
Health	Ergonomics	All	Manual tasks requiring force, repetition and/or awkward postures.	18 Health & Safety	3-Serious	D-Unlikely	Moderate
Health	Personal/Behavioural	All	Workplace stress or fatigue from abnormal long work hours.	18 Health & Safety	3-Serious	D-Unlikely	Moderate
Health	Radiation	All	Incorrect use and exposure to radiation density gauges.	18 Health & Safety	3-Serious	E-Rare	Moderate
Health	Radiation	All	Over-exposure to the ultraviolet radiation.	18 Health & Safety	3-Serious	C-Possible	High
Health	Sound/Vibration	All	Personal noise exposure associated with performing or working near noisy tasks.	18 Health & Safety	3-Serious	D-Unlikely	Moderate
Health	Sound/Vibration	All	Exposure to vibration when using hand tools or operating heavy equipment.	18 Health & Safety	2-Medium	C-Possible	Moderate
Health	Substances	All	Dust emissions generated from mining and shiploading activities reducing air quality at sensitive receptors.	9 Air Quality	2-Medium	D-Unlikely	Low
Health	Substances	Construction	Dust emissions generated from construction activities reducing air quality at sensitive receptors.	9 Air Quality	2-Medium	D-Unlikely	Low
Health	Substances	All	Exposure to diesel particulate (DPM) when operating or working in the vicinity of heavy equipment.	18 Health & Safety	3-Serious	D-Unlikely	Moderate
Health	Substances	All	Inhalation of dust.	18 Health & Safety	2-Medium	D-Unlikely	Low
Health	Substances	All	Inhalation of respirable dust containing crystalline silica.	18 Health & Safety	3-Serious	D-Unlikely	Moderate
Health	Substances	All	Inhalation of fumes (eg: welding).	18 Health & Safety	3-Serious	D-Unlikely	Moderate
Health	Thermal/Fire/Explosion	All	Exposure to heat.	18 Health & Safety	2-Medium	C-Possible	Moderate
Safety	Climatic/Natural Events	All	Emergency Condition (e.g. cyclones).	19 Hazard and Risk	3-Serious	D-Unlikely	Moderate
Safety	Electrical/Magnetic	All	Electric shock as a result of contact with electrical energy.	18 Health & Safety	3-Serious	D-Unlikely	Moderate
Safety	Electrical/Magnetic	All	Welding activities resulting in electric shock or eye injury.	18 Health & Safety	3-Serious	D-Unlikely	Moderate
Safety	Electrical/Magnetic	All	Low voltage electric shock received during general operational duties.	18 Health & Safety	2-Medium	C-Possible	Moderate
Safety	Gravity	All	Aircraft crash.	14 Traffic & Transport	4-Major	E-Rare	High
Safety	Gravity	All	Fall from height.	18 Health & Safety	3-Serious	D-Unlikely	Moderate
Safety	Gravity	All	Injury caused by failure of lifting equipment, collapse or shifting load supported on stands or storage racks. Person struck by object in the red zone of suspended load.	18 Health & Safety	3-Serious	D-Unlikely	Moderate
Safety	Gravity	All	Tools / equipment dropped from plant and conveyor walkways during maintenance activities, collapse of structure, engulfment by bauxite falling from above, or collapse of excavation trench.	18 Health & Safety	3-Serious	D-Unlikely	Moderate
Safety	Mechanical	All	Injury from chain saw during tree lopping operations.	18 Health & Safety	3-Serious	D-Unlikely	Moderate
Safety	Mechanical	All	Contact with energised rotating equipment.	18 Health & Safety	3-Serious	D-Unlikely	Moderate

Category	Aspect	Phase	Aspect Description	Relevant EIS Section (Impact and Mitigation Measure)	Consequence	Likelihood	Risk Classification
Safety	Personal/Behavioural	All	Unauthorised access to operational area resulting in harm to member of public	18 Health & Safety	4-Major	D-Unlikely	High
Safety	Personal/Behavioural	All	Unauthorised access to operational area resulting in injury to worker or property damage	18 Health & Safety	2-Medium	C-Possible	Moderate
Safety	Pressure	All	Aggressive release of pressurised fluid/gas	18 Health & Safety	3-Serious	D-Unlikely	Moderate
Safety	Pressure	All	Personnel struck by lines during towing or berthing	18 Health & Safety	4-Major	D-Unlikely	High
Safety	Substances	All	Battery acid spill	18 Health & Safety	2-Medium	C-Possible	Moderate
Safety	Thermal/Fire/Explosion	All	Burns received as a result of conducting routine maintenance on fixed and mobile equipment	18 Health & Safety	2-Medium	C-Possible	Moderate
Safety	Thermal/Fire/Explosion	All	Explosions of oxy/acetylene equipment	18 Health & Safety	2-Medium	C-Possible	Moderate
Safety	Thermal/Fire/Explosion	All	Major facility fire or explosion	18 Health & Safety	4-Major	D-Unlikely	High
Safety	Thermal/Fire/Explosion	All	Burns caused by electrical, oil, fuel and tyre fires	18 Health & Safety	2-Medium	C-Possible	Moderate
Safety	Vehicles & Transport	All	Vessel collision with another object (including wharf and other vessels)	14 Traffic & Transport	3-Serious	D-Unlikely	Moderate
Safety	Vehicles & Transport	All	Capsize of barge, ferry or other boat	14 Traffic & Transport	3-Serious	D-Unlikely	Moderate
Safety	Vehicles & Transport	All	Mobile equipment collisions or accidents (public access roads)	14 Traffic & Transport	3-Serious	C-Possible	High
Safety	Vehicles & Transport	All	Mobile equipment collisions or accidents (mine roads)	18 Health & Safety	3-Serious	C-Possible	High
Safety	Vehicles & Transport	All	Pedestrian struck by uncontrolled movement of mine equipment	18 Health & Safety	4-Major	D-Unlikely	High
Safety	Vehicles & Transport	All	Trees/branches causing injury to equipment operators during clearing	18 Health & Safety	2-Medium	C-Possible	Moderate
Safety	Vehicles & Transport	All	Collisions between stacker / shiploader and pedestrians/vehicles	18 Health & Safety	3-Serious	D-Unlikely	Moderate
Safety	Work Environment	All	Person exposed to low-oxygen environment as a result of incorrect Confined Space entry	18 Health & Safety	3-Serious	D-Unlikely	Moderate
Safety	Work Environment	All	Slips, Trips or falls caused by uneven surfaces or poor lighting	18 Health & Safety	2-Medium	C-Possible	Moderate
Safety	Work Environment	All	Visitor/worker injured in unfamiliar work environment	18 Health & Safety	2-Medium	C-Possible	Moderate
Safety	Work Environment	All	Delayed access to medical assistance due to limited communication or access when working in isolated/remote area	18 Health & Safety	2-Medium	C-Possible	Moderate
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Environmental Impact Statement

for South of Embley Project

Section 19
Appendix

APPENDIX 19A

PRELIMINARY PROJECT
HEALTH SAFETY AND ENVIRONMENT RISK REGISTER

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	Climatic/Natural Events	All	Uncontrolled bushfire burns immature rehabilitation.	19 Hazard and Risk	3-Serious	D-Unlikely	Moderate
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Environment	Land Use	All	Poor soil handling techniques resulting in reduced soil quality for rehabilitation.	3 Land	3-Serious	D-Unlikely	Moderate
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Environment	Lighting	All	Port lighting disorienting marine turtles.	6 Marine	3-Serious	C-Possible	High
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Environment	Sound/Vibration	Construction	Underwater noise generated by piling causing impact to marine fauna.	10 Noise	3-Serious	D-Unlikely	Moderate
Environment	Substances	All	Ineffective operation of oily water separators causing hydrocarbon spill (able to be remediated).	13 Waste	2-Medium	C-Possible	Moderate
Environment	Substances	Operational	Contamination of water as a result of seepage from tailings dams (recoverable).	13 Waste	1-Minor	C-Possible	Low
Environment	Substances	Operational	Bauxite spill from the shiploader.	14 Traffic & Transport	2-Medium	C-Possible	Moderate
Environment	Substances	All	Discharge of hydrocarbons into the Hey or Embley River from fuel transfers causing contamination to land/water or impact to flora/fauna (able to be contained by booms and remediated).	19 Hazard and Risk	3-Serious	D-Unlikely	Moderate
Environment	Substances	All	Spill of hydrocarbons during use, storage or transfer on site causing contamination to land/water (able to be remediated).	19 Hazard and Risk	2-Medium	C-Possible	Moderate
Environment	Substances	Construction	Dredging and spoil disposal causing impact to marine or estuarine environment.	6 Marine	3-Serious	C-Possible	High
Environment	Substances	All	Suspended sediment or hydocarbons in runoff water from hardstand areas, roads, washdown bays, tailings dams or process water entering natural waterways (recoverable).	6 Marine 8 Freshwater Aquatic Ecology	2-Medium	C-Possible	Moderate
Environment	Substances	Operational	Air pollution caused by breakdown in generating unit exhaust system (on site impact only due distance to sensitive receptors).	9 Air Quality	2-Medium	D-Unlikely	Low
Environment	Substances	Operational	Dust emissions generated from mining or shiploading activities impact flora and fauna (recoverable).	9 Air Quality	2-Medium	D-Unlikely	Low
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Environment	Waste	All	Incorrect reuse or segregation of recyclables resulting in increased volumes of waste to landfill.	13 Waste	1-Minor	D-Unlikely	Low
Environment	Waste	All	Incorrect segregation of hazardous waste.	13 Waste	2-Medium	C-Possible	Moderate
Environment	Biological	All	Failure of water storage dam causes downstream physical damage to flora/fauna (recoverable).	5 Water	3-Serious	E-Rare	Moderate
Health	Biological	All	Medical staff exposed infectious disease from bodily fluids whilst treating a patient.	18 Health & Safety	3-Serious	E-Rare	Moderate
Health	Biological	All	Exposure to bacterial or infectious disease while working on / near sewage treatment facilities.	18 Health & Safety	3-Serious	E-Rare	Moderate
Health	Biological	All	Sting or bite from insect, spider, snake, dingo or crocodile.	18 Health & Safety	3-Serious	D-Unlikely	Moderate
Health	Biological	All	Inhalation of aerosols contaminated with legionella.	18 Health & Safety	3-Serious	E-Rare	Moderate
Health	Biological	Construction	Illness caused by bacteria in food.	18 Health & Safety	2-Medium	C-Possible	Moderate
Health	Biological	All	Illness caused by potable water not meeting drinking water criteria.	18 Health & Safety	2-Medium	D-Unlikely	Low
Health	Climatic/Natural Events	All	Exposure to smoke and fumes as a result of fire or gas leak.	18 Health & Safety	3-Serious	D-Unlikely	Moderate
Health	Electrical/Magnetic	All	Exposure to electromagnetic fields.	18 Health & Safety	2-Medium	E-Rare	Low
Health	Ergonomics	All	Manual tasks requiring force, repetition and/or awkward postures.	18 Health & Safety	3-Serious	D-Unlikely	Moderate
Health	Personal/Behavioural	All	Workplace stress or fatigue from abnormal long work hours.	18 Health & Safety	3-Serious	D-Unlikely	Moderate
Health	Radiation	All	Incorrect use and exposure to radiation density gauges.	18 Health & Safety	3-Serious	E-Rare	Moderate
Health	Radiation	All	Over-exposure to the ultraviolet radiation.	18 Health & Safety	3-Serious	C-Possible	High
Health	Sound/Vibration	All	Personal noise exposure associated with performing or working near noisy tasks.	18 Health & Safety	3-Serious	D-Unlikely	Moderate
Health	Sound/Vibration	All	Exposure to vibration when using hand tools or operating heavy equipment.	18 Health & Safety	2-Medium	C-Possible	Moderate
Health	Substances	All	Dust emissions generated from mining and shiploading activities reducing air quality at sensitive receptors.	9 Air Quality	2-Medium	D-Unlikely	Low
Health	Substances	Construction	Dust emissions generated from construction activities reducing air quality at sensitive receptors.	9 Air Quality	2-Medium	D-Unlikely	Low
Health	Substances	All	Exposure to diesel particulate (DPM) when operating or working in the vicinity of heavy equipment.	18 Health & Safety	3-Serious	D-Unlikely	Moderate
Health	Substances	All	Inhalation of dust.	18 Health & Safety	2-Medium	D-Unlikely	Low
Health	Substances	All	Inhalation of respirable dust containing crystalline silica.	18 Health & Safety	3-Serious	D-Unlikely	Moderate
Health	Substances	All	Inhalation of fumes (eg: welding).	18 Health & Safety	3-Serious	D-Unlikely	Moderate
Health	Thermal/Fire/Explosion	All	Exposure to heat.	18 Health & Safety	2-Medium	C-Possible	Moderate
Safety	Climatic/Natural Events	All	Emergency Condition (e.g. cyclones).	19 Hazard and Risk	3-Serious	D-Unlikely	Moderate
Safety	Electrical/Magnetic	All	Electric shock as a result of contact with electrical energy.	18 Health & Safety	3-Serious	D-Unlikely	Moderate
Safety	Electrical/Magnetic	All	Welding activities resulting in electric shock or eye injury.	18 Health & Safety	3-Serious	D-Unlikely	Moderate
Safety	Electrical/Magnetic	All	Low voltage electric shock received during general operational duties.	18 Health & Safety	2-Medium	C-Possible	Moderate
Safety	Gravity	All	Aircraft crash.	14 Traffic & Transport	4-Major	E-Rare	High
Safety	Gravity	All	Fall from height.	18 Health & Safety	3-Serious	D-Unlikely	Moderate
Safety	Gravity	All	Injury caused by failure of lifting equipment, collapse or shifting load supported on stands or storage racks. Person struck by object in the red zone of suspended load.	18 Health & Safety	3-Serious	D-Unlikely	Moderate
Safety	Gravity	All	Tools / equipment dropped from plant and conveyor walkways during maintenance activities, collapse of structure, engulfment by bauxite falling from above, or collapse of excavation trench.	18 Health & Safety	3-Serious	D-Unlikely	Moderate
Safety	Mechanical	All	Injury from chain saw during tree lopping operations.	18 Health & Safety	3-Serious	D-Unlikely	Moderate
Safety	Mechanical	All	Contact with energised rotating equipment.	18 Health & Safety	3-Serious	D-Unlikely	Moderate

Category	Aspect	Phase	Aspect Description	Relevant EIS Section (Impact and Mitigation Measure)	Consequence	Likelihood	Risk Classification
Safety	Personal/Behavioural	All	Unauthorised access to operational area resulting in harm to member of public	18 Health & Safety	4-Major	D-Unlikely	High
Safety	Personal/Behavioural	All	Unauthorised access to operational area resulting in injury to worker or property damage	18 Health & Safety	2-Medium	C-Possible	Moderate
Safety	Pressure	All	Aggressive release of pressurised fluid/gas	18 Health & Safety	3-Serious	D-Unlikely	Moderate
Safety	Pressure	All	Personnel struck by lines during towing or berthing	18 Health & Safety	4-Major	D-Unlikely	High
Safety	Substances	All	Battery acid spill	18 Health & Safety	2-Medium	C-Possible	Moderate
Safety	Thermal/Fire/Explosion	All	Burns received as a result of conducting routine maintenance on fixed and mobile equipment	18 Health & Safety	2-Medium	C-Possible	Moderate
Safety	Thermal/Fire/Explosion	All	Explosions of oxy/acetylene equipment	18 Health & Safety	2-Medium	C-Possible	Moderate
Safety	Thermal/Fire/Explosion	All	Major facility fire or explosion	18 Health & Safety	4-Major	D-Unlikely	High
Safety	Thermal/Fire/Explosion	All	Burns caused by electrical, oil, fuel and tyre fires	18 Health & Safety	2-Medium	C-Possible	Moderate
Safety	Vehicles & Transport	All	Vessel collision with another object (including wharf and other vessels)	14 Traffic & Transport	3-Serious	D-Unlikely	Moderate
Safety	Vehicles & Transport	All	Capsize of barge, ferry or other boat	14 Traffic & Transport	3-Serious	D-Unlikely	Moderate
Safety	Vehicles & Transport	All	Mobile equipment collisions or accidents (public access roads)	14 Traffic & Transport	3-Serious	C-Possible	High
Safety	Vehicles & Transport	All	Mobile equipment collisions or accidents (mine roads)	18 Health & Safety	3-Serious	C-Possible	High
Safety	Vehicles & Transport	All	Pedestrian struck by uncontrolled movement of mine equipment	18 Health & Safety	4-Major	D-Unlikely	High
Safety	Vehicles & Transport	All	Trees/branches causing injury to equipment operators during clearing	18 Health & Safety	2-Medium	C-Possible	Moderate
Safety	Vehicles & Transport	All	Collisions between stacker / shiploader and pedestrians/vehicles	18 Health & Safety	3-Serious	D-Unlikely	Moderate
Safety	Work Environment	All	Person exposed to low-oxygen environment as a result of incorrect Confined Space entry	18 Health & Safety	3-Serious	D-Unlikely	Moderate
Safety	Work Environment	All	Slips, Trips or falls caused by uneven surfaces or poor lighting	18 Health & Safety	2-Medium	C-Possible	Moderate
Safety	Work Environment	All	Visitor/worker injured in unfamiliar work environment	18 Health & Safety	2-Medium	C-Possible	Moderate
Safety	Work Environment	All	Delayed access to medical assistance due to limited communication or access when working in isolated/remote area	18 Health & Safety	2-Medium	C-Possible	Moderate
					Note: Risk Classification is based on Rio Tinto Risk Guideline and assumes proposed controls have been implemented		

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Environmental Impact Statement

for South of Embley Project

Definitions, abbreviations and units

Definitions

Term	Definition
a-Net Acidity	The result obtained when the values for various components of soil acidity and acid neutralising capacity are substituted into the Acid Base Accounting equation. Calculated as: Net Acidity = Potential sulfidic acidity + Existing Acidity – (Acid Neutralising Capacity/Fineness Factor) Expressed in equivalent acid neutralising units (mol H+/ t).
A-weighted	The measurement of sound pressure level in which the amplitude of the sound signal is negatively weighted in frequencies below 1,000Hz in accordance with a weighing scale known as the 'A' weighing scale. This scale was established to closely simulate human perception of the relative level of pure tone sounds.
Acid neutralising capacity (ANC)	Measurement of a soil's ability to neutralize or buffer added acid.
Aerobic	Having or providing oxygen.
Aestivate	To be dormant, often buried within the soil or under leaf litter, during months of drought.
Aggradation	The build-up of sediment or some other substance.
Aggregate	Washed gravel with a near uniform particle size. Added to cement to make concrete.
Algal mat	A thin layer of algae formed over the surface of the benthos.
Alluvial	Sediments deposited by flowing water. Relating to material deposited by, or in transit in, flowing water.
Alumina	Mined bauxite is refined into alumina (which is smelted into aluminium).
Aluminium	Mined bauxite is refined into alumina, and alumina is smelted into aluminium.
Ambient	Surrounding or background.
Ambient noise	The sum of the noise from all sources, near and far, in a given environment.
Anabat	The AnaBat is bat detector which monitors the ultrasonic echolocation calls of bats for species identification and activity measurement.
Anaerobic	Having or producing no oxygen.
Analysis of variance (ANOVA)	A statistical method for making simultaneous comparisons between two or more means. A statistical method that yields values that can be tested to determine whether a significant relation exists between variables.
Annual exceedance probability (AEP)	The likelihood that an event of a nominated size or larger will occur in any one year.
Annual return	The sending or receiving of yearly documents, for the purposes of the EP Act.
anoxic	Relating to a metabolic state where there is no free oxygen, but molecularly bound oxygen is still available. Commonly characterised as measuring less than 2mg/L of dissolved oxygen.
Anthropogenic	Caused by humans or human activity.
Aquifer	Rock or sediment in a formation, group of formations or part of a formation that is saturated and sufficiently permeable to transmit economic quantities of water to wells and springs.
(Confined) Aquifer	An aquifer that is overlain by a confining bed. The confining bed has a significantly lower hydraulic conductivity than the aquifer.

Term	Definition
(Unconfined) Aquifer	An aquifer in which there are no confining beds between the zone of saturation and the surface. There will be a water table in an unconfined aquifer.
Arboreal	Living or spending the majority of it's time in the trees.
Artesian aquifer	A confined aquifer whose water is pressurized.
Assemblage	The set of species occurring in a particular area without regard to their ecological interactions.
Australian Height Datum (AHD)	A level datum, uniform throughout Australia, based on an origin determined from observations of mean sea level at tide gauge stations, located at more than 30 points along the Australian coastline.
Autotrophic	Organisms that undergo photosynthesis, ie primary producers.
Average Minimum Background Noise Level	Assessed as the background noise level per standard time interval that was exceeded for ninety per cent of the interval, defined in AS 1055 as the rating background noise level.
Average recurrence interval (ARI)	The average or expected value of the period between exceedances of a given variable.
Avifauna	The birds of a particular region or period.
Background noise	The noise ordinarily present and continuous at a given location, excluding extraneous noise and the noise source of interest. Commonly measured using the statistical parameter, L_{A90}, the A-weighted noise level that was exceeded for ninety per cent of the monitoring period.
"Bank full" flow	The channel flow rate that exists when the water surface is level with the channel bank elevation above which the water would spill out of the channel or begin to enter the floodplain.
Baseflow	The stream flow rate that cannot be directly attributed to storm events. The flow rate is usually not constant, but varies with groundwater levels and long-term weather conditions.
Baseflow index (BFI)	The amount of runoff that becomes baseflow.
Bathymetry	Water depths or sea bed contours.
Beneficiation	The processing of crude bauxite to produce product grade bauxite – a process where oversized particles are removed by screening and fine particles are removed by washing.
Benthic	Associated with the bottom of a water body.
Benthos	The sediment at the bottom of a waterway.
Bilateral Agreement	The Agreement made under section 45 of the EPBC Act between the Commonwealth and the State of Queensland dated 11 August 2009, which provides (among other things) for the accreditation of certain Queensland EIS processes to ensure an integrated and coordinated approach for actions requiring approval from both the Commonwealth and the State of Queensland.
Bioavailability	The extent to which a compound is available for intake by organisms. A measure of how available a toxic pollutant is to the biological processes of an organism.
Biodegradation	Breakdown of substances by micro-organisms, particularly bacteria and fungi.
Biomass	Quantity of living organic matter.
Bioregion	Region where the floral or faunal communities are similar.
Biota	All of the organisms, including animals, plants, fungi, and microorganisms, found in a given area.
Borrow pit	An excavation providing earth to be used as a construction material.

Term	Definition
Box culvert	A culvert of rectangular cross-section.
Brackish	Relating to a slightly salty content.
Bulkuru wetland	Bulkuru is the common name for the sedge *Eleocharis dulcis*, also known as "spike-rush". Bulkuru wetlands are coastal grass-sedge wetlands, under moderate or low saline influence, containing *Eleocharis dulcis.*
Bund	An embankment constructed around an area to prevent the inflow or outflow of liquids. Also called Bunding.
Calcination	The chemical process of converting calcium carbonate (lime) to calcium oxide and carbon dioxide though application of heat.
CALMET	CALMET is a meteorological pre-processor that can provide the meteorological inputs required to run numerous dispersion models including ISC3. CALMET produces fields of wind components, air temperature, relative humidity, mixing height and other micro-meteorological variables.
Carbonate	A group of oxide minerals comprising mainly carbon and oxygen. Often composed of the skeletal remains of marine or freshwater organisms.
Carcinogenicity	The state of being carcinogenic - any substance that is an agent directly involved in the exacerbation of cancer or in the increase of its propagation.
Catchment	A water intake area or all parts of a drainage basin.
Cation Exchange Capacity (CEC)	The total amount of exchangeable cations that a soil can absorb. Cations are positive ions such as calcium, magnesium, potassium, sodium, hydrogen, aluminium and manganese, these being the most important ones found in soils. Cation exchange is the process whereby these ions interchange between the soil solution and the clay or organic matter complexes in the soil. The process is very important as it has a major controlling effect on soil properties and behaviour, stability of soil structure, the nutrients available for plant growth, soil pH, and the soil's reaction to fertilisers and other ameliorants added to the soil.
Cauliflorous	Borne on the trunk; applied especially to tropical trees in which flower shoots grow from the main trunk.
Causeway	A raised carriageway constructed across a watercourse where the culvert has a rectangular cross-section.
Channelisation	The formation of deeper channels within a waterway.
Charophyte algae	The group of green algae that are most closely related to land plants.
Chlorophyll-a	A photosynthetic pigment found in most algae. Concentrations of chlorophyll-a in a water sample provide a good estimate of abundance of algae.
Collar	A collar is put down a drill hole to stop the walls from caving in.
Colloidal	Atoms or molecules dispersed in a gas, liquid or solid, which resist sedimentation (setting to the bottom).
Colluvial	Material mostly transported by gravity.
CONCAWE	Method of noise modelling and is the only method dealing explicitly with the influence of wind and the stability of the atmosphere using Pasquill stability categories.
Conglomerate	Sedimentary rock consisting of poorly sorted grains (typically pebbles surrounded by finer materials, such as sand or silt).
Consolidate	The process or processes by which loose soft or liquid earth materials (e.g. sand) become firm and coherent (e.g. sandstone).
Crib	A mining term for a meal eaten at work.
Critical bed-shear stress	The minimum amount of shear stress exerted by currents required to initiate particle motion.

Term	Definition
Deadweight tonnage (dwt)	A measure of how much weight a ship is carrying or can safely carry - the sum of the weights of cargo, fuel, fresh water, ballast water, provisions, passengers, and crew.
Decibel (dB)	The unit of sound measurement.
Decibel (dB)(Linear)	A linear scale that treats all audible frequencies as having equal value. Whereas the "A-weighting filter," which is an approximation of loudness, is used to correct the sound pressure levels to more accurately reflect what the human ear perceives.
Delft3D	A 2D/3D modelling system used to investigate hydrodynamics, sediment transport and morphology and water quality for fluvial, estuarine and coastal environments.
Demersal	Living on the sea floor or just above it.
Desiccation	Drying out due to the effects of the environment.
Directory of Important Wetlands (DIWA)	The Directory identifies and provides information on the values of nationally important wetlands across Australia.
Dissolved Oxygen (DO)	The amount of oxygen dissolved in water.
Drainage pattern	The pattern formed by drainage lines, gullies, streams and rivers.
Draw down	A lowering of the water table of an unconfined aquifer or the potentiometric surface of a confined aquifer caused by pumping of the groundwater from wells.
Easement	A right held by the Proponent to make use of the land of another, for example, for the installation and operation of a pipeline. Also referred to as a right of way.
Ebb tide	The period between high tide and the next low tide in which the sea is receding.
Ecological Sustainable Development (ESD)	Development that improves the quality of life in a way that maintains the ecological processes on which life depends.
Ecotone	The transitional zone between two vegetation types (ecosystems).
Ecotoxicological	Toxic effects, caused by natural or synthetic pollutants, to the constituents of ecosystems.
El Niño	El Niño-Southern Oscillation (ENSO) is often called just "El Niño", and is a quasi periodic climate pattern that occurs across the tropical Pacific with a roughlyfive year cycle. ENSO is associated with floods, droughts and other weather disturbances in many regions of the world, which vary with each event.
Electrical Conductivity	A measure of the conduction of electricity through water or a water extract of soil. An indicator of soil salinity.
Elutriate	Elutriate testing is a bench-scale test designed to simulate and predict the water quality impacts from dredging or dredged material disposal. Elutriate testing simulates the potential transfer of chemicals from the dredged sediments into the water column during dredging or in-water disposal operations. A volume of sediment is vigorously mixed with a larger volume of water. The solids are allowed to settle out and the resulting water is then chemically analysed.
EM Plan	Environmental Management Plan (as per EP Act)
Energy Efficiency Opportunities program (EEO)	The Australian Government's Energy Efficiency Opportunities program encourages large energy-using businesses to improve their energy efficiency by requiring businesses to identify, evaluate and report publicly on cost effective energy savings opportunities
Environmental authority	Licence or Approval issued under the EP Act to conduct specified 'Environmentally Relevant Activities'.
Environmental flow	Freshwater flow that is maintained solely for environmental reasons.
Environmentally Relevant Activities	Activities listed under Environmental Protection regulation that require an environmental authority.

Term	Definition
Ephemeral	A stream that flows briefly only in direct response to precipitation in the immediate locality and the channel of which at all times remains above the water table.
Epibenthic	Occurring on, but not penetrating, the surface of the ocean floor.
Estuary	That part of the mouth or lower reach of a river in which it's current meets the sea's tides, and is subject to their effects.
Equivalent persons	Unit of measurement used to determine the demand for sewerage reticulation services.
Euryhaline	Tolerant of a wide range of water salinities.
Eutrophic	A body of water impacted by high nutrients.
Eutrophication	The process by which water bodies, such as lakes, estuaries, or slow-moving streams receive excess nutrients that stimulate excessive plant growth. This enhanced plant growth, reduces dissolved oxygen in the water when dead plant material decomposes and can cause other organisms to die.
Excess Acid Neutralising Capacity (ANCE)	Suspension Peroxide Oxidation Combined Acidity and Sulphate HCl- titration to pH 4, minus titratable acidity to pH 6.5 (converted to equivalent % $CaCO_3$).
Exchangeable sodium percentage (ESP)	The proportion of the cation exchange capacity occupied by sodium ions, expressed as a percentage. Soils with a high ESP are typically unstable and as a consequence have high erodibility.
FEFLOW	A finite element groundwater modelling package for simulation of groundwater behaviour.
Fetch	The length of water over which a given wind has blown.
Fishway	A structure designed to enable fish to move past a physical barrier (e.g. dam or weir) in a waterway.
Flocc	Aggregated mass.
Flocculants	A substance added to a solution to produce an agglomeration of suspended particles.
Flocculate	Form into an aggregated lumpy or fluffy mass.
Flood tide	The period between low tide and the next high tide in which the sea is rising.
Fluvial	The processes associated with rivers and streams and the deposits and landforms created by them.
Fly-in fly-out workforce	A workforce that is flown to or near a site at the start of their roster, stays in workforce-only accommodation on or near the site and is then flown out again at the end of the roster – generally to a regional centre or city.
Flyrock	The fragments of rock thrown and scattered during blasting.
Foreshore	The part of the seashore between the highwater mark and the low-water mark.
Free Field	A sound field in a medium of such extent that the effects of the boundaries are negligible throughout the region of interest.
Frequency	A combination of sound pressure and frequency determine perceived loudness.
Frugivorous	Having a diet that consists mostly of fruit; fruit-eating.
Gabion rock basket	A basket filled with rock, or similar material, usually rectangular in profile, used in the construction of retaining walls and erosion control structures.
Gallery forest	Forests that form as corridors along rivers or wetlands and projects into landscapes that are otherwise only sparsely treed.

Term	Definition
Gaussian (applied to mathematics)	Normal statistical distribution, usually appearing in graph form as a "bell" curve.
Geochemical Abundance Index (GAI)	The GAI quantifies an assay result for a particular element in terms of the average crustal abundance for that element. The index, based on a log 2 scale, is expressed in 7 integer increments (ie 0 through to 6). As a general rule, a GAI of greater than 3 indicates significant enrichment to a level that warrants further examination.
Geomorphology	The description and interpretation of landforms.
Ghost nets	Discarded fishing nets.
Global Positioning System (GPS)	A GPS navigation device is any device that receives Global Positioning System signals for the purpose of determining the present location.
GoldSim model	GoldSim is a simulation program for carrying out dynamic, probabilistic simulation.
Gorgonians	Corals having a horny or calcareous branching skeleton. Also known as sea whip or sea fan.
Greenhouse gases (GHG)	Gases such as carbon dioxide and methane which, when dispersed in the atmosphere, tend to trap heat.
Hardness	A measure of the concentration of calcium and magnesium ions in water.
Hazchem	Abbreviation used for the hazardous chemical substances coding system used in the Australian Code for the Transportation of Dangerous Goods by Road and Rail. The system is defined in the Australian Standard AS 1216 and uses a classification and labelling system adopted by the United Nations.
Heavy vehicle	A truck, transport or other vehicle with a gross vehicle weight above a specified level (for example: over 8 tonnes).
Heterotrophic	An organisms that do not undergo photosynthesis (e.g. bacteria and fungi)
Herbrecs database	Database including taxon names and specimen data from Queensland Herbarium (part of DERM).
Herpetofauna	Reptiles and amphibians.
Horizon	A consistently coloured and textured layer of soil.
Hydraulic	Of or relating to water or other liquid in motion; operated, moved, or effected by water or liquid.
Hydraulic conductivity	Measure of the ease with which water will pass through earth material; defined as the rate of flow through a cross-section of one square metre under a unit hydraulic gradient at right angles to the direction of flow (m/day).
Hydrocarbon	A compound consisting of hydrogen and carbon.
Hydrodynamics	The motion and action of water and other liquids including currents and oceanic circulation.
Hydrograph	A graph showing the discharge, stage (elevation), velocity, or other properties of the flow with respect to time for a given point on a stream.
Infauna	Aquatic animals that live in the substrate of a body of water, especially in a soft sea bottom (sand or mud substrate).
Initial Advice Statement (IAS)	A document used to initiate the environmental impact assessment procedures of the Queensland Government.
Interfluvial	Promontory above the confluence of two rivers, or in the bend of a meander.
Intertidal	Area between low and high tide which is subject to daily changes in physical and biological conditions from tide movement.
(temperature) Inversion	When air temperature increases with height in certain layers.

Term	Definition
Invertebrates	Animals that do not have a backbone, e.g. insects, crustaceans.
Industrial Source Complex Version 3 (ISC3) model	A standard USEPA steady state Gaussian plume regulatory model which provides indications of ground level concentrations of airborne pollutants.
ISO 14001	An international standard that provides the requirements for an Environmental Management System (EMS).
Kaolinite	A clay mineral consisting of aluminium silicate.
La Niña	A coupled ocean-atmosphere phenomenon similar to El Niño. During a period of La Niña, the sea surface temperature across the equatorial Eastern Central Pacific Ocean will be lower than normal by 0.5 C. La Niña causes mostly the opposite effects of El Niño.
Lacustrine wetland	Area of permanent water with little flow.
Landfarm	An area where contaminated soils are spread and incorporated into the soil and periodically turned over to aerate the mixture and initiate a bioremediation treatment process.
Leachate	Elements or compounds in solution that have been dissolved from water flowing over a material.
Lithosols	Soils limited in depth by continuous coherent and hard rock within 10cm of the surface.
Littoral	The littoral zone extends from the high water mark, which is rarely inundated, to shoreline areas that are permanently submerged.
Longshore/ alongshore	Parallel and close to the coastline (also alongshore)
Lux	The SI unit of illuminance and luminous emittance. It is used in photometry as a measure of the intensity, as perceived by the human eye, of light that hits or passes through a surface.
Neap tide	Tides with the smallest height difference between high tide and low tide, usually occurring when the moon is one quarter and three quarters full.
Nearshore	The region extending seaward from the shoreline.
Macrobenthos	Large benthos.
Macroinvertebrate	An invertebrate large enough to be seen without magnification.
Macrophyte	A plant large enough to be seen with the naked eye.
MARPOL Convention	The International Convention for the Prevention of Pollution from Ships (MARPOL) is the main international convention covering prevention of pollution of the marine environment by ships from operational or accidental causes.
Masking	The raising of a listener's threshold of hearing for a given sound due to the presence of another sound.
Material Safety Data Sheet (MSDS)	A document containing important information about a hazardous chemical (which may be a hazardous substance and/or dangerous goods), and provides information such as precautions for safe use and handling, to safely manage the risk from hazardous substance exposure.
Mesic habitat	Moderately moist habitat.
Microchiropteran	Small or micro bat species.
Micron	One millionth of a metre.
Mine Industrial Area Drainage Slot	A sump in the mine industrial area where stormwater runoff from the mine industrial area will drain to prior to being pumped to either the process water pond or the tailings dam.

Term	Definition
Mutagenicity	A measure of the extent to which something is mutagenic (changes the genetic material, usually DNA, of an organism and thus increases the frequency of mutations above the natural background level)
National Greenhouse and Energy Reporting Scheme (NGERS)	The National Greenhouse and Energy Reporting Scheme was created by the National Greenhouse and Energy Reporting Act 2007 and Regulations 2008 and requires corporations that emit greenhouse gases or consume or produce energy above certain threshold levels to register and report on the emissions and energy consumption or production of their corporate groups.
National Pollutant Inventory (NPI)	Australia's national public database of pollutant emissions. It has emission estimates for 93 toxic substances and the source and location of these emissions.
Nephelometer	An instrument for measuring suspended particulates in a liquid.
Notifiable Activity	Activities identified as being likely to cause land contamination are listed as Notifiable Activities in Schedule 3 of the *Environmental Protection Act 1994*.
Obligate	Restricted to a particular set of environmental conditions, without which an organism cannot survive e.g. obligate freshwater biota can only survive in freshwater conditions.
Oedema	Swelling due to an accumulation of fluid in the tissues.
OHSAS 18001	The internationally recognized certification specification for occupational health and safety management systems and gives requirements for an occupational health and safety management systems.
Organotin	Highly toxic chemicals comprising tin combined with organic molecules, used in antifouling paints such as tributyl tin to protect the hulls of boats and ships, buoys, and pilings from marine organisms such as barnacles.
Osmoregulation	The process by which fish maintain equilibrium of body salts relative to their environment.
Oxidation-Reduction Potential (ORP)	The reduction and oxidation characteristics of water, which gives an indication of what oxygen levels are likely to be.
Overburden	Rock and/or soil overlying the bauxite resource.
Palustrine	The palustrine environment includes all non-tidal wetlands dominated by trees, shrubs, persistent emergent macrophytes, emergent mosses or lichens, and all such wetlands that occur in tidal areas where salinity due to ocean-derived salts is below 5 parts per thousand (ppt). Ecosystem occurring between an aquatic and terrestrial habitat (e.g. permanent marshes and swamps, springs).
Panamax vessel	The largest ships that can pass through the Panama Canal.
Particulate matter	Minute airborne particles.
Particle Size Analysis (PSA)	The quantifiable separation of a soil sample into predetermined particle size groups such as clay, silt, fine sand, coarse sand and gravel. The amounts are normally expressed as percentages by weight of dry soil.
Pelagic	Living in the open sea rather than in coastal or inland waters. Pertaining to the part of the open sea or ocean comprising the water column, ie, all of the sea other than that near the coast or the sea floor.
Perched Aquifer	A region in the unsaturated zone where the soil may be locally saturated because it overlies a low-permeability unit.
Perennial	Lasting for an indefinite amount of time.
Permeability	The capacity of a material to transmit fluid.
PET richness	The richness of pollution-sensitive invertebrate taxa (Plecoptera (stoneflies), Ephemoptera (mayflies), and Trichoptera (caddisflies)) within an area.
PET taxa	Taxa with external gill filaments, such as Plecoptera (stoneflies), Ephemeroptera (mayflies) and Trichoptera (caddisflies).

Term	Definition
Photosynthesis	A process that converts carbon dioxide into organic compounds, especially sugars, using the energy from sunlight.
Pisolitic	Composed of small, round concretions. A rock texture characterized by a small-scale conglomeration of tiny spherical (literally, pealike) brown masses in a lighter-colored matrix.
Plume	A column of one fluid moving through another.
Polymerisation	A process in which many small and simple molecules (called monomers) join together to form a much larger molecule, called a polymer.
Pore water	Pore water is the water filling the spaces between grains of sediment.
Potable water	Water suitable, on the basis of both health and aesthetic considerations, for drinking purposes.
Power Factor Correction	A technique to improve the efficiency of alternating current electric motors.
Project area	Incorporates the "site" and the remaining areas of ML7024 and ML 6024 that would not be disturbed.
Propagule	Seed or spore.
Quantitative	An assessment based on the amount or number of something.
Reclaimed	Filled.
Recharge	Water flowing into an aquifer.
Recharge Area	An area in which there are downward components of hydraulic head in the aquifer. Infiltration moves downward into the deeper parts of an aquifer in a recharge area.
(Tailings) Recovery slots	Trenches dug adjacent to tailings dams to recover water.
Relictual	A species that at an earlier time was abundant in a large area but now occurs at only one or a few small areas.
Remnant vegetation	Patches of vegetation amongst a clearing.
Riparian	Pertaining to, or situated on the bank of, a body of water, especially a watercourse such as a river.
Ripping	The process of fracturing rock or compacted soil by dragging a metal tool through intact strata using a bulldozer.
Riverine wetland	Wetland situated in a river channel, containing moving water either continuously or periodically.
Rock revetment	A facing of stone, riprap or other erosion-resistant material placed on a sloping face of earth such as the edge of stream channel or shoreline, to stabilise the bank and protect it from the erosive action of water.
Salinity	The total content of dissolved solids in surface or ground water, commonly expressed as parts of dissolved solids per million parts of solution (ppm), or milligrams of dissolved solids per litre of solution (mg/L).
Saturation	The extent or degree to which the voids in rock contain water; usually expressed as a percent related to total void or pore space.
Scarping	The erosion of a dune or berm by wave-attack during a storm or a large swell.
Secondary lamella	The primary and secondary gill lamellae increase the amount of oxygen intake of the blood in fish.
Senescent	In the stage of growth in a plant or plant part from maturity to death.
Sessile	Permanently attached to a substrate; not free to move about.
Scarify (soil)	To break up and loosen (soil) to a shallow depth.

Term	Definition
Scrubbing	Cleaning a gas of impurities.
Sediment pond	A structure designed to intercept and retain sediment transported by the rainfall runoff.
Senescing	Aging and deteriorating, e.g pools that dry out over time.
Sheet pile wall	A physical barrier applied by driving solid sheets of impermeable material into the ground.
SIGNAL 2	An index of macroinvertebrate communities that gives an indication of the types of pollution and other physical and chemical factors affecting a site.
SILO	The Bureau of Meteorology web site that provides meteorological and agricultural data.
Site	For the purposes of the South of Embley EPBC Act assessment, the "site" refers to the infrastructure and mining areas on land, and offshore dredging and disposal areas offshore.
Sodic	Having a high sodium content.
Sodicity	The level of exchangeable sodium cations in the soil. It relates to likely dispersion on wetting and hence ability to be eroded and transported in stormwater.
Soil profile	A vertical section of soil.
Sound Attenuation	The reduction in the intensity or in the pressure level of sound which is transmitted from one point to another.
Sound Power Level	The total sound energy radiated from a source per unit of time. Ten times the logarithm to the base 10 of the ratio of a given power to a reference power.
Spillway	An open channel, weir, conduit, tunnel or other structure designed to allow discharges from a dam, used to safely discharge flood flows or release water.
Spring tide	Tides with the greatest range between highs and lows, usually occurring during the full or new moons.
Storativity	The volume of water released from an aquifer per unit surface area of the aquifer and per unit change in head.
Strategic Port Land	Land administered by the North Queensland Bulk Ports Corporation Limited (NQBP).
Stratigraphic	The arrangement of strata (geological layers).
Subcatchment	An area within a catchment drained by one or more tributaries of the main water body.
Substrate	The underlying base to something, e.g. the streambed.
Tailings	Bauxite tailings are the fine-grained waste material resulting from bauxite processing (beneficiation).
Terrigenous	Having a terrestrial, as opposed to marine, origin.
Teratogenicity	The capability to cause malformations or defects to an embryo or foetus
The Air Pollution Model (TAPM)	A three dimensional meteorological and air pollution model developed by Australia's Commonwealth Scientific and Industrial Research Organisation (CSIRO) Division of Atmospheric Research.
Theis equation	This equation is used to find the average transmissivity and storativity values near a pumping well, from data collected during an aquifer test.
Titratable Actual Acidity (TAA)	Measures the actual acidity of soil prior to any oxidation taking place. Acidity titration to pH 6.5 with standardised NaOH on 1:40, suspension in 1 M potassium chloride. (Unit: mol H+/t).
Titratable Peroxide Acidity (TPA)	Acidity titration to pH 6.5 with standardised NaOH on 1: 40, suspension in 1 M potassium chloride after hydrogen peroxide digestion. (Unit: mol H+/t).

Term	Definition
Titratable Sulphidic Acidity (TSA)	Calculated as (TPA – TAA). (Unit: mol H+/t).
Total Dissolved Solids (TDS)	The concentration of common dissolved salts found in water and reported by volume (mg/L).
Total Suspended Solids (TSS)	The concentration of filterable particles in water (retained on a 0.45 保m filter) and reported by volume (mg/L).
Toxicity	The degree of poison or ill effects that a substance produces.
Traditional Owners	Traditional Aboriginal owners or other Aborigines to whom the protection of an area is entrusted in accordance with Aboriginal tradition.
Transmissivity	The rate of flow of water through a vertical strip of aquifer which is one unit wide and which extends the full saturated depth of the aquifer.
Trophic	Pertaining to food webs.
Turbidity	A measure of the cloudiness of water which is determined by the amount of light scattered by suspended particles.
Turkey's nest dams	Off-stream dams that do not capture any surface water from the catchment above the dam meaning that they only capture the rainfall that falls directly on the dam impoundment.
Vascular plant	Vascular plants are those plants that have lignified tissues for conducting water, minerals, and photosynthetic products through the plant. Vascular plants include the ferns, clubmosses, flowering plants, conifers and other gymnosperms.
Wastewater	Water used in a process to carry unwanted materials away or process water that can no longer be used or is surplus to the process.
Water table	Level below which the ground is saturated with water. The surface in an unconfined aquifer or confining bed at which the pore water pressure is atmospheric.
Wildlife Online	The public, online interface for querying the WildNet database.
Wildnet database	A computerised information database on Queensland's wildlife provided by DERM. WildNet contains recorded wildlife sightings and listings of plants, fungi, protists, mammals, birds, reptiles, amphibians, freshwater fish, marine cartilaginous fish and butterflies in Queensland.
Wind rose	A diagram summarising the frequencies of winds of different strengths and directions as measured at a specific point over an extended period of time.
Windrows	A continuous mound of loose material.

Abbreviations

AAA	Advanced Analytical Australia Pty Ltd
AADT	Average Annual Daily Traffic
ABS	Australian Bureau of Statistics
ABWMAC	Australian Ballast Water Management Advisory Committee
ADCP	Acoustic Doppler Current Profiler
AEP	Annual Exceedance Probability
AHD	Australian Height Datum
AI	All injury (frequency rate)
ALARP	As Low As Reasonably Practical
ALS	Australian Laboratory Services
AMP	Alcohol Management Plan
ANC	Acid Neutralising Capacity
ANCE	Excess Acid Neutralising Capacity
ANCOLD	Australian National Committee on Large Dams
ANOVA	Analysis of variance
ANZECC/ARMCANZ	Australian and New Zealand Environment and Conservation Council/Agriculture and Resource Management Council of Australia and New Zealand.
ANZSIC	Australia and New Zealand Standard Industrial Classification
AQIS	Australian Quarantine Inspection Service
ARI	Annual Recurrence Intervals
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
AS	Australian Standards
ASS	Acid Sulphate Soils
ASX	Australian Securities Exchange
ATSIP	Aboriginal and Torres Strait Islander Partnership
AWBM	Australian Water Balance Model
BFI	Baseflow index
BMEA	Bauxite Mining and Exchange Agreement
BOM	Australian Bureau of Meteorology

BRR Plan	RTA Weipa's Business Resilience and Recovery (BRR) Plan (otherwise known as an "Emergency Management Plan")
BTEC	Brucellosis and Tuberculosis Eradication Programme
C&K	Crèche and Kindergarten Association
Caa	'Reacted' calcium. Calcium made soluble by the acid generated from hydrogen peroxide digestion. Calculated as (CaP – Ca KCl) (Unit: %Ca)
Ca_{KCl}	Potassium chloride extractable calcium. Calcium soluble in 1 M potassium chloride (after TAA titration) (Unit: mol H+/ t).
Ca_{NAS}	Net acid soluble calcium. The calcium soluble in 4 M HCl that is not soluble in 1 M KCl (CaHCl – CaKCl). It can be used (in combination with MgNAS) to provide an estimate of the soil carbonate content.
Cap	Peroxide calcium. Calcium extracted in 1 M potassium chloride and determined following hydrogen peroxide digestion and TPA titration.
CAMBA	China-Australia Migratory Bird Agreement
CDEP	Community Development Employment Project
CEA	Community Enterprise Australia
CEC	Cation Exchange Capacity
CECR	Centre for Environmental Contaminants Research
CFU	Coliform Forming Unit
Chalco	The Aluminium Corporation of China Limited
CHEMP	Community, Heritage and Environment Management Plan
CG	The Coordinator-General of the state of Queensland
CLR	Contaminated Land Register
CO_2-e	Carbon dioxide equivalents
CPOM	Coarse Particulate Organic Matter
CPRS	Carbon Pollution Reduction Scheme
CPUE	Catch per unit effort
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CSR	Crown Separation Ratio
Cwlth	Commonwealth
CYPLUS	Cape York Peninsula Land Use Strategy
CYPSFM	Cape York Peninsula Sustainable Fire Management
DAE	Dilute acid extraction
dB	Decibel (the unit of sound measurement)

dB(A)	'A' Weighted overall sound pressure level
DBT	Dibutyltin (DBT)
DEEDI	Queensland Department of Employment, Economic Development & Innovation
DEH	Former Commonwealth Department of Environment and Heritage
DERM	The Queensland Department of Environment and Resource Management - comprised of the former Department of Natural Resources and Water, and the Environmental Protection Agency.
DET	Former Queensland Department of Employment and Training
DEWHA	Former Commonwealth Department of the Environment, Water, Heritage and the Arts – now Commonwealth Department of Sustainability, Environment, Water, Population and Communities.
DG	Disposal Ground i.e. - existing disposal ground in Albatross Bay
DH	Drill hole
DHI	Danish Hydraulic Institute
DIP	Former Queensland Department of Infrastructure and Planning
DIWA	Directory of Important Wetlands.
DLGP	Queensland Department of Local Government and Planning
DME	Former Queensland Department of Minerals and Energy – now part of DEEDI
DMR	Former Queensland Department of Main Roads – now part of DTMR
DNR	Former Queensland Department of Natural Resources – now part of DERM
DNRW	Former Queensland Department of Natural Resources and Water – now part of DERM
DNRM	Former Queensland Department of Natural Resources and Mines – now part of DERM
DO	Dissolved Oxygen
DOC	Dissolved Organic Carbon
DoC	Department of Communities
DOGIT	Deed of grant in trust
DPI&F	Former Queensland Department of Primary Industries and Fisheries – now Queensland Primary Industries and Fisheries (QPI&F) within Queensland Department of Employment, Economic Development & Innovation
DPI	Former Queensland Department of Primary Industries – now Queensland Primary Industries and Fisheries (QPI&F) within Queensland Department of Employment, Economic Development & Innovation
DSEWPaC	Commonwealth Department of Sustainability, Environment, Water, Population and Communities
DTMR	Queensland Department of Transport and Main Roads
dwt	deadweight tonnage
EBMPA	Ely Bauxite Mining Project Agreement
EC	Electrical Conductivity

EEC	Endangered Ecological Communities
EEO	Energy Efficiency Opportunities
EIA	Environmental Impact Assessment
EIS	Environmental Impact Statement
ELY CC	Ely Coordinating Committee
EMR	Environmental Management Register
EMS	Environmental Management System
ENSO	El Niño Southern Oscillation - often called just "El Niño"
EP Act	*Environment Protection Act 1994*
EPA	Former Queensland Environmental Protection Agency – now part of DERM
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth)
EPM	Exploration Permit – Minerals issued pursuant to the *Mineral Resources Act 1989*
EPP (Air)	*Environmental Protection (Air) Policy 2008*
EPP (Noise)	*Environmental Protection (Noise) Policy 2008*
EPP (Waste)	*Environmental Protection (Waste) Policy 2000*
EPP (Water)	*The Environmental Protection (Water) Policy 2009*
ESA	Equivalent Standard Axles
ESD	Environmentally Sustainable Development
ESP	Exchangeable sodium percentage
EVs	Environmental Values
F (as in Al F)	Filtered or dissolved
FCA	Federal Court of Australia
FHA	Fish Habitat Area under the *Fisheries Act 1994*
FNQ	Far North Queensland
FNQRDGP	Far North Queensland Rural Division of General Practice
FRC	Family and Responsibilities Commission
FRR	Final Rehabilitation Report
FTE	Full time equivalent jobs
GAB	Great Artesian Basin
GAB-ROP	Great Artesian Basin Resource Allocation Plan

GAB WRP	*Water Resource (Great Artesian Basin) Plan 2006*
GAI	Geochemical Abundance Index
GARID	Guidelines for Assessment of Road Impacts of Development
GCCFA	Gulf of Carpentaria Commercial Fishermen Association
GDP	Gross Domestic Product
GEL	Generally Expected Levels
GHG	Greenhouse Gas
GIS	Geographic Information System
GPM	General Prediction Model
GPS	Global Positioning System
GQAL	Good Quality Agricultural Land
GRP	Gross Regional Product
ha	Hectare
HACC	Home and Community Care
HAT	Highest Astronomical Tide
HDPE	High-density polyethylene
HSE	Health, Safety and Environment
Hz	Hertz
IAS	Initial Advice Statement as defined by part 4 of the *State Development and Public Works Organisation Act 1971*
IDAS	Integrated Development Assessment System (any activity classified as development in Queensland must obtain approval under the Integrated Development Assessment System as required under the *Sustainable Planning Act 2009)*
ILUA	Indigenous Land Use Agreement
IO Table	Input Output Table as defined by the Australian Bureau of Statistics
IPCC	Intergovernmental Panel on Climate Change
ISC3	Industrial Source Complex Version 3 (ISC3) model
ISO	International Standards Organisation
IUCN	International Union for Conservation of Nature
JAMBA	Japan-Australia Migratory Bird Agreement
JCU	James Cook University
JORC	The Australian Joint Ore Reserve Committee

kN	kilonewton
$L_{10\ (T)}$	Noise level exceeded for 10% of the measurement period (T). This represents the upper intrusive noise level and is often used to represent traffic/ music noise.
$L_{A1,\ adj,\ T}$	The A-weighted sound pressure level, adjusted for tonal character or impulsiveness, that is exceeded for 1% of the measurement period T when measured using time-weighting 'F'.
$L_{A10,\ adj,\ T}$	The A-weighted sound pressure level, adjusted for tonal character or impulsiveness, that is exceeded for 10% of the measurement period T when measured using time-weighting 'F'.
$L_{90\ (T)}$	Noise level exceeded for 90% of the measurement period (T). This represents the background noise level excluding nearby sources.
$L_{eq\ (T)}$	Energy averaged noise level over the measurement period (T)
$L_{Aeq,\ adj,\ T}$	An A-weighted sound pressure level of a continuous steady sound, adjusted for tonal character, that within the measurement period T has the same mean square sound pressure of a sound that varies with time.
L_{max}	Maximum instantaneous noise level during a measured period.
LAP	Local Aboriginal People
LAPS	Limited Area Prediction System
LAT	Lowest Astronomical Tide
LOEC	Lowest Observed Effects Concentration
LOR	Limit of reporting
LTI	Lost Time Injury
Mg a	'Reacted' magnesium. Magnesium solubilised by acid generated from hydrogen peroxide digestion and calculated as (MgP – MgKCl). (Unit: %Mg).
Mg_{KCl}	Potassium chloride extractable as magnesium. Magnesium soluble in 1 M potassium chloride (after TAA titration). (Unit: %Mg).
Mg_{P}	Peroxide magnesium. Magnesium extracted in 1 M potassium chloride and determined following hydrogen peroxide digestion and TPA titration. (Unit: %Mg).
MBT	Monobutyltin
MDL	Mineral Development Licence
MHHW	Mean High High-Water
MHLW	Mean High Low-Water
MIA	Mine Infrastructure Area
ML	Mining Lease issued pursuant to the *Mineral Resources Act 1989*
MLHW	Mean Low High-Water
MLLW	Mean Low Low-Water
MNES	Matters of national environmental significance (under the *Environment Protection and Biodiversity Conservation Act 1999*)
MRA	Mineral Resources Act 1989

MSDS	Material Safety Data Sheet
MSL	Mean Sea Level
MSQ	Maritime Safety Queensland
Mdptpa	Million dry product tonnes per annum
NEPC	National Environment Protection Council
NAGD	National Assessment Guidelines for Dredging (Commonwealth of Australia, 2009)
NATA	National Association of Testing Authorities
NCA	*Nature Conservation Act 1994*
NDG	New Disposal Ground
NGA	National Greenhouse Accounts
NGERS	National Greenhouse and Energy Reporting Scheme
NMI	National Measurement Institute
No.	Number
NODGDM	*National Ocean Disposal Guidelines for Dredged Materials* (Commonwealth of Australia 2002)
NoE	North of the Embley River (where existing RTA operations are located)
NPF	Northern Prawn Fishery
NPI	National Pollutant Inventory
NQBP	North Queensland Bulk Ports Corporation Limited - formerly Ports Corporation of Queensland (PCQ)
NRW	Former Queensland Department of Natural Resources and Water – now part of DERM
NTU	Nephelometric Turbidity Units (unit of measurement for water turbidity)
NTU-e	Nephelometric Turbidity Units-equivalent
OEL	Occupational Exposure Level
OESR	Office of Economic and Statistical Research
OP score	Overall Position score
ORP	Oxidation reduction potential
PA	Port area
PAH	Polyaromatic hydrocarbons
PASS	Potential Acid Sulphate Soils
PAR	Photosynthetically active radiation
PIFU	Queensland Government's Planning Information and Forecasting Unit

PCQ	The former Ports Corporation of Queensland, now North Queensland Bulk Ports Corporation Limited (NQBP)
PDR	Peninsula Developmental Road
PFC	Percentage Foliage Cover
pH	Absolute value of the decimal logarithm of the hydrogen-ion concentration (activity); used as an indicator of acidity (pH < 7) or alkalinity (pH > 7)
pH_F	The field pH of soil
pH_{FOX}	The field pH of soil after oxidation with peroxide
pH_{KCl}	Potassium chloride suspension pH. pH in a 1:40 (W/V) suspension of soil in a solution of 1 M potassium chloride
pH_{OX}	The pH after oxidation with peroxide
PHC	Primary Health Care. The PHC Governance team in the Office of Rural and Remote Health (ORRH) of Queensland Health supports the provision of evidence based care in the primary health care centres.
PHCC	Primary Health Care Centre
PM_{10}	Particulate matter less than 10 microns in diameter
$PM_{2.5}$	Particulate matter less than 2.5 microns in diameter
PPE	Personal Protective Equipment
ppt	Parts per thousand
ppb	Parts per billion
PQL	Practical quantitation limits
PSD	Particle size distribution
QASSIT	Queensland Acid Sulphate Soils Investigation Team
QFJA	Queensland Fisheries Joint Authority
QH	Queensland Health
QPS	Queensland Police Service
QPWS	The Queensland Parks and Wildlife Service
QR	Queensland Rail
QT	The Queensland Department of Transport
QTAC	Queensland Tertiary Admissions Centre
RAKES	Rapid Appraisal of Key and Endangered Sites
RE	Regional Ecosystem
RFDS	Royal Flying Doctor Service
ROM	Run-of-mine

RORO	Roll on - roll off
RPA	Regional Partnership Heads of Agreement
RPDM	Road Planning and Design Manual
RSPP	Radiation Safety Protection Plans
RTA	RTA Weipa Pty Ltd
RTM	Rio Tinto Marine
$S_{ANC_BT/FF}$	Acid neutralising capacity measured by acid digest followed by back titration of the acid that has not been consumed, expressed in equivalent percentage pyrite sulfur.
S_{CR}	Chromium reducible sulfur (a measure of potential sulfidic acidity). Sulfide measured by iodometric titration after acidic chromous chloride reduction. (Unit: %S).
S_{KCl}	Potassium chloride extractable sulfur. Sulfur extracted in 1 M potassium chloride (after TAA titration). (Unit: %S).
S_{NAS}	Net acid soluble sulfur. Calculated as (SHCl – SKCl). (Unit: %S).
S_P	Peroxide sulfur. Sulfur extracted in 1 M potassium chloride and determined following hydrogen peroxide digestion and TPA titration. (Unit: %S).
S_{POS}	Peroxide oxidisable sulfur. Sulfur oxidised by peroxide digestion and calculated as (Sp – SKCl). (Unit: %S).
SAP	Sampling and analysis plan
SD	Statistical Division
SDPWOA	*State Development and Public Works Act 1971*
SGS	SGS Economics and Planning Pty Ltd (economics and planning consultancy)
SIA	Social Impact Assessment
SIGNAL	Stream Invertebrate Grade Number – Average Level (a method of assessing the tolerance of macroinvertebrates to pollution)
SoE	South of the Embley
SoE S-C	SoE Project Sub-Committee (of the Western Cape Communities Coordinating Committee)
SOI	Southern Oscillation Index
SOP	Safe Operating Procedure
SPOCAS	Suspension Peroxide Oxidation Combined Acidity and Sulphate
SPP	State Planning Policy
SPRAT Database	Species Profiles and Threats Database. A database maintained by Department of Sustainability, Environment, Water, Population and Communities designed to provide statutory, biological and ecological information on species and ecological communities, migratory species, marine species protected under the Environment Protection and Biodiversity Conservation Act 1999.
std	Standard
STP	Sewage treatment plant
SWAN	Simulating Waves Nearshore model

T (as in Al T)	Total
TAA	Titratable actual acidity
TAP	Threat Abatement Plan
TAPM	The Air Pollution Model
TBT	Tributyltin (an organotin species)
TDS	Total Dissolved Solids
Temp	Temperature
TKN	Total Kjeldahl Nitrogen (organic nitrogen)
TMP	Traffic Management Plan
TN	Total nitrogen
TP	Total phosphorus
TPM	Transition Probability Matrix
TO	Traditional Owner
TOC	Total Organic Carbon
ToR	Terms of Reference as defined by Part 4 of the *State Development and Public Works Organisation Act 1971*
TSF	Tailings Storage Facility
TSP	Total Suspended Particulate
TSS	Total Suspended Solids
Turb	Turbidity
UN	United Nations
VET	Vocational Education and Training (qualification)
VMA	*Vegetation Management Act 1999*
VTE	vehicle trip ends
WCC	Western Cape College
WCCCA	Western Cape Communities Co-existence Agreement
WCCT	The Western Cape Communities Trust
WCCCC	Western Cape Communities Coordinating Committee
WHA	World Heritage Area
WIHS	Weipa Integrated Health Service
WQO	Water quality objectives

WTA	Weipa Town Authority
WTB	Weipa Town Boundary
2D	Two-dimensional
95%UCL	The upper limit of the sample mean, with 95 per cent confidence

Units

Time Intervals	
s	second
d	day
hr	hour
hr/d	hours per day
a	annum
Length	
m	metre
nm	nanometre
km	kilometre
cm	centimetre
mm	millimetre
Mass	
kg	kilogram
t	tonne
kt	kilotonne
dpt	dry product tonne
Mt	million tonnes
Mdpt	million dry product tonnes
dptph	dry product tonnes per hour
Mtpa	million tonnes per annum
Mdptpa	million dry product tonnes per annum
Density	
µg/m³	micrograms per cubic metre
g/m^3	grams per cubic metre
Concentration	
µg/l	micrograms per litre
mg/l	milligrams per litre

Area	
m^2	square metre
ha	hectare
Volume	
m^3	cubic metre
Mm^3	million cubic metres
kL	kilolitre (1,000 litres)
ML	megalitre (1,000,000 litres)
GL	gigalitre (1,000,000,000 litres)
L	litre
Flow Rate	
m^3/s	cubic metre per second
L/s	litres per second
ML/a	megalitre per annum
GL/a	gigalitre per annum
Hydraulic conductivity	
m/d	metres per day
Energy	
GJ	gigajoule
kW	kilowatt
MW	megawatt
kJ/kg	kilojoule per kilogram
MWh	megawatt hour
Temperature	
°C	degrees Celsius
Noise	
dB	decibel
dB(A)	decibel (A-Weighted scale)
Pressure	
µPa	micro-Pascal

Potential	
kV	kilovolt
mV	millvolt
dS/m	deci Siemens per metre
µS/cm	micro Siemens per centimetre
mS/cm	milli Siemens per centimetre
Frequency	
Hz	hertz
Photosynthetically Active Radiation	
µE/cm^2	Micro-Einsteins per square centimetre

Prefixes for Units

Quantity	Symbol	Value
Giga	G	10^{9}
Mega	M	10^{6}
Kilo	k	10^{3}(1000)
Deci	d	10^{-1}(0.1)
Centi	c	10^{-2}(0.01)
Milli	m	10^{-3}(0.001)
Micro	µ	10^{-6}
Nano	n	10^{-9}

Rio Tinto Alcan

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