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Section 7

Threatened Species and Ecological Communities - Estuarine and Marine Fauna

7 Threatened Estuarine and Marine Fauna

7.1 Introduction

7.1.1 General Structure of the Section

This section documents the results of the detailed profiling and impact assessment work undertaken for the ten threatened estuarine and marine species (six marine turtles and four elasmobranchs) that were assessed in detail because they are known, likely or could possibly occur based on the results of the review of matters of NES and the assessment methodology documented in **Section 4.3**.

The species are:

- Green Turtle (*Chelonia mydas*) – listed as vulnerable and migratory under the EPBC Act. Likely to occur within areas of the proposed Port, and Hey and Embley River ferry/barge terminals. Possibly occurs within areas of the proposed new spoil ground and Albatross Bay spoil ground;
- Hawksbill Turtle (*Eretmochelys imbricata*) – listed as vulnerable and migratory under the EPBC Act. Known to occur within areas adjacent to the proposed Port. Likely to occur within areas of the proposed Port. Possibly occurs within areas of proposed new spoil ground, Albatross Bay spoil ground and Hey and Embley River ferry/barge terminals;
- Flatback Turtle (*Natator depressus*) – listed as vulnerable and migratory under the EPBC Act Known to occur within and adjacent to areas of the proposed Port. Likely to occur within areas proposed for the Hey and Embley River ferry/barge terminals. Possibly occurs within areas of the proposed new spoil ground and Albatross Bay spoil ground;
- Loggerhead Turtle (*Caretta caretta*) – listed as endangered and migratory under the EPBC Act. Likely to occur within areas of the proposed Port, proposed new spoil ground and Albatross Bay spoil ground, and within areas proposed for the Hey and Embley River ferry/barge terminals;
- Olive Ridley Turtle (*Lepidochelys olivacea*) - listed as endangered and migratory under the EPBC Act. Known to occur within areas adjacent to the proposed Port. Likely to occur within areas proposed for the Hey and Embley River ferry/barge terminals. Possibly occurs within areas of proposed new spoil ground and Albatross Bay spoil ground;
- Leatherback Turtle (*Dermochelys coriacea*) - listed as endangered and migratory under the EPBC Act. Likely to occur within areas of the proposed Port, proposed new spoil ground and Albatross Bay spoil ground. Unlikely to occur within areas proposed for Hey and Embley River ferry/barge terminals;
- Dwarf Sawfish/Queensland Sawfish (*Pristis clavata*) - listed as vulnerable under the EPBC Act. Likely to occur within areas of the proposed Port and within areas proposed for the Hey and Embley River Ferry/Barge terminals. Unlikely to occur within areas of the proposed new spoil ground and Albatross Bay spoil ground and Dam C;
- Green Sawfish (*Pristis zijsron*) - listed as vulnerable under the EPBC Act. Likely to occur within areas of the proposed Port and within areas proposed for the Hey and Embley River ferry/barge terminals. Unlikely to occur within areas of the proposed new spoil ground and Albatross Bay spoil ground and Dam C;
- Freshwater Sawfish (*Pristis microdon*) - listed as endangered and migratory under the EPBC Act Possibly occurs within areas of the proposed Port, Hey and Embley River ferry/barge terminals and areas of the proposed new spoil ground and Albatross Bay spoil ground. Unlikely within areas of Dam C; and,

- Speartooth Shark (*Glyphis sp. A*) - listed as critically endangered under the EPBC Act. Possibly occurs within areas proposed for the Hey and Embley River ferry/barge terminals and estuarine and lowermost freshwater reaches of the Project area. Unlikely to occur within areas of the proposed Port, proposed new spoil ground and Albatross Bay spoil ground and Dam C.

Assessment of listed non-avian migratory species, including Dugong, the Estuarine Crocodile and cetacean species, is presented in **Section 9**.

Section 4.5 (MNES Impact Assessment and Mitigation Measures) of the Tailored EIS Guidelines for the Project require an assessment of the matters of NES that are likely or known to occur in the areas that would be or are likely to be impacted by the proposed action. The Tailored EIS Guidelines are structured into two parts that can be summarised as follows:

- Part A relates to potential impacts associated with the mine, Port and associated infrastructure, and outlines the assessment requirements for three of the six controlling provisions (listed threatened species and communities, listed migratory species and Commonwealth marine areas) associated with these activities; and,
- Part B sets out the assessment requirements that are to be addressed in relation to the impacts of the Project that have not been addressed in Part A. It includes the requirements to:

assess impacts relating to Project-related shipping activities for all six controlling provisions; and,
assess the impacts of the mine, Port and associated infrastructure for the three controlling provisions not included in Part A (World Heritage properties, National Heritage places and the Great Barrier Reef Marine Park).

This section is designed to meet the requirements of both Part A and Part B of Section 4.5 of the Tailored EIS Guidelines relating to impacts on threatened estuarine and marine species. Detailed data collection/profiling and impact assessment work was conducted in the vicinity of the mine, Port and associated infrastructure as that is where greater potential impacts to these species were determined to be. This is because the development of the mine, Port and associated infrastructure would require physical construction and development activities that could temporarily or permanently displace species, or impact habitat. The data collection/profiling information and impact assessment work for threatened estuarine and marine species associated with Project-related shipping activities was undertaken at a broader level of detail commensurate with the lower likelihood of potential impacts associated with these activities (refer **Section 4.5.3**). This approach is consistent with the requirements of Part B of Section 4.5 of the Tailored EIS Guidelines, which requires the assessment related to Project-related shipping activities to be undertaken commensurate with the likelihood of potential impact to the matters of NES.

This section is structured to document the results of the assessment of threatened estuarine and marine species and present the information in a logical progression. This section is structured as follows:

Section 7.2 provides an overview of the benthic habitat survey approach and results. **Section 7.3** relates to marine turtles, and **Section 7.4** relates to elasmobranchs. Each of these sections includes the following subsections:

- **Subsection 1 – General Overview** (**7.3.1**, **7.4.1**)

provides an overview of the secondary source profiling work undertaken, regional preferences, distribution and populations, ecology and habitat and known threats for each species.

- **Subsection 2 - Species Profile** (**7.3.2**, **7.4.2**)

describes the secondary source profiling work undertaken, regional preferences, distribution and populations, ecology and habitat and known threats for each species.

- **Subsection 3 – Survey and Results** (**7.2**, **7.3.3**, **7.4.3**)

describes the specific survey efforts and the results that describe Project area habitat preferences and the presence/abundance of the species in the Project area.

- **Subsection 4 – Likelihood of Occurrence within the Project Area** (**7.3.4**, **7.4.4**)

provides a summary of the preferred habitat and likelihood of occurrence of each species within the Project area.

- **Subsection 5 – Relevant Impacts** (**7.3.5**, **7.4.5**)

describes the relevant direct and indirect impacts of the Project.

- **Subsection 6 – Avoidance, Mitigation, Enhancement Measures and Residual Effects** (**7.3.6, 7.4.6**)

describes the measures proposed to reduce the relevant impacts of the Project and the residual risk of impacts.

- **Subsection 5 – Offset Measures** (**7.3.7**, **7.4.7**)

describes the measures proposed to offset any significant impacts of the Project, where required.

Cumulative and consequential impacts on these species are documented in **Section 18.3.4**. The cumulative and consequential impact assessment was undertaken at a higher/more strategic level of detail when compared to the Project-specific impact assessment because it is based on the potential activities that may or may not occur as a result of other projects.

7.1.2 General Approach to Detailed Impact Assessment

The Tailored EIS Guidelines require detailed impact assessments for each species identified as either known or likely to occur within the Project area. A conservative approach was taken and species that could possibly occur were also selected for more detailed assessment. **Section 4.3** describes how the likelihood of occurrence for each species was identified. The detailed impact assessment included a focus on the potential impacts of the construction and operational phases of the Project and associated impacts to species and their key habitats.

In general, the impact assessment process for each species focussed on the following key steps:

1. determination of the potential impacts of the Project on species and their key habitats;
2. identification of avoidance, mitigation, and enhancement measures to avoid and/or mitigate potential adverse impacts; and,
3. determination of the significance of the residual impacts.

Table 7-1 outlines the potential direct and indirect impacts considered in the detailed impact assessment for both the construction and operational/maintenance phases of the Project. A description of the relevant direct and indirect impacts (both unmitigated and residual impacts) is provided in **Section 7.3** for marine turtles and **Section 7.4** for elasmobranchs.

The selection of impacts has been based on the assessment of the likelihood of impacts as discussed in **Section 4**, including potential impacts from Project-related shipping (refer **Section 4.5** and **Appendix 4-A**). Certain risks associated with Project-related shipping, such as the introduction of pest species, have not been included on the basis that the likelihood of impacts occurring from these events would be rare (refer **Section 4.5.3.14**), and therefore are not relevant impacts for estuarine and marine species.

Table 7-1 Potential Direct and Indirect Impacts on Marine and Estuarine Fauna

Direct Impacts	Indirect Impacts
Physical disturbance to benthic or intertidal habitats from dredging, reclamation or piling	Changes to recreational use of beaches
Creation of a turbidity plume	Changes to coastal processes (erosion and deposition)
Deposition of dredged sediments on benthic habitat	Restricted movement in riverine habitat (Dam C)
Physical disturbance to beach habitats from piling or temporary beach access	
Entrainment in dredge	
Altered light regime	
Underwater acoustic impacts from pile driving and vessel movements	
Marine oil spill	
Vessel discharges	
Vessel strike	

The magnitude of relevant impacts has been considered with reference to the *Matters of National Environmental Significance: Significant Impact Guidelines 1.1* (DEWHA 2009c) for threatened estuarine and marine species, and have been categorised as:

- None/negligible impact – unlikely to be any effect or consequence on the species.
- Minor impact – a small area of potential habitat or a small number of individuals will be directly or indirectly affected in no more than a few discrete locations but an important population will not be affected.
- Moderate impact – a large area of potential habitat, or a small number of individuals will be directly or indirectly affected and impact will occur over numerous sites. An important population may experience some short to medium term effects.
- High impact – impact would occur over a relatively large area of potential habitat and lead to the loss of a large proportion of the local habitat or important population. There are likely to be long-term impacts to an important population.

High and moderate residual impacts are considered to be significant, and none/negligible and minor residual impacts are not considered to be significant.

7.2 Benthic and Shoreline Habitats

Biophysical and ecological data were collected to describe the existing marine and estuarine environment in the vicinity of the Project area. **Figure 3-8** shows the general study area used to describe the existing marine and estuarine environment and predict the environmental impacts from the Project. This area includes:

- the proposed Port site;
- the proposed new spoil ground, 17km offshore of Boyd Point;
- the existing Albatross Bay spoil ground;
- the location for the temporary seaborne access;
- the location for barge and ferry facilities in the Embley and Hey Rivers; and,
- the Ward River and Norman Creek estuaries.

The data collection/profiling information and impact assessment work for threatened estuarine and marine species associated with Project-related shipping activities was undertaken at a broader level of detail commensurate with the lower likelihood of potential impacts associated with these activities (**Section 4.5.3**). This approach is consistent with the requirements of Section 4.5 Part B of the Tailored EIS Guidelines, which requires that assessment related to Project-related shipping activities be undertaken commensurate with the likelihood of potential impact on threatened estuarine and marine species. A summary of the marine and estuarine baseline data collected and studies conducted for the Project is provided in **Table 7-2** along with a cross reference to where further details can be found. **Sections 7.2.1**, **7.3.2** and **7.4.2** detail the survey methodology used to assess threatened marine and estuarine fauna and potential habitats in the vicinity of the Project. The methodologies and modelling approaches that were undertaken are widely accepted as scientifically valid and rigorous techniques in the assessment of marine habitats and hydrodynamic processes.

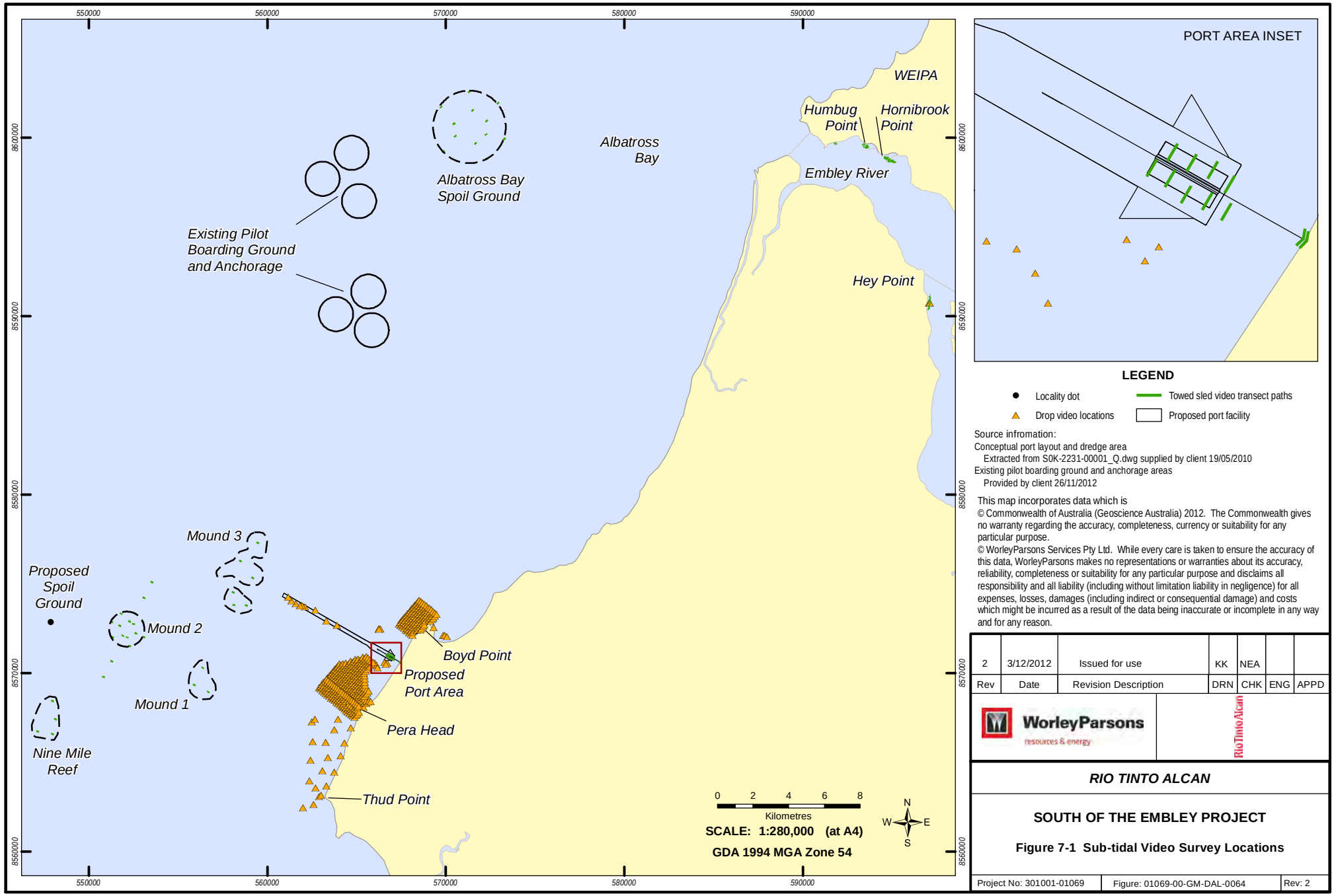
Key habitats associated with marine turtles, sawfish and the Speartooth Shark in the vicinity of the Project are discussed below and include:

- coastal habitats;
- inshore and offshore reefs;
- mangroves;
- estuarine habitat;
- seagrass; and,
- soft sediments.

Benthic (sea floor) habitat surveys were completed within the Project area during October 2007, June 2008, November 2008, June 2009, July 2009, June 2010, and February 2012. A combination of towed video sled and drop camera video techniques (**Figure 7-1**) and van Veen grab sampling (**Figure 4-4** to **Figure 4-6**) were adopted for these studies. A summary of benthic habitat surveys conducted is presented in **Table 7-3**.

Table 7-2 Summary of Marine and Estuarine Baseline Surveys

Baseline Data / Study	Port Area	Proposed New Spoil Ground	Hornibrook and Humbug Terminals	Hey River Terminal	Albatross Bay Spoil Ground	Cross Reference
Water quality	✓	✓	✓	✓	✓	**Section 16.1**
Sediment characteristics	✓	✓	✓	✓		**Section 7.2.9** and **Appendix 7-A, 7-B** and **7-C**
Physical environment and coastal processes	✓	✓				**Section 7.2.1**
Benthic habitat mapping – drop camera video	✓		✓	✓		**Section 7.2.2**
Benthic habitat mapping – towed video sled	✓	✓				**Section 7.2.2**
Mangrove survey	✓		✓	✓		**Section 7.2.5**
Marine Turtle survey	✓					**Section 7.3.3**
Piling underwater noise modelling	✓					**Section 15**
Project-related shipping impacts	✓					**Section 4.5**
Aquatic ecology baseline			✓	✓		**Section 7.4.2**



Source infromation:
Conceptual port layout and dredge area
Extracted from S0K-2231-00001_Q.dwg supplied by client 19/05/2010
Existing pilot boarding ground and anchorage areas
Provided by client 26/11/2012

Rev	Date	Revision Description	DRN	CHK	ENG	APPD
2	3/12/2012	Issued for use	KK	NEA		

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SOUTH OF THE EMBLEY PROJECT

Figure 7-1 Sub-tidal Video Survey Locations

Project No: 301001-01069	Figure: 01069-00-GM-DAL-0064	Rev: 2

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Table 7-3 Benthic Habitat Surveys

Location	Method	Number of Sites	Survey date
Proposed new spoil ground	Towed sled	18	Oct 2007
Mounds areas (10km WNW from the Port)	Towed sled	9	Oct 2007
Proposed Port area	Towed sled	9	Oct 2007
Sub-tidal soft reef area (150m south of the Port)	Drop video	9	Oct 2007
Hey River terminal	Drop video	Preliminary inspection	Oct 2007
Hey River terminal	Drop video	10	Nov 2008
Hey River terminal	Drop video	12	Jun 2009
Hey River terminal	van Veen Grab	61	Feb 2012
Hornibrook terminal	Drop video	Preliminary inspection	Jun 2008
Hornibrook terminal	Drop video	11	Jun 2009
Hornibrook terminal	van Veen Grab	76	Feb 2012
Humbug terminal	Drop video	Preliminary inspection	Jun 2008
Humbug terminal	Drop video	7	Jun 2008
Humbug terminal	van Veen Grab	39	Feb 2012
Pera Head**	Drop video	Preliminary inspection	Oct 2007
Pera Head	Drop video	299 (points on grid)	Jun 2008
Boyd Point**	Drop video	Preliminary inspection	Oct 2007
Boyd Point	Drop video	114 (points on grid)	Jun 2008
Pera Head to Thud Point	Drop video	19	Jun 2010
Port area departure channel	Drop video	20	Jun 2010
Nine Mile Reef	Drop video	4	Jun 2010
Temporary Barge Access	Drop Video	9 transects	Feb 2012
Anchorages	Drop Video	2 transects	Feb 2012
Temporary Passenger Jetty Boyd Bay Option	Drop Video	5 transects (225 frames analysed)	Feb 2012
Temporary Passenger Jetty Boyd Point Option	Drop Video	1 transect	Feb 2012

** Preliminary inspection following identification of hard coral reefs

Standard survey techniques were used to assess benthic habitats, taking account of the inability to undertake diver surveys due to the presence of Estuarine Crocodiles. Towed video sled was used over low profile soft sediment and seagrass habitats. Towed video transects typically covered a distance of 100m and had a field of view approximately 0.5m wide. 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 along transects ranging from about 20m to 50m in length. Detailed reef habitat surveys also utilised drop camera video methods at grid points (refer Section 6.3.1.1 in RTA 2011) and captured an area of 0.5m by 0.5m.

Grab sampling (van Veen grab 0.5L volume; 0.0025m^2 sample area) was undertaken in February 2012, with samples washed through a 1mm sieve and the presence or absence of seagrass with and without rhizomes attached was recorded. The temporary seaborne access locations were sampled by underwater video on 400m transects at 60m and 170m from shore. Video transect surveys were also conducted at the passenger jetty option in Boyd Bay and at Boyd Point as well as the two anchorages. In-water surveys were not undertaken due to potential safety risks posed by Estuarine Crocodiles in the area.

7.2.1 Coastal habitats

Hydrodynamic numerical modelling was conducted to assess the two ways in which the proposed Port facility could impact upon coastal morphology through changes to shoreline sediment transport processes:

- interruption of along-shore sediment transport by blocking or capturing sediment moving along the coast and altering shoreline profile; and,
- larger storm waves reaching the shoreline through the deepened dredge area, increasing cross-shore sediment movement and leading to beach and/or cliff erosion.

7.2.1.1 Along-shore Sediment Transport

Annual along-shore transport was estimated through wave, current and sediment transport modelling for 15 historical storm events over an 18 year period. The results of the modelling show that alongshore transport rates vary considerably (100 to 80,000m^3 per event) depending upon wave height, approach direction and storm duration. The material being transported in storm events can move north or south along the coast depending on the storm track and mean wave direction. However, net transport of sediments occurs towards the north (towards Boyd Point). Results of modelling indicate that for even the largest of the modelled storms, along-shore sediment transport occurred within 350m of the shoreline.

The dredge area and proposed Port facility structure may alter current and wave movements and interrupt this sediment movement. As the dredge area commences at a distance of 500m from the shoreline and outside of the zone of along-shore sediment transport, negligible impact on coastal morphology from the dredge area is expected. It is concluded that the open trestle design proposed for the marine loading facility would not significantly impede or capture sediment moving along the shoreline. Therefore the structure may result in only minor local changes, including changes to sand shoals in the near-shore zone and localised scour around the individual legs of the trestle. Along-shore transport on the beach is not predicted to be impacted.

7.2.1.2 Cross-shore Sediment Transport

The impact of the proposed dredge area for the Port on the near-shore wave climate was assessed through wave modelling of both existing and design cases for a range of wave directions. Under natural coastal processes, sediments are eroded from the beach and cliffs and deposit in offshore sand bars. During subsequent periods of calmer weather, smaller waves may move some of the sediment in the bars back onto the beach. Modelling assessed the potential for:

- increased wave heights to increase beach and cliff erosion; and,
- for the dredged area to act as a sediment sink where eroded sediment is deposited and cannot return to beach, leading to progressive erosion of the beach.

Results indicate that wave heights are not expected to change by more than 4% as a result of the dredging works. The greatest increases are expected around the berth area for waves approaching from the north and south southwest, a decrease in wave height is expected in the lee of the dredge area for the case of waves approaching along the departure channel alignment. Closer to the shoreline, wave height changes are expected to be less than 1%. Modelling indicates that changes to the wave climate are predominantly confined to the area around the proposed berth at the Port.

Due to the predicted minor changes in wave height in the near-shore area, storm wave penetration to the shore is not predicted to be significantly increased by the dredge area and therefore minimal increase in beach and cliff erosion is expected. Sand bars are predicted to form inshore of the dredge area and no beach sediment is lost into the berth pockets in this simulation. Modelling predicted that negligible change to coastal morphology would occur for both existing and dredged cases.

Simulations assessed the impact of the dredged berth profile for the Port under a range of possible offshore wave conditions with no discernible change in ocean bed level observed. Minor changes were observed in sand transport rates, inferring that sand shoal movements could result in the near-shore zone in the vicinity of the trestle. A sensitivity analysis was undertaken for the sediments sizes occurring at the site to determine the extent of cross-shore sediment transport. Results of the sensitivity tests indicate that fine sand (d=0.2mm) present in the near-shore area could be mobilised and transported further offshore than the coarse sand (d=0.6mm) found on the beach. Under extreme conditions, fine sand was deposited up to 400m offshore, approximately 100m landward of the berth pocket. As indicated above, this is considered to be a negligible impact.

Proposed open trestle structures for the Port generally allow transitions of >90% of wave energy and would therefore have minimal impact on wave climate. Predicted changes from impacts to along shore sediment movements above would not be increased due to the slight reduction in wave energy transition under the jetty.

7.2.2 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 and proposed new spoil ground during October 2007 and June 2008. An additional video camera survey was undertaken in February 2012 at the proposed temporary seaborne access areas and anchorage area. These techniques are widely accepted and scientifically valid techniques in the assessment of marine benthic habitats. Data collected using these techniques enabled the percentage of live benthic cover to be quantified, provided diversity estimates via still imagery analysis and allowed habitat mapping. Detailed sampling grids incorporating 125m spacing were applied over Pera Head and Boyd Point during the 2007 and 2008 surveys, 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.

7.2.3 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 surveys commissioned by RTA and 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 in 2007 and 2008 had already confirmed the extent of reef habitats at Pera Head and Boyd Point and Pera Head to Thud Point in June 2010.

Drop camera video inspection was also undertaken in June 2010 at Nine Mile Reef approximately 6km south south-west of the proposed new spoil ground. This is the nearest substantial seabed feature to the proposed new spoil ground.

Inspection of potential reef habitat south of Thud Point was not undertaken due to it being unlikely that turbid plumes due to dredging activities would extend inshore beyond Thud Point. This was confirmed through turbidity plume modelling (**Appendix 7-A**).

7.2.4 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 in the area. Although poorly mapped, fringing and near-shore 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).

The iron stone formations present along the western shoreline of Cape York support the development of shallow fringing hard coral and soft benthos reef communities. Reef habitat similar to that present within the Project area is also found approximately 75km to the north of Albatross Bay, in the vicinity of the mouth of Port Musgrave. Dog Reef is a rocky algal reef system that extends approximately 7km to the south of the mouth of Port Musgrave and averages about 800m in width, with patchy live hard and soft coral cover. Kerr Reef is situated approximately 16km 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 Project area.

7.2.4.1 Proposed Port and Temporary Seaborne Access

Near shore fringing reefal substrates in the vicinity of the proposed Port occur at Boyd Point, Pera Head and between Pera Head and Thud Point. These patchy reefs support hard corals and low profile reefs containing soft coral – sponge assemblages, with generally a low proportion of live cover. The reef habitats have established primarily over ironstone formations. Video results confirm the presence of fringing and submerged reefs located at Boyd Point, approximately 2km north of the proposed Port, and Pera Head approximately 2.8km south of the proposed Port. These reefal substrates cover an area of approximately 49ha and 72ha respectively.

Percentage cover of benthic assemblages on 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. At Boyd Point, 26 of the 94 locations recorded habitat suitable for colonisation (i.e. rock and/or other cover such as algae). At Pera Head, 49 of the 269 locations recorded habitat suitable for live cover (i.e. rock) and 26

of the locations recorded live cover ranging from 5% to 100% cover at individual sampling locations. **Figure 7-2** shows the locations where live cover and suitable habitat were recorded. **Table 7-4** presents the estimates of cover derived from the data collected (refer to Section 6.1.1 of the Queensland SEIS for further details (RTA 2012)).

Table 7-4 Inshore Reef Areas and Extent of Dominant Benthic Assemblages

Location	Total estimated substrate available for reefal colonisation (ha)	Estimated % Hard Coral Cover	Estimated Total Hard Coral (ha)	Estimated % Soft Coral Cover	Estimated Total Soft Coral (ha)	Estimated % Sponge Cover	Estimated Total Sponges (ha)
Boyd Point	49	4.2%	2.1	2.7%	1.3	2.1%	1.0
Port area (between Boyd Point to Pera Head) [1]	23	0%	0	1.0%	0.2	1.8%	0.4
Pera Head	72	6.2%	4.5	6.3%	4.5	3.7%	2.7
South from Pera Head to Thud Point (inferred) [2]	274	6.2%	16.9	6.3%	17.2	3.7%	10.2

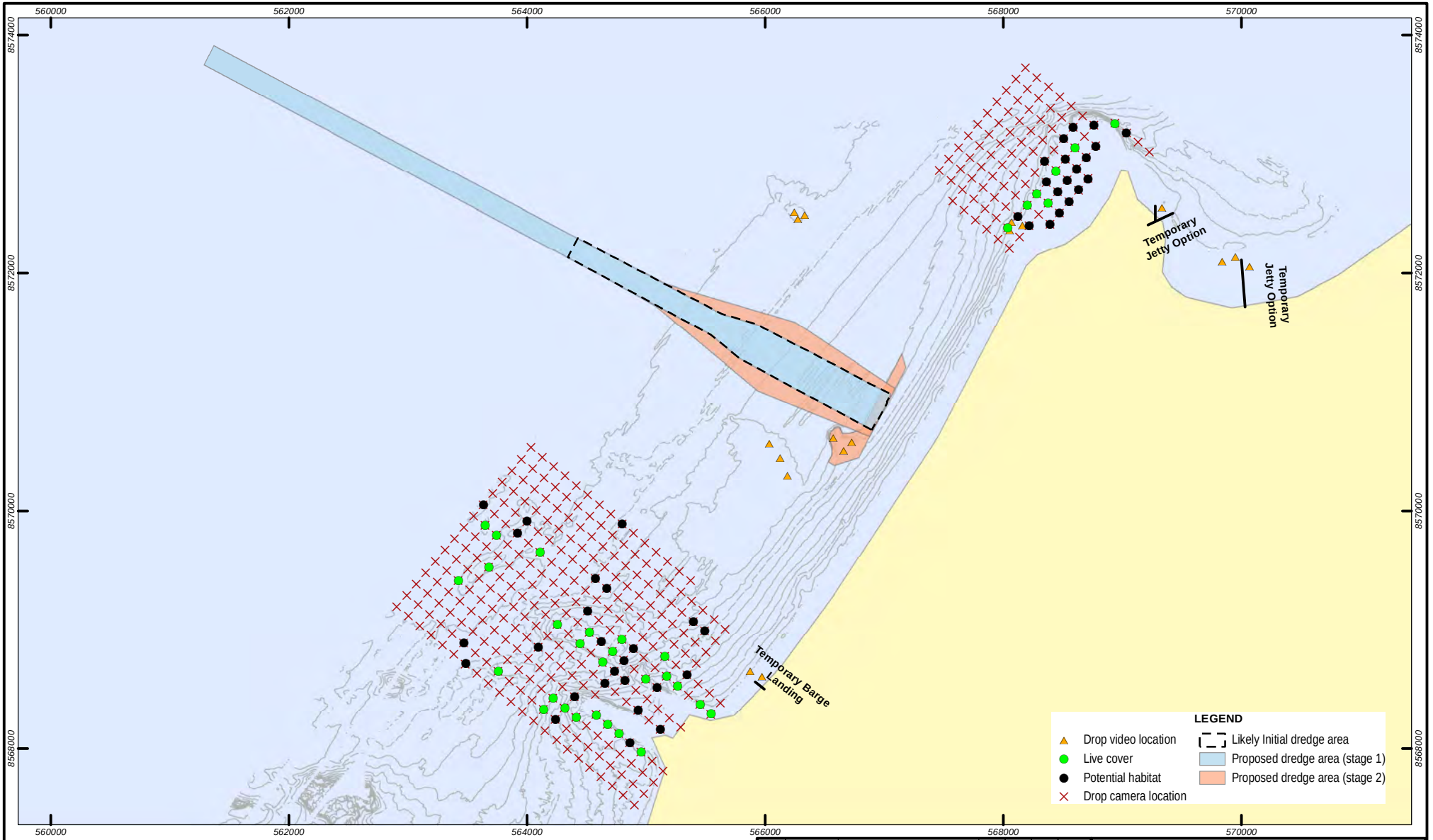
1 The estimates of reefal area available, and estimates of live cover for the Port area were based on a review of six videos (with limited resolution). Refer to Section 6.1.2 of Queensland SEIS (RTA 2012) for details.

2 The estimated reefal area available for colonisation south from Pera Head to Thud Point was inferred from analysis of aerial photographs. As there are no direct data on live cover from this area, the estimates are based on the maximum percentage cover from the areas where data were available.

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 Estuarine Crocodiles pose a safety threat.

Overall, the reef systems between Boyd Point and Pera Head (inclusive) cover approximately 144ha, of which 6.6ha is hard coral, 6.0ha is soft coral and 4.1ha is sponges. The reef systems south of Pera Head to Thud Point cover approximately 274ha, of which 16.9ha is hard coral, 17.2ha is soft coral and 10.2ha is sponges. No coral or sponge habitat would be removed during Stage 1 of the proposed Port. Approximately 6ha of sponge habitat with less than 2% live cover would be removed should Stage 2 of the Port be developed.

Additional drop camera surveys undertaken in February 2012 confirmed that there was no live coral or reef to support coral in the footprint of the proposed temporary barge landing area, Boyd Bay temporary passenger jetty option or anchorages, however live coral was present in the footprint of the 2m wide temporary passenger jetty option near Boyd Point. A qualitative review estimated that live coral cover ranged between 5-25% in sandy areas between coral outcrops (bombies) and 30-60% on the outcrops. Large *Porites* bombies (up to 2m diameter) are the dominant reefal structure in this area. Plate corals (comprising mostly *Montipora* sp.), *Acroporids*, *Faviids*, *Turbinaria* sp., *Pocillopora* sp. and soft corals are also common. Images of benthic habitats from Boyd Point reef, Pera Head reef, the proposed Port, Thud Point reef and open benthic habitat within the departure channel area are shown in **Plate 7-1**. Where possible, piles would be positioned to avoid coral outcrops; however, very small areas of live coral may be disturbed if the passenger jetty is constructed in this area.



Source information:
Bathymetry supplied by Matrix Consulting.
Boyd Point dredging plan based on 501-S0-1710-00100_00G.DXF supplied by client 2012

0 0.5 1
Kilometers

SCALE: 1:45,000 (at A4)
GDA 1994 MGA Zone 54

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SOUTH OF EMBLEY PROJECT

Figure 7-2: Reefal Habitat Between Pera Head and Boyd Point

Project No: 301001-01069	Figure: 01069-00-GM-DAL-0065	Rev: 2

Compiled by BRISBANE GEOMATICS

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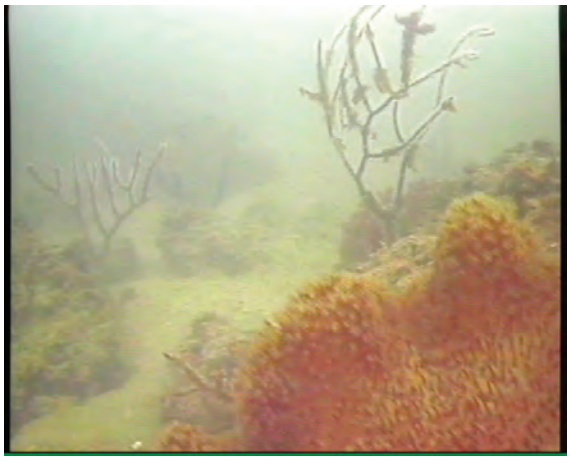
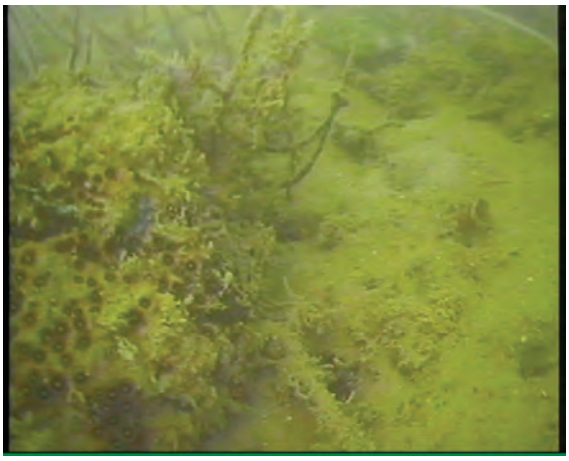
Plate 7-1 Images of Typical Benthic Assemblages

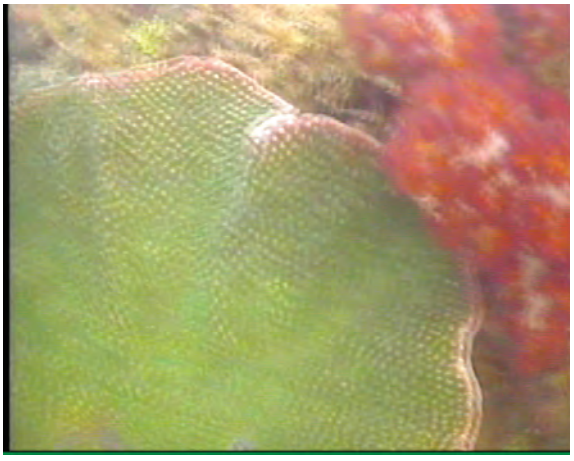


Boyd Point – Mixed branching soft corals, hard corals, rocks, sand and Sarcophyton (soft coral)

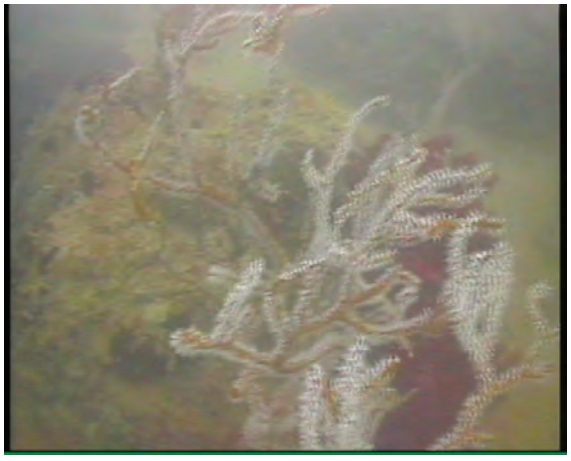


Boyd Point Reef Spur – Seawhips, soft corals, entrusting algae and zoanthids

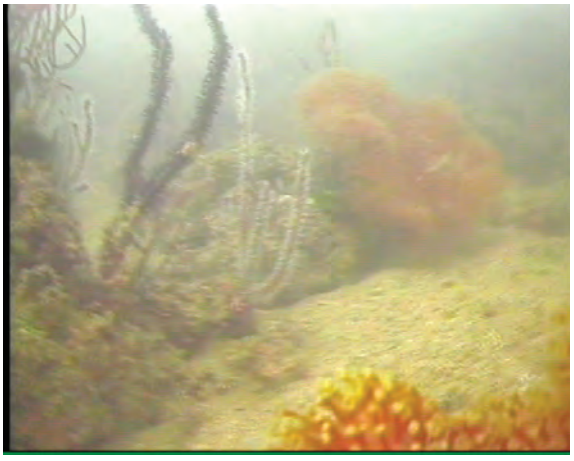
Pera Head – Turbinaria hard coral, seawhips, rocks and entrusting algae



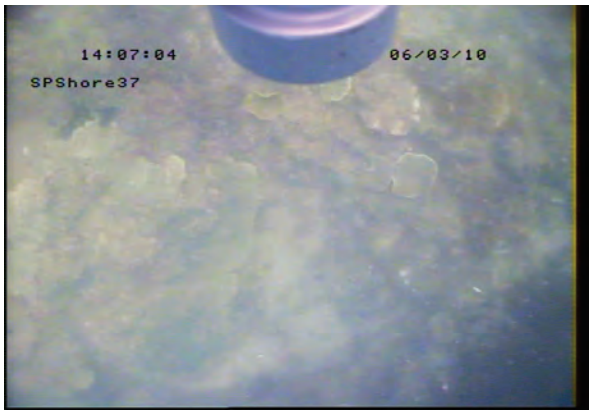
Pera Head – Turbinaria hard coral and soft coral



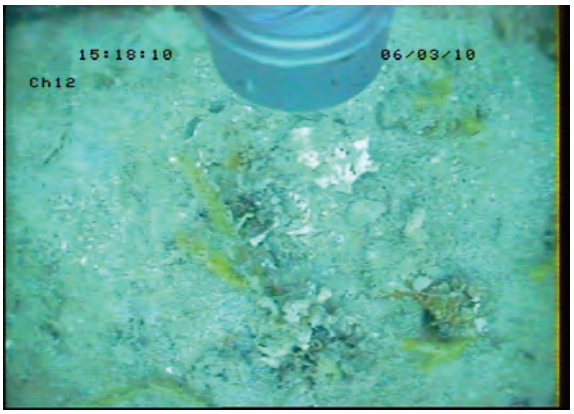
Pera Head – Branching soft corals, polyps out



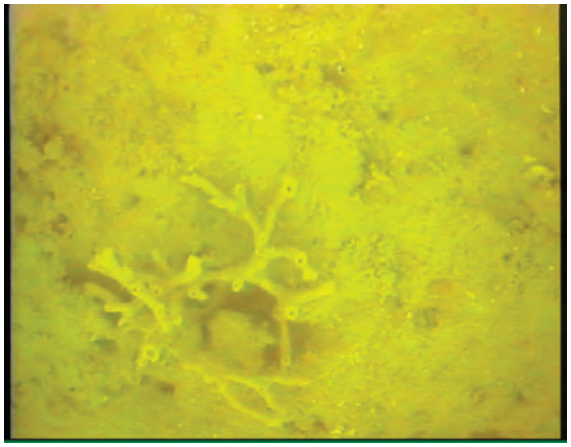
Pera Head – Soft corals, rock and coarse sand substrate at base of reef slope



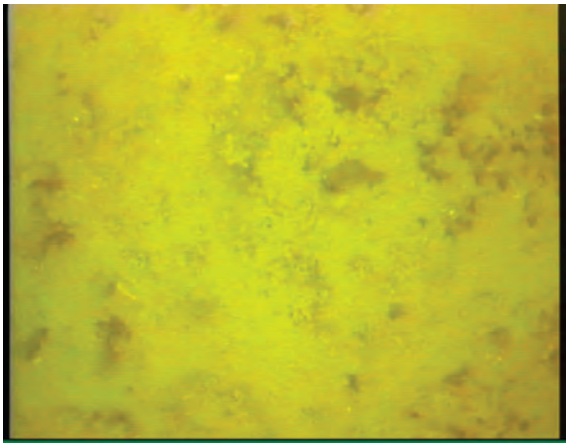
Shallow reef spur south of Pera Head – Montipora and Turbinaria hard corals.



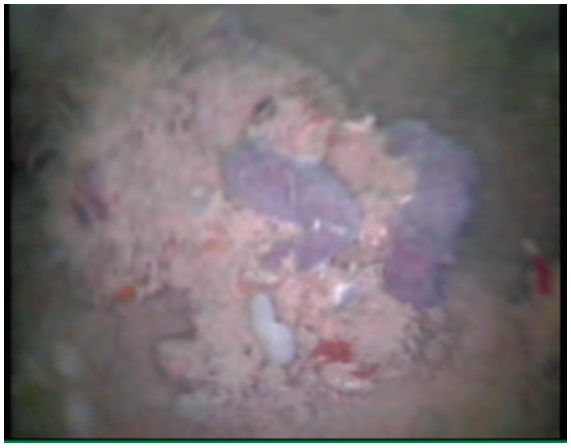
Inner channel alignment – Sponges, bryazoans and encrusting algae



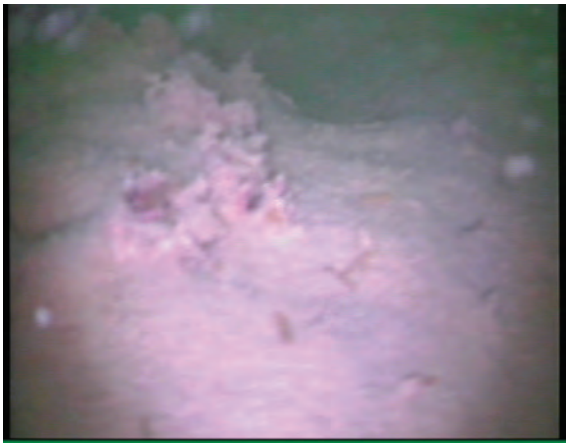
Port berth area – Open silty sand with sponge



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 the lifecycles of near-shore 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 midshelf and inshore reef corals. They noted that in contrast to corals located on mid to offshore reefs, which are commonly broadcast spawners having one gametogenic cycle a year, many of inshore and coastal coral species do not mass-spawn, or have variable modes of reproduction that are poorly described. Research indicated that inshore corals of the genera *Porites*, *Pavona* and *Turbinaria* generally have colonies that contain separate sexes and spawn their 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, which are also commonly identified in inshore areas, 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 in inshore areas of the Pilbara region to not spawn synchronously over a few nights each year. Consequently, their patterns of reproduction are unpredictable and remain largely unknown. The situation discussed by Gilmour *et al.* (2006) may reflect the situation of inshore reef areas of the Gulf of Carpentaria and therefore specific times of spawning within the year and in the Project area may be difficult to predict. However, the research described above may indicate 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 habitats may provide a food resource for a range of marine turtle species in the area.

7.2.4.2 Proposed New Spoil Ground

Eighteen towed video sled transects were undertaken in October 2007 within and adjacent to the proposed new spoil ground. The proposed new spoil ground offshore from Boyd Point is located in approximately -25m water depth to LAT. No seabed features (e.g. patch reefs) were identified within the footprint of the proposed new spoil ground. The proposed new spoil ground location was selected primarily due to the absence of such features. The area is characterised by flat, unvegetated, soft sediment (**Section 7.2.4**) 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 new spoil ground 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 –25m LAT, arising from a silty sand substrate and occasional rock outcrops.

Nine Mile Reef is accessed frequently by recreational fishers targeting species such as mackerel, cobia, tuna, finger mark and trevally.

7.2.5 Mangrove Habitat

Mangrove communities were surveyed 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.

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, Hornibrook ferry terminal location and Humbug barge terminal location (**Plate 7-2**).

At the proposed Hornibrook terminal location, to the north east of the proposed car park and landing, a mangrove community has developed within the tidally inundated low area within bunds constructed by North Queensland Bulk Ports in the 1980's for retaining dredge spoil from the Port of Weipa. This community includes Club Mangrove (*Avicennia annulata*), Spotted-leaved Red Mangrove (*Rhizophora stylosa*), Tall Stilted Mangrove (*Rhizophora apiculata*), Cottonwood (*Hibiscus tiliaceus*), Grey Mangrove (*Avicennia marina* subsp. *eucalyptifolia*), and Blind-your-eye Mangrove (*Excoecaria agallocha*). For more information refer to the Section 2.7.3 in the Queensland SEIS (RTA 2012).

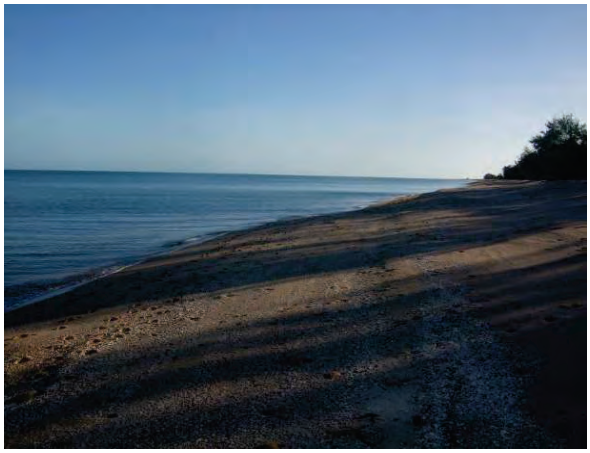
The foreshore at the location of the proposed Hey River barge/ferry terminal has a thin mangrove fringe (1–2 trees wide), established over a mud and gravel shore at the base of a low pisolite plateau.

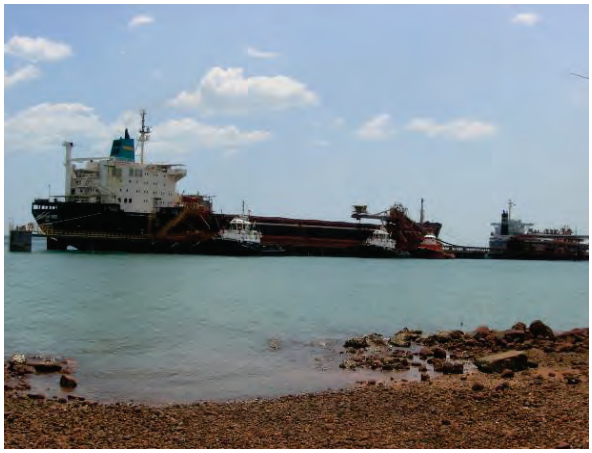
A maximum of 400m^2 of mangroves would be required to be removed to construct the Hey River barge/ferry terminal. The mangrove species in the Hey River estuary include:

- *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 (RTA 2011).

Plate 7-2 Proposed Port Location (left) and Proposed Hornibrook Ferry Terminal Location (right)





7.2.6 Estuarine Habitat

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 the estuaries. Saline flats are common on the landward side of mangrove forests and are particularly extensive along lower Winda Winda Creek and the Ward River. These flats 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 *Eleocharis 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).

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 that limit tidal intrusion and the development of an "estuarine" mixing zone. These latter systems are more appropriately described as swale swamp ecosystems.

Distinctions in estuarine catchment hydrology influence the composition and relative dominance of the 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 in 2002 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 against 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).

7.2.7 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) or –2.2m LAT (Roelofs *et al.* 2003).

DAFF 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, 2008 and 2011 (DAFF and NQBP 2011);
- annual mapping of seagrass distribution and confirmation of species composition in a defined Intensive Monitoring Area (IMA; refer **Figure 4-7**), which focuses on meadows in the vicinity of the existing Port of Weipa 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 4-7** for meadow locations) primarily in the Embley River.

The 2011 survey of the entire Port of Weipa (DAFF and NQBP 2011) identified approximately 4,155ha of seagrass present primarily in aggregated patches, with continuous cover representing only about 5% of seagrass area. The mapped area was the lowest recorded since September 2001.

7.2.7.1 Port Area Seagrass Distribution

The annual 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; however, aerial surveys every three years are used to map seagrass beds in areas outside the IMA.

Extensive towed video and drop camera video surveys undertaken for the Project between Boyd Point and Thud Point and at the proposed new spoil ground found no seagrass in either of 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. No seagrass beds were found, or are known to occur, within the footprint of the proposed Port.

Physical conditions, sediments and prevailing bathymetry are unlikely to support the occurrence of seagrass within the footprint of the proposed Port (Rasheed, Pers Comm. 2010). Further details of the

prevailing oceanographic conditions and coastal processes are provided in Section 6.1 of the Queensland EIS (RTA 2011).

Historical surveys undertaken between 1984 and 1988, and identified from the DAFF 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 *H. ovalis* adjacent to the mouth of Norman Creek, about 15km south of the proposed Port; and,
- 5% cover of *H. decipiens* located approximately 45km south of the proposed Port near Aurukun.

The locations of the three patches of seagrass in Boyd Bay and south to Aurukun identified during surveys from 1984 to 1988 and in 2012 are shown on **Figure 4-3**. The seagrass species identified are considered pioneering species and highly variable in their distribution over time.

In February 2012, additional surveys were also undertaken at the proposed temporary seaborne access areas and anchorages locations. No seagrass was found in the footprints of the temporary barge landing area, the Boyd Point temporary passenger jetty option or anchorages. Low density (overall density of 8.7 ± 1.3 shoots/m^2), isolated patches of seagrass (*H. uninervis*) was found during the survey of the Boyd Bay option for the proposed temporary passenger jetty. A maximum direct disturbance area of 20m^2 due to piles for the temporary passenger jetty would occur in this area if this option is chosen.

7.2.7.2 Embley and Hey River Seagrass Distribution

In August 2011, it was estimated there were approximately 1,031ha of seagrass in 14 meadows within the bounds of the IMA within the Embley and Hey Rivers (DAFF and NQBP 2011). This continues the steady increase in seagrass area within the IMA since the lowest recorded levels in 2008 and is the largest area recorded since 2004, although it is still significantly lower than the peak recorded in 2001. Seagrass meadows in the IMA continue to be dominated by *E. acoroides*, a distinctive species with very long, ribbon like leaves (30–150cm long and 1.5cm wide). Overall, seagrass was considered to be in a reasonable but vulnerable condition (DAFF and NQBP 2011). **Figure 4-6** shows the seagrass meadow types and cover (aggregated patches, continuous cover or isolated patches) within the IMA during the August 2011 survey in relation to the proposed barge and ferry terminal infrastructure.

The extent and cover of the seagrass beds in Albatross Bay and estuaries can vary significantly on an annual basis. Climatic conditions are 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 of 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 attributed to a response to regional and local climate conditions, including exposure during tidal cycles, temperature and solar irradiance, leading to “burning” – browning of the leaves and subsequent death of the plant. Monitoring 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. In 2010, the biomass in A2 increased significantly, before significantly decreasing again in 2011 (similar to the biomass reported in 2009). While DAFF considers the driver for *Enhalus* sp. biomass change is tidal exposure, it does not discount that other natural and anthropogenic factors may contribute (McKenna and Rasheed 2010).

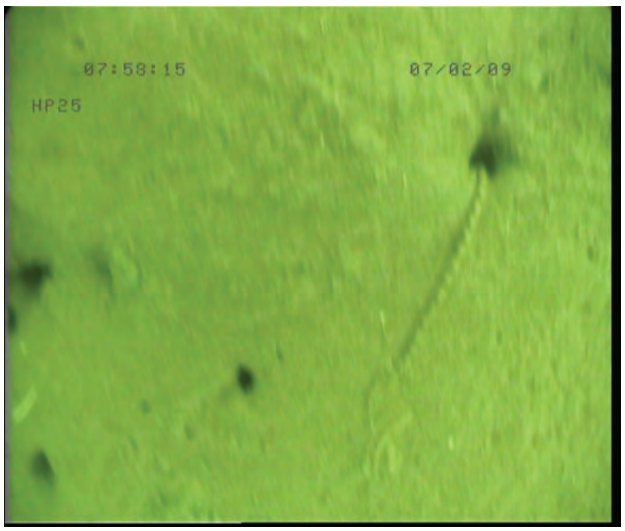
Additional detailed inspection for seagrass at the Hornibrook ferry terminal, Humbug barge terminal, and Hey River barge/ferry terminal locations was undertaken during July 2009 and February 2012, as described below.

Hornibrook Terminal

Surveys undertaken by DAFF (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 (**Figure 4-4**).

Drop camera video survey of the sub-tidal banks at Hornibrook Point was undertaken in July 2009 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 Hornibrook terminal to a maximum depth of approximately 0.3m LAT (–2.1m MSL). The substrate within the dredge footprint of the Hornibrook terminal comprised bare, soft silts (refer **Plate 7-3**).

Plate 7-3 Bare Soft Soils within the Dredge Footprint



Sampling using a van Veen grab was undertaken in February 2012. The survey did not identify seagrass within the dredging footprint of the Hornibrook terminal or in areas landward of the Lorim Point Ship Loaders, however *E. acoroides* leaves (no rhizomes attached) were identified at one location within the proposed tug berth footprint adjacent to the Hornibrook terminal and at several locations further to the east. As there were no rhizomes attached in these samples, it is possible that the leaves drifted to these locations with tides/currents. *Enhalus acoroides* (with rhizomes attached) was confirmed in three locations approximately 600m east of the proposed Hornibrook terminal. The substrate within the dredge footprint of the Hornibrook terminal comprised soft silts with bauxite in locations near the ship loader conveyor.

The absence of seagrass during the 2012 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 surveys by DAFF (September 2009, September 2010 and August 2011) indicated only aggregated patches of *E. acoroides* were present in the vicinity of Hornibrook Point and within the adjacent embayment to the east (**Figure 4-4**).

Humbug Terminal

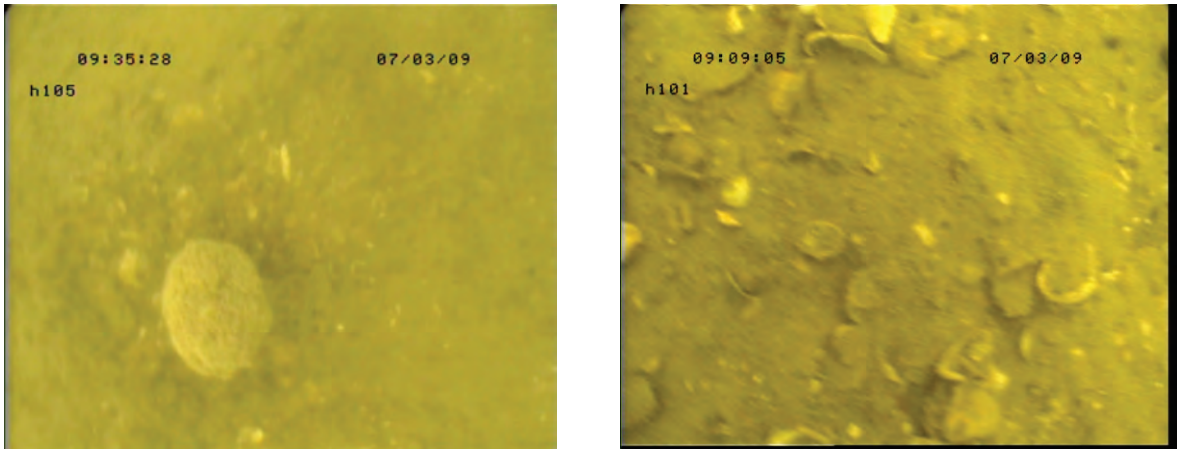
Surveys of the proposed Humbug terminal area and surrounds in July 2009 did not identify seagrass within or immediately adjacent to its proposed dredging footprint. However, visual inspection during early May 2010 coinciding with peak spring tides, did reveal isolated patches of *E. acoroides* in good condition within and adjacent to the proposed dredge footprint of the Humbug terminal at low tide. Grab sampling undertaken in February 2012 found no seagrass within the dredge footprint of the Humbug terminal, but did record one sample approximately 100m north north-west of the dredge area (*H. ovalis*). A large patch of exposed rubble was observed within the intertidal zone between Humbug Wharf and the Weipa sewage outfall, at a distance of approximately 300m from the Humbug Wharf. A range of encrusting biota was associated with this rubble field. The February 2012 grab survey within the proposed Humbug terminal dredge footprint found fine silts in inshore locations with increasing amounts of shell grit and fine sand further offshore.

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 (**Plate 7-4**).

Seagrass monitoring between 2000 and 2011 (Chartrand and Rasheed 2009, DAFF and NQBP 2011, McKenna and Rasheed 2010) in the vicinity of the Hey River terminal location occasionally reported a very thin patch of isolated seagrass. The species composition of this seagrass has varied over the years, being recorded as absent in 2000, 2003, 2006, 2007, 2009 and 2010, as *H. uninervis* with *H. ovalis* in 2001, as *E. acoroides* with mixed species in 2002, as *E. acoroides* in 2004, 2005 and 2008, and as isolated *H. uninervis* (narrow leaf form) in 2011.

Plate 7-4 Hey River Terminal Area: Soft Coral (left). Mud and Shells give way to Gravel and Rocky Rubble nearer the Intertidal Zone (right)



Preliminary drop camera surveys undertaken in the Hey River terminal dredge footprint in October 2007 and November 2008 did not record any seagrass. An additional detailed survey was undertaken in June 2009 to confirm the absence of seagrass within the Hey River terminal dredge footprint and adjacent areas. Based on the prevailing tidal conditions, drifting drop camera video inspection was undertaken along 12 transects encompassing the proposed dredge 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 +0.3m to –1.8m LAT, which is well within the primary depth range of seagrass reported for the Embley River estuary by Roelofs *et al*. (2003) of shallower than -2.2m LAT (-4m MSL). No seagrass was recorded from the drift video transects undertaken. 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. *H. ovalis*). Grab surveys conducted in February 2012 also did not find any seagrass within, or adjacent to, the Hey River terminal dredge area (**Figure 4-7**).

The small cove and associated intertidal zone to the north of the proposed Hey River terminal has consistently been reported by DAFF as having a seagrass meadow comprised of isolated and/or aggregated seagrass. In 2000 it was reported as an isolated *H. uninervis* / *H. ovalis* mixed species meadow, between 2001 and 2008 it was reported as an aggregated or isolated meadow dominated by *E. acoroides*, in 2010 it was reported as an isolated *H. uninervis* meadow, and in 2011 it was reported as an isolated *E. acoroides* meadow.

Inspection of the small cove and associated intertidal zone to the north of the proposed Hey River terminal in June 2009 did not locate aggregated seagrass patches as mapped in 2008 (Chartrand and Rasheed 2009). Rather, this intertidal area was dominated by a dark rock and rubble substrate. Grab sampling in February 2012 also could not confirm the presence of seagrass, however, three samples from this cove did have *E. acoroides* leaves present and examination of the vessel's depth sounder indicated that isolated patches of a large seagrass were likely to be present.

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). 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.

Overall, it is considered that if any seagrasses do occur at the proposed Hey River terminal site from time to time, they are likely to contribute minimally to primary productivity in the area.

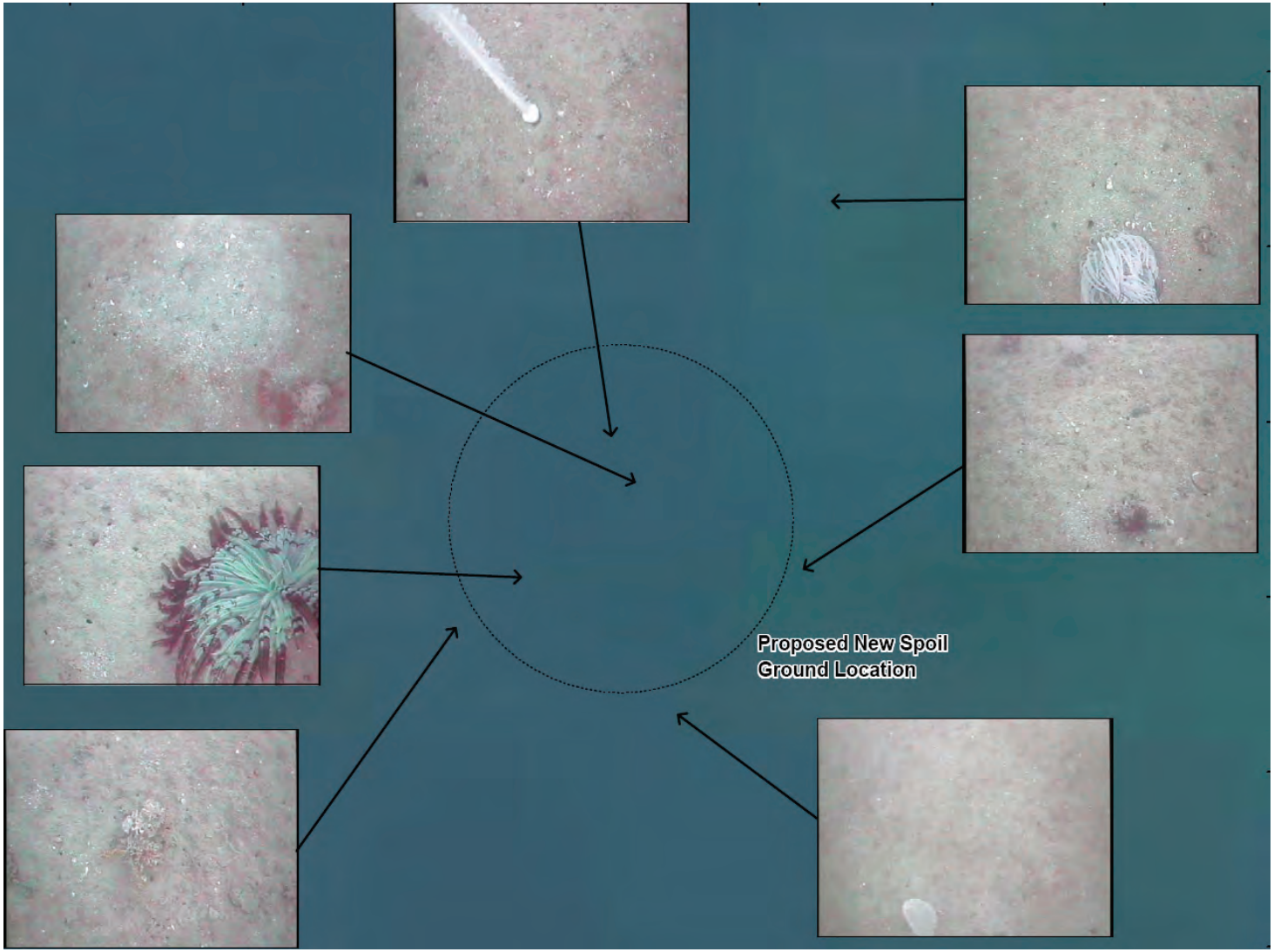
7.2.8 Ward River and Norman Creek

Historical observations of the Norman Creek estuary identified seagrass beds including *H. ovalis*, *H. pinifolia* and *E. acoroides*, and *H. ovalis* and *H. pinifolia* in the Ward River estuary. Formal surveys in May 2009 recorded only *H. pinifolia* in both of these estuaries. At both locations, seagrass was patchily distributed and primarily restricted to shallow intertidal flats. Average cover of seagrass was higher in the Ward River estuary, where survey efforts concentrated on the lower estuary "Ward Lake" site, in which cover ranged from 0-65% (average cover between 7% and 56%). In Norman Creek cover ranged from 0-40%, but averaged less than 10% at all sites. Further details of these surveys are provided in Section 8.6.2.2 of the Queensland EIS (RTA 2011). It is recognised that the May 2009 survey represents only a single snapshot in time, and that the biomass and diversity of seagrass communities will vary seasonally. Summer (wet season) freshwater flows and runoff are known to reduce seagrass abundance (Coles *et al.* 2004).

7.2.9 Soft Sediment Habitat

The Project area contains extensive intertidal and sub-tidal soft sediment habitats. The development footprints for all marine infrastructure components of the Project (Port area, proposed new spoil ground, Albatross Bay spoil ground, Hornibrook ferry terminal, Humbug barge terminal, Hey River barge/ferry terminal, and anchorages) 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. Field surveys show the Albatross Bay spoil ground and the anchorage area off the Port of Weipa is not shallow in nature, is not close to any reef communities and does not contain any seagrass beds **Figure 7-3** shows the types of unvegetated seabed at the proposed new spoil ground in October 2007.

Figure 7-3 Seabed at the Proposed New Spoil Ground



7.2.10 Dredge Material Sediment Testing

The chemical and physical characteristics of material that would be dredged from the proposed Port area and the barge/ferry terminals were assessed in accordance with *National Assessment Guidelines for Dredging 2009* (NAGD). The assessments (Worley Parsons 2012a and 2012b), which included elutriate and bioavailability testing, concluded that all dredge spoil is suitable for unconfined ocean disposal. Testing did not identify any constituents present at contaminant levels of environmental concern that would persist in the water column during dredging or sea disposal. A copy of the Sea Disposal Application forms are provided in **Appendix 7-B**.

The Draft Dredge Management Plans for the proposed Port and river facilities are presented in **Appendix 7-C** and **Appendix 7-D** respectively.

7.3 Marine Turtles

7.3.1 General Overview

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 low densities in the vicinity of the Project area and feed in the surrounding waters. Flatback Turtles nest all year round, with a peak in nesting occurring between May and September. Uncertainty exists over the peak timing of nesting of the other species in the Project area (DSEWPaC 2012f).

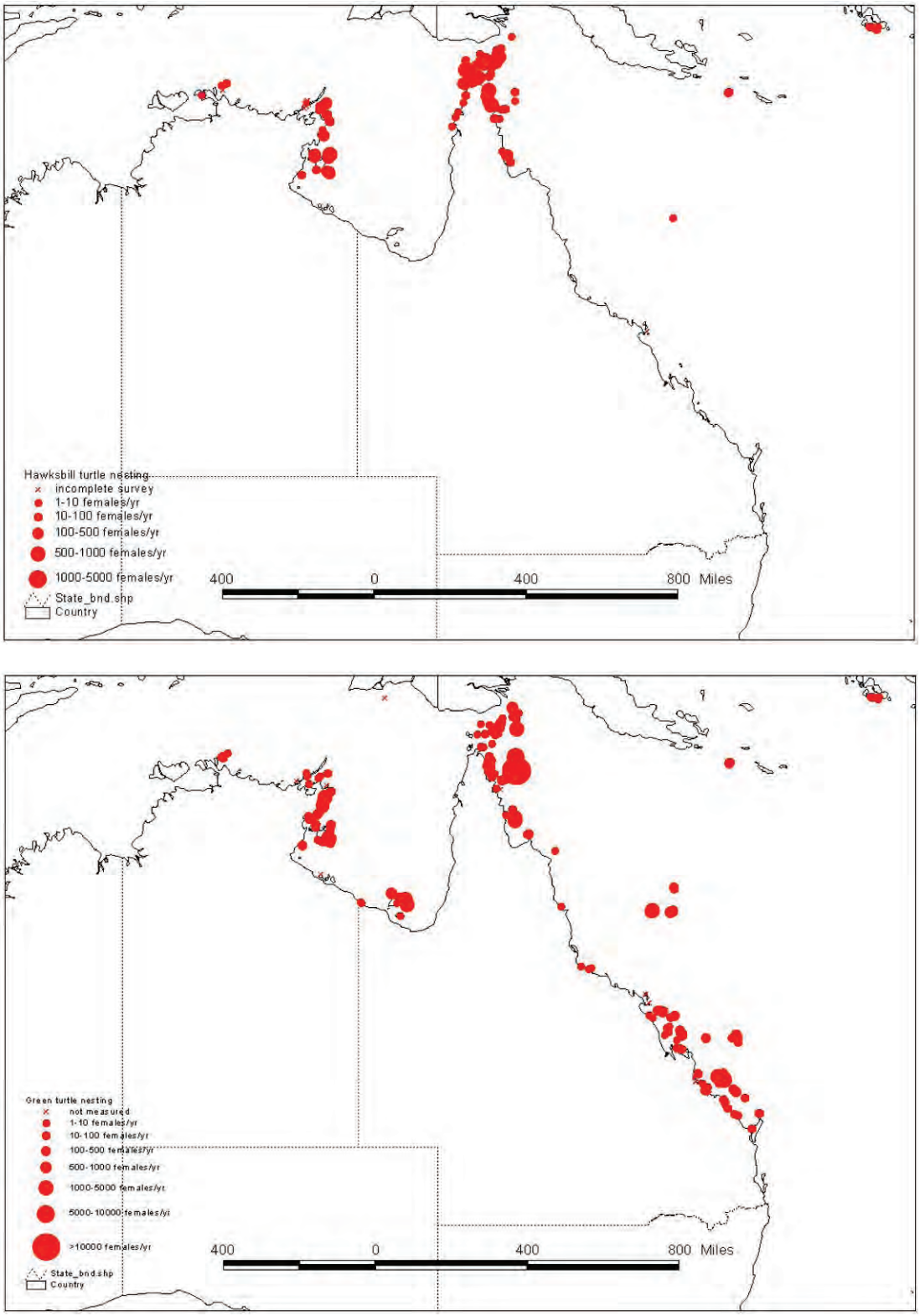
A further three marine turtle species – the Loggerhead Turtle (*Caretta caretta*), the Leatherback Turtle (*Dermochelys coriacea*) and the Green Turtle (*Chelonia mydas*) have not been recorded nesting but may feed in the waters surrounding the Project area. The Leatherback Turtle is generally recognised as principally utilising offshore pelagic areas for foraging, and coastal waters such as the proposed Port site are not key habitat for this species. The known nesting locations of these six marine turtle species in northern and eastern Australia are shown in **Figure 7-4** to **Figure 7-6**. All are listed as threatened species under the EPBC Act.

Marine turtles are characterised by a complex life history whereby all species undertake significant migrations between nesting, mating and foraging grounds, although the extent of these migrations varies between species. 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 marine 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).

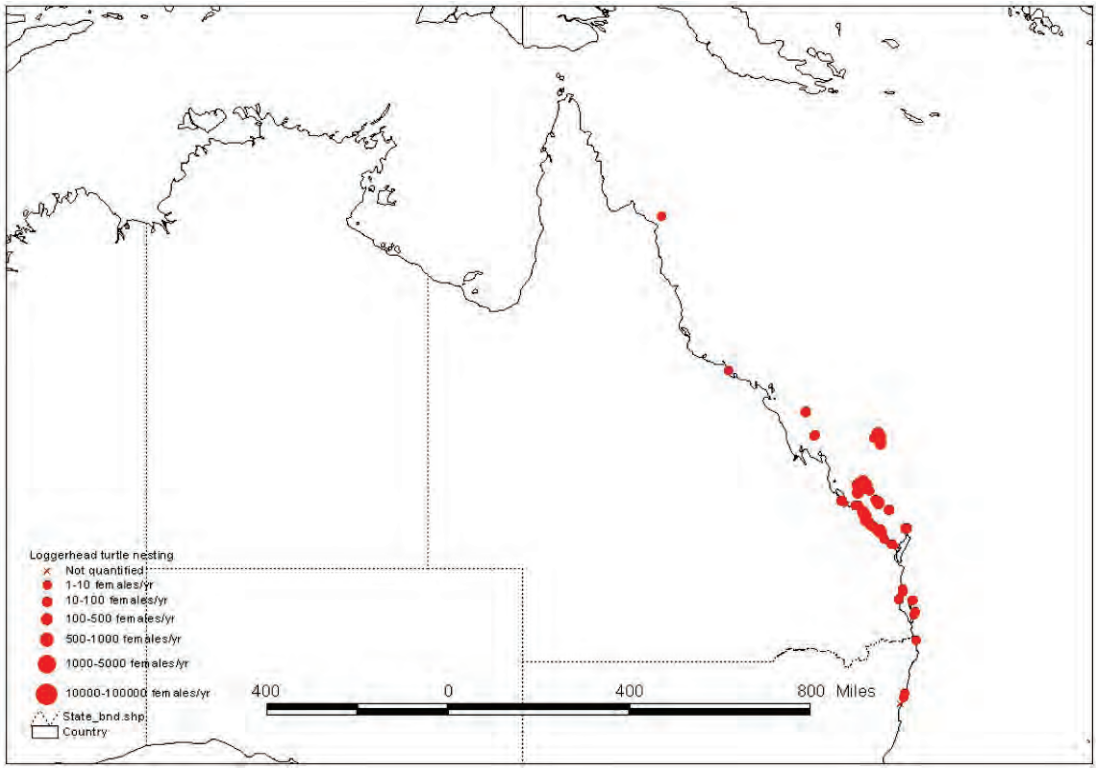
Once hatched, lighting cues are critical for hatchlings to move from the beach to the ocean – a behaviour known as sea-finding. In simple terms, where there are no anthropogenic light sources, hatchlings move away from the dark silhouetted shoreline towards the brighter ocean horizon. Brightness in this context 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, marine 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).

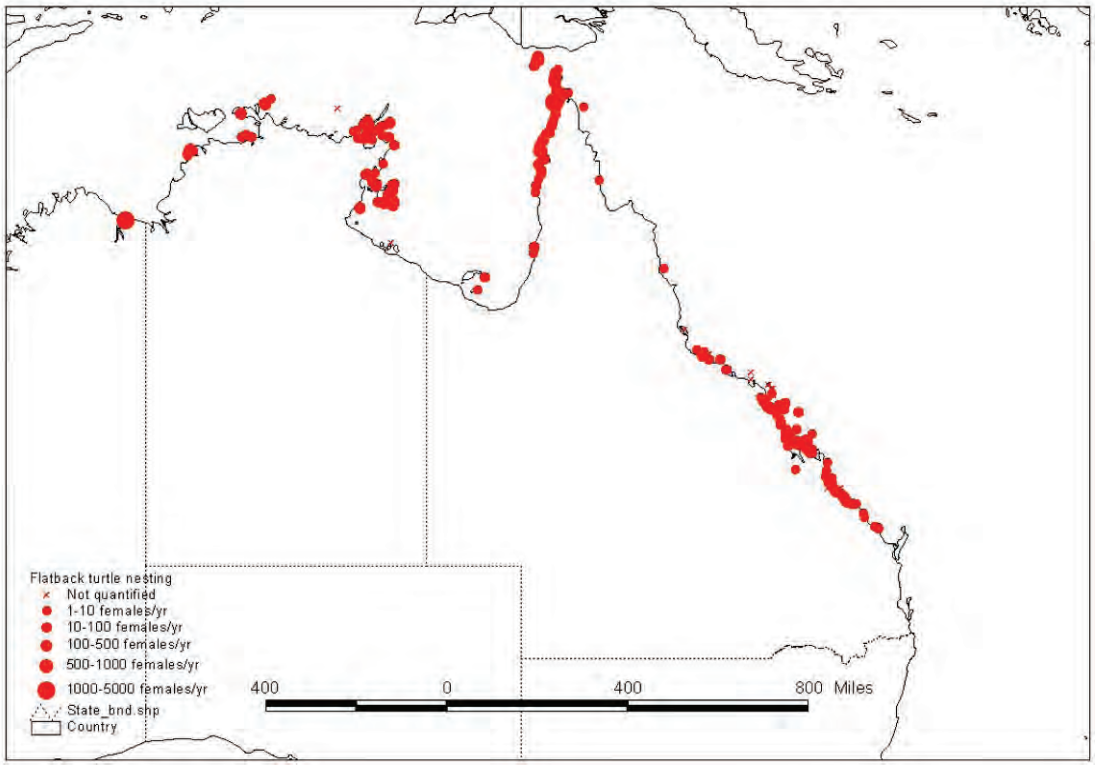
Figure 7-4 Nesting Locations for Hawksbill Turtles (top) and Green Turtles (bottom)



Source: Limpus and Miller (2008)

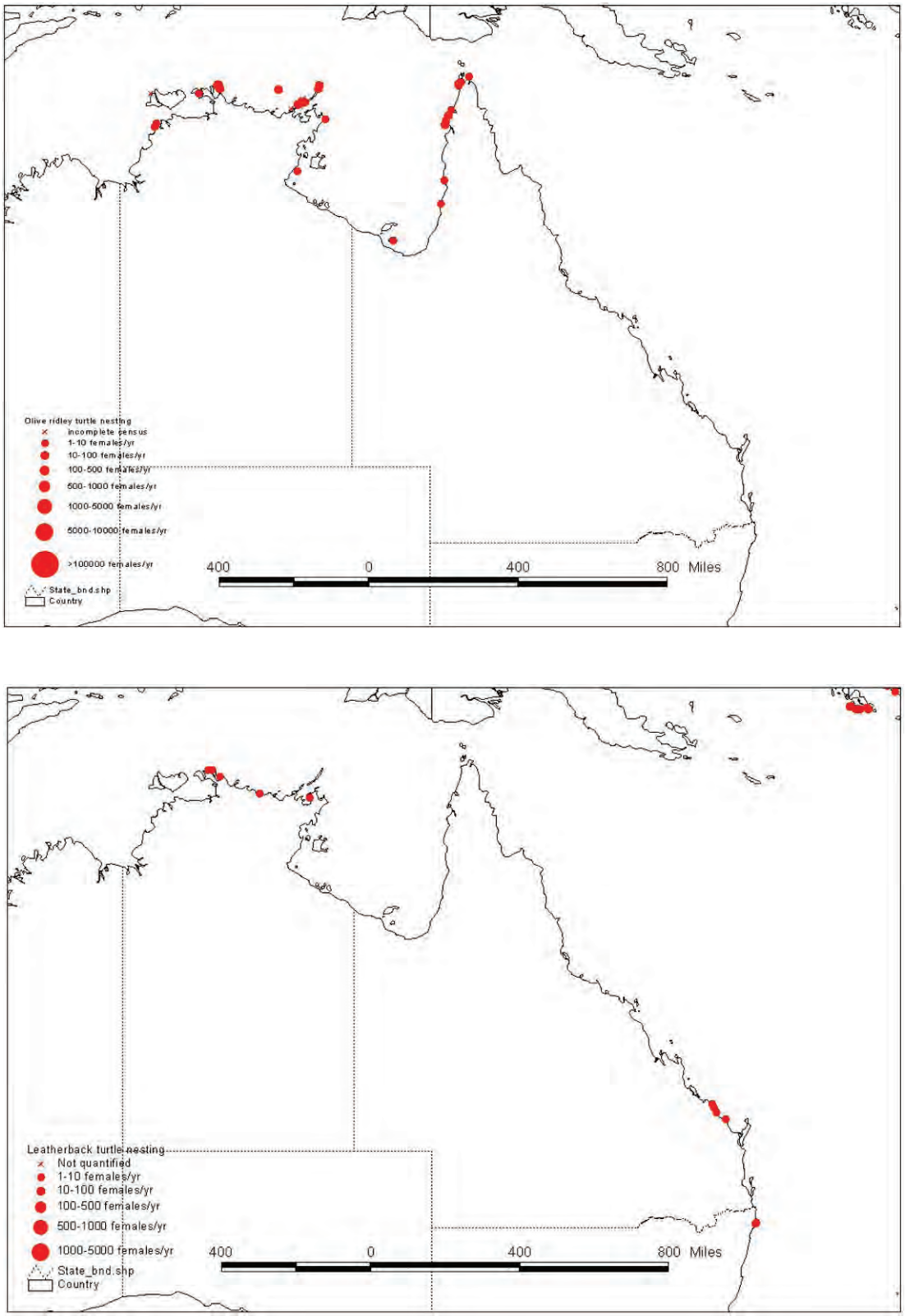
Figure 7-5 Nesting Locations for Loggerhead Turtles (top) and Flatback Turtles (bottom)





Source: Limpus and Miller (2008)

Figure 7-6 Nesting Locations for Olive Ridley Turtles (top) and Leatherback Turtles (bottom)



Source: Limpus and Miller (2008)

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 marine 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. 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) (**Plate 7-5** and **Plate 7-6**). Predation by feral pigs is currently considered the most significant of these threats. Feral pigs are a well-acknowledged environmental problem in Australia. Predation has been identified as a key threat to marine turtles under the EPBC Act in the 'Recovery Plan for Marine Turtles in Australia' (Environment Australia 2003) and the *Threat Abatement Plan for predation, habitat degradation, competition and disease transmission by feral pigs* (DEH 2005). Doherty (2005) and Limpus and Chatto (2004) identify one of the greatest threats to marine turtle populations on the west coast of Cape York is the loss of eggs from predation by feral pigs. Doherty (2005) reported 70% of nests surveyed in 2003-2004 between Pennefather River and Duyfken Point were destroyed by feral pig predation, with a 100% predation rate early in the nesting season. The Cape York Sustainable Futures (CYSF) Sea Turtle Project (CYSF 2011) reported that between 2009 and 2011 well over 30,000 feral pigs have been eradicated from fragile coastal ecosystems (on western Cape York) through aerial culling. This eradication program resulted in a reduction of feral pig predation on marine turtle nest eggs by up to 70% in the majority of key breeding areas on the western coast of Cape York. Prior to the commencement of the CYSF project feral pigs were predating close to 100% of turtle nests laid on Western Cape York beaches.

Available data indicates that currently between 70% and 100% of turtle nests are predated by feral pigs. This is consistent withthe intensity of nest disturbance by feral pigs that was observed during surveys in 2007 and 2008 as being 70%, particularly at Boyd Point immediately to the north of the proposed Port area where there are no cliffs impeding beach access. Based on a 70% reduction in predation rate due to feral pig control demonstrated by CYSF, it is expected that 50% to 70% of nests would produce hatchlings.

Ghost nets are discarded or lost nets that float in the ocean until they wash up on beaches. These nets can entangle and kill marine turtles in the open ocean and/or 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 (Ghost Nets Australia 2012).

Preferred food items for marine turtles vary between species and can include seagrass, seaweed, soft-bodied animals (such as soft corals, sea cucumbers and jellyfish), bivalve and gastropod molluscs, and crabs (Bjorndal 1996, Brand-Gardner *et al.* 1999, Limpus 2007, 2008a, 2008b, 2008c, 2009a 2009b).

Distribution, habitat preferences, and threats for each marine turtle species are detailed in the species profiles in **Section 7.3.2** and their foraging habitats and preferred food items are summarised in **Table 7-5**.

Plate 7-5 Example of Feral Pig Digging North of Boyd Point

Plate 7-6 Juvenile Olive Ridley Turtle Carcass in a Ghost Net near Pera Head

Table 7-5 Marine 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)

7.3.2 Species Profiles

7.3.2.1 Green Turtle (Chelonia mydas)

Regional Distribution and Population

Green Turtles are listed as vulnerable and migratory under the EPBC Act.

Green Turtles are found in tropical and subtropical waters throughout the world. The SPRAT database estimates that the Australian populations of Green Turtles consist of more than 70,000 individuals, distributed across seven genetically distinct regional subpopulations (DSEWPaC 2012q).

The Green Turtle has a worldwide distribution in tropical and subtropical waters. Major Green Turtle nesting colonies in the Atlantic occur on Ascension Island, Aves Island, Costa Rica, and Surinam.

Within the U.S., Green Turtles nest in large numbers in Florida and Hawaii. In Australia, there are seven regional populations of Green Turtles that nest in different areas: the southern Great Barrier Reef; the northern Great Barrier Reef; the Coral Sea; the Gulf of Carpentaria; Western Australia's north-west shelf; the Ashmore and Cartier Reefs; and, Scott Reef. The largest Green Turtle nesting aggregation in the world occurs on Raine Island, in the Great Barrier Reef, Australia, where thousands of females nest nightly in an average nesting season (Limpus 2008c, Witherington *et al.* 2006). Limpus (2008c) reports that tagged female Green Turtles from the southern Great Barrier Reef subpopulation and the northern Great Barrier Reef subpopulation have been recaptured in the vicinity of the Project area. Thus, Green Turtles found within the Project area may belong to the southern Great Barrier Reef subpopulation (containing around 8,000 individuals), the northern Great Barrier Reef subpopulation (containing around 41,000 individuals) or the southern Gulf of Carpentaria subpopulation (containing around 5,000 individuals), or may be from one of the other subpopulations within the Australasian region.

Green Turtles are distributed throughout tropical zones, and are found nesting in large aggregations at numerous sites including at Ascension Island (Carr 1975), Tortuguero, Costa Rica (Bjorndal 1980), and Raine Island, Australia (Limpus and Reed 1985). The Gulf of Carpentaria reportedly has two main nesting areas including the Wellesley Island Group, with major rookeries at Bountiful, Pisonia and Rocky Islands, and the Eastern Arnhem Land, Groote Eylandt and Sir Edward Pellew Islands area (Limpus 2009a). The known nesting locations of Green Turtles in Australia are shown in **Figure 7-4** and non-nesting records of the species, from the Marine Wildlife Stranding and Mortality Database annual reports and other sightings, in eastern Gulf of Carpentaria are shown in **Figure 7-7**.

Ecology and Habitat

Green Turtles nest, forage and migrate across tropical northern Australia. Green Turtles forage in shallow coastal areas, in particular seagrass beds, feeding principally on seagrass and seaweeds although juveniles are also carnivorous (Bjorndal 1996). Green Turtles are also known to feed on driftlines and rafts of *Sargassum* during their younger pelagic phases. 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. The nearest important known nesting and foraging ground to the Project area is the Wellesley Islands in the south-western corner of the Gulf of Carpentaria. The species is known to migrate more than 2,600km between their feeding and nesting grounds.

Critical habitat is habitat that the Minister has listed in the Register of Critical Habitat (prepared under Section 207A of the EPBC Act) in relation to an EPBC-listed species or ecological community. DSEWPaC's Register of Critical Habitat does not identify any critical habitat for the Green Turtle.

Threats

In Australia, the current main threats to Green Turtles are disturbance (e.g. light disturbance) and habitat damage due to coastal development, by-catch from fisheries and shark control measures, feral pig predation on nests, vessel strikes, entanglement and ingestion of marine debris, and in some areas, Indigenous harvesting (DSEWPaC 2012q).

Currently, there are two major threats to marine turtles along western Cape York – predation of nests by feral pigs and entanglement in lost or discarded fishing nets (ghost nets).

7.3.2.2 Hawksbill Turtle (Eretmochelys imbricata)

Regional Distribution and Population

The Hawksbill Turtle is listed as vulnerable and migratory under the EPBC Act.

Hawksbill Turtles are distributed throughout the tropical, subtropical and temperate waters in all the oceans of the world (DSEWPaC 2012f). There are no accurate estimates of global Hawksbill Turtle population numbers, however, Australia is home one of the largest breeding populations of Hawksbill Turtles in the world (Limpus 1995).

RioTintoAlcan

Project Boundary
Locality
River / Creek
Road / track

Green Turtle *(Chelonia Mydas)*

Stranding Mortality Database Record
Recorded Location

Sources: Atlas of Living Australia (2012), Greenland *et al.* (2002), Greenland and Limpus (2003, 2004), Haines *et al.* (1999), Haines and Limpus (2000), Poiner and Harris (1996), Queensland Museum (2012)

Note: Nesting locations are not shown. See Figure 7-4 for the Green Turtle nesting locations

South of Embley Project

Fig. 7-7: Green Turtle Records (eastern Gulf of Carpentaria)

N

0 150km

Datum/Projection: GDA94/MGA Zone 54 Date: 01/11/2012

Hawksbill Turtles normally nest in diffuse aggregations, with major nesting sites existing at Milman Island, Australia (Loop *et al.* 1995), Tortuguero, Costa Rica (Bjorndal *et al.* 1985), the Seychelles (Diamond 1976), and several other locations. The total population number of Hawksbill Turtles in Australia and within the Project area is unknown. Several thousand females nest along Queensland beaches each year, and approximately 3,000 females in Western Australia. **Figure 7-4** shows the known nesting locations of Hawksbill Turtles in Australia and non-nesting records of the species, from the Marine Wildlife Stranding and Mortality Database annual reports and other sightings, in eastern Gulf of Carpentaria are shown in **Figure 7-8**.

There are two genetically separate subpopulations of the Hawksbill Turtle: 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).

Ecology and Habitat

Nesting of Hawksbill Turtles is mainly confined to tropical beaches between January and April in the northern Great Barrier Reef and in the Torres Strait, and between July and December in the Northern Territory (Chatto 1998, Dobbs *et al*. 1999). Sexual maturity is not reached until after 31 years of age and during breeding, Hawksbill Turtles have an inter-nesting interval (time between clutches) of approximately 14.5 days. Hawksbill Turtles produce large clutches of up to 220 eggs.

The preferred foraging habitat of the Hawksbill Turtle is rocky and coral reefs where it feeds on invertebrates (primarily sponges), and lesser amounts of algae and seagrass. The species is known to migrate up to 2,400km between foraging areas and nesting beaches (Bjorndal *et al*. 1985, Miller *et al.* 1998, Parmenter 1983). 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.

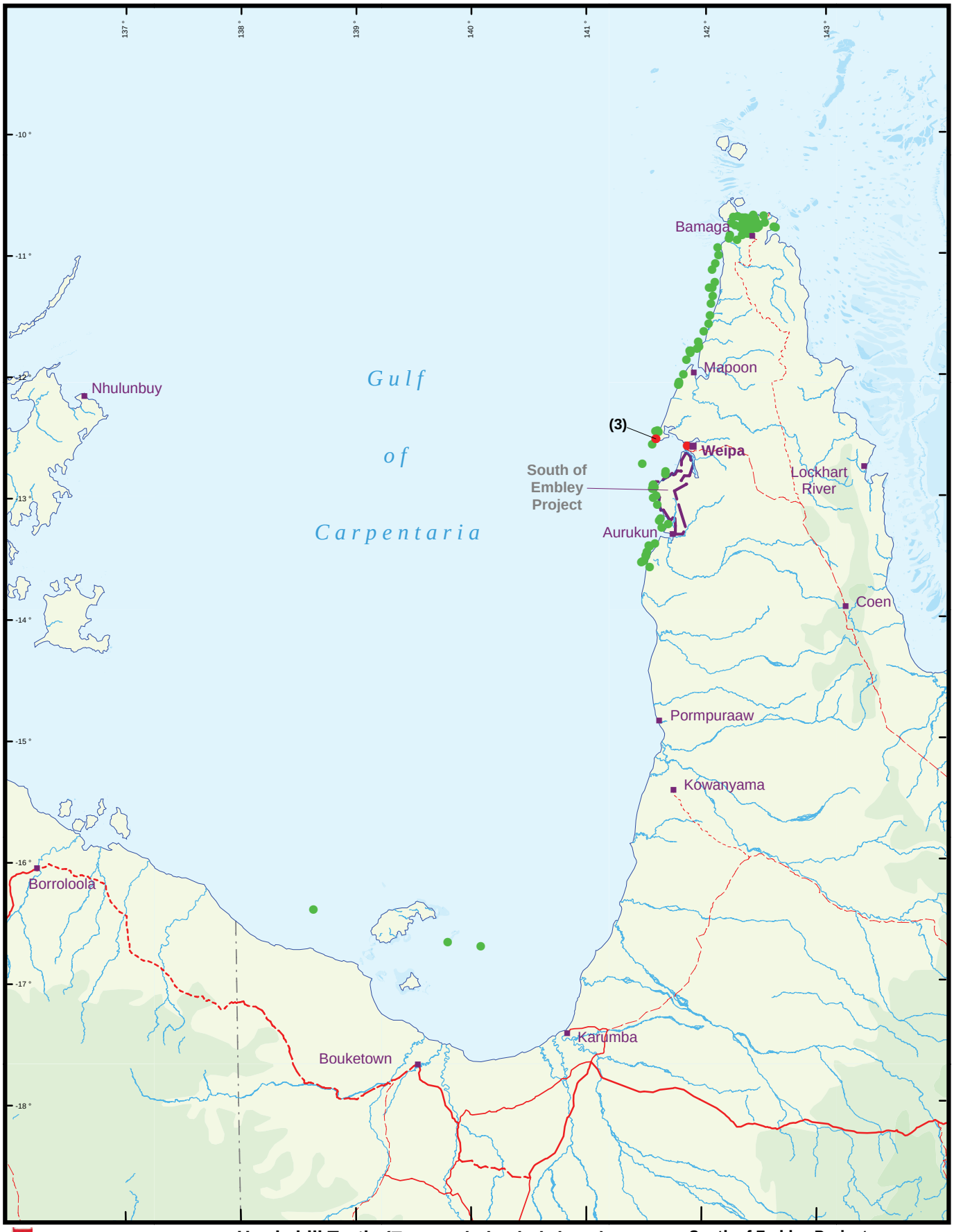
Critical habitat is habitat that the Minister has listed in the Register of Critical Habitat (prepared under Section 207A of the EPBC Act) in relation to an EPBC-listed species or ecological community. DSEWPaC's Register of Critical Habitat does not identify any critical habitat for the Hawksbill Turtle.

Threats

The decline of this species has resulted primarily from human exploitation for tortoiseshell. While the legal Hawksbill Turtle shell trade ended when Japan agreed to stop importing shell in 1993, a significant illegal trade continues.

In Australia, the current main threats to the Hawksbill Turtle are disturbance (e.g. light disturbance) and habitat damage due to coastal development, by-catch from fisheries and shark control measures, feral pig predation on nests, vessel strikes, entanglement in and ingestion of marine debris, and Indigenous harvesting in some areas (DSEWPaC 2012q).

Currently, there are two major threats to marine turtles along western Cape York – predation of nests by feral pigs and entanglement in lost or discarded fishing nets (ghost nets).



Project Boundary
Locality
River / Creek
Road / track

Hawksbill Turtle *(Eretmochelys imbricata)*

Stranding Mortality Database Record
Recorded Location
(3) Number of records at location

SOURCES: Greenland *et al.* (2002), Greenland and Limpus (2003), Haines and Limpus (2000), Poiner and Harris (1996), Queensland Museum (2012), Vanden Berghe (2007)

Note: Nesting locations are not shown. See Figure 7-4 for the Hawksbill Turtle nesting locations

South of Embley Project

Fig. 7-8:
Hawksbill Turtle Records
(eastern Gulf of Carpentaria)

N

0 150km

Datum/Projection: GDA94/MGA Zone 54 Date: 01/11/2012

Rio Tinto Alcan

7.3.2.3 Flatback Turtle (Natator depressus)

Regional Distribution and Population

The Flatback Turtle is listed as vulnerable and migratory under the EPBC Act.

The Flatback Turtle is found only in the tropical waters of northern Australia, Papua New Guinea and west Papua, Indonesia. There are currently no estimates for the size of the global population of Flatback Turtles (DSEWPaC 2012q), however there are estimated to be more than 20,000 nesting females (Sea Turtle Conservancy 2011). No population estimates are available for the north-eastern Gulf of Carpentaria and the Torres Strait, however the major nesting rookeries are located on Crab, Deliverance and Kerr Islands and there are many minor breeding aggregations spread along the beaches of north western Cape York (Limpus 2007). In the southern Gulf of Carpentaria nesting rookeries are situated on Wellesley and Sir Edward Pellew Islands (DSEWPaC 2012q). The total population number of Flatback Turtles within the Project area is unknown. The population of Flatback Turtles in the Gulf of Carpentaria is considered to be in the early stages of decline (Limpus 2007). Nesting aggregations in the Gulf of Carpentaria and Torres Strait (Deliverance and Kerr Islands) are afforded protection via the Warul Kawa Indigenous Protected Area and these nesting sites are located in very remote areas of coast isolated from current development (DSEWPaC 2012q).

The known nesting locations of Flatback Turtles in Australia are shown in **Figure 7-5** and non-nesting records of the species, from the Marine Wildlife Stranding and Mortality Database annual reports and other sightings, in eastern Gulf of Carpentaria are shown in **Figure 7-9**.

Ecology and Habitat

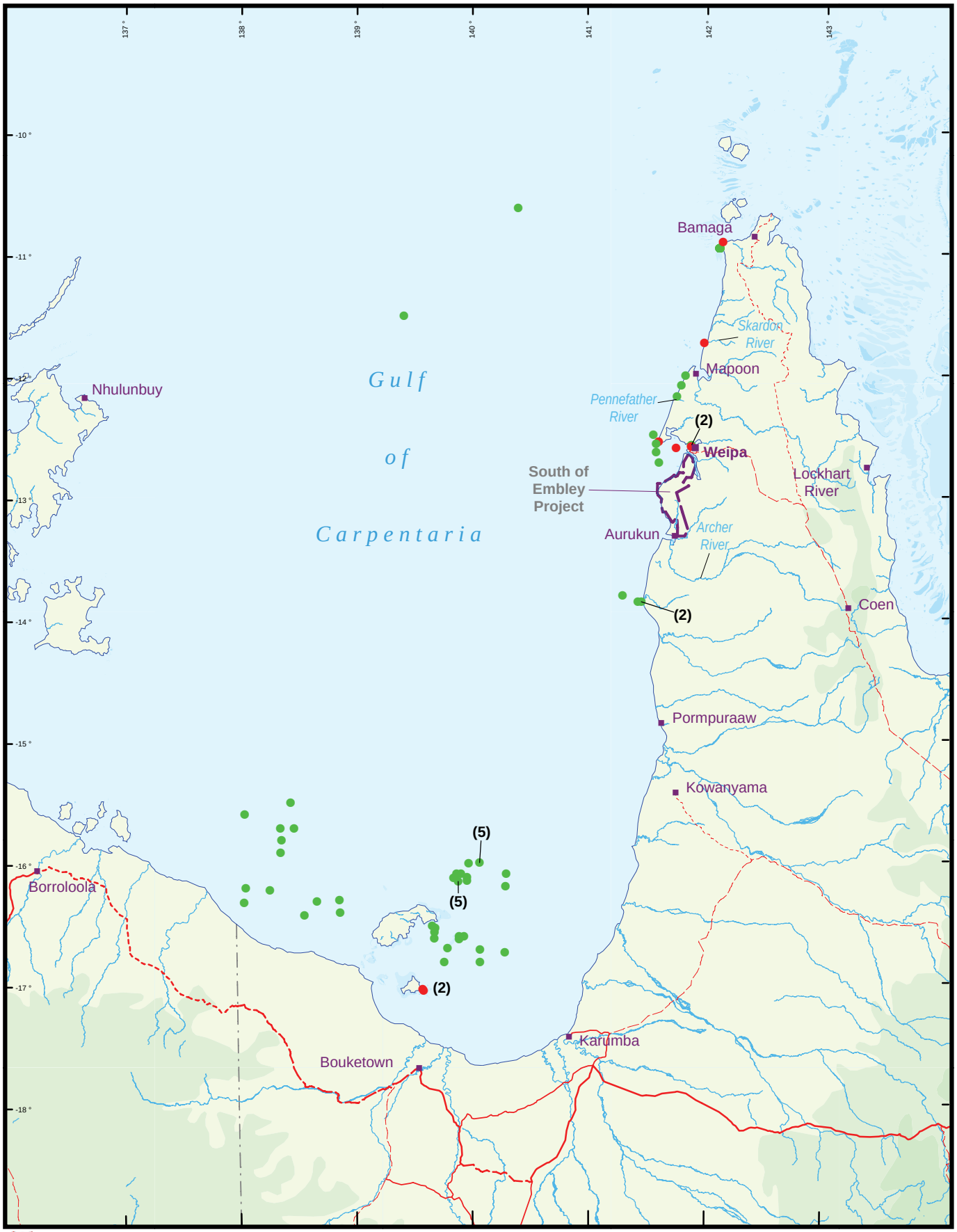
The Flatback Turtle has the smallest geographic range of all the marine turtle species. Their distribution is restricted to tropical regions of the continental shelf and coastal waters of northern Australia, southern Indonesia, and southern Papua New Guinea. They do not have an oceanic phase or undertake long, open ocean migrations as do other marine turtle species, and are usually found in waters less than 70m in depth. The Flatback Turtle lays an average of 50 eggs per nest. Flatback Turtle nesting occurs in the vicinity of the proposed Port area. Nesting occurs all year round, peaking in May through to September (DSEWPaC 2012f).

Foraging habitats for the species are soft-bottom, coastal waters and rocky reefs including but not limited to shallow water habitats where they feed principally on soft bodied animals including sea cucumbers, sea pens and soft corals.

Critical habitat is habitat that the Minister has listed in the Register of Critical Habitat (prepared under Section 207A of the EPBC Act) in relation to an EPBC-listed species or ecological community. DSEWPaC's Register of Critical Habitat does not identify any critical habitat for the Flatback Turtle.

Threats

In Australia, the current main threats to Flatback Turtles are disturbance (e.g. light disturbance) and habitat damage due to coastal development, by-catch from fisheries and shark control measures, feral animal predation on nests, vessel strikes, entanglement and ingestion of marine debris and, in some areas, Indigenous harvesting (DSEWPaC 2012q). Feral pigs destroy up to 90% of the nests on Western Cape York (Limpus *et al.* 1993) and foxes and dogs destroy hundreds of nests in eastern Queensland (DSEWPaC 2012q).



Project Boundary
Locality
River / Creek
Road / track

Flatback Turtle *(Natator depressus)*

Stranding Mortality Database Record
Recorded Location
(2) Number of records at location

SOURCES: Greenland *et al.* (2002), Greenland and Limpus (2003), Haines *et al.* (2003), Haines and Limpus (2000), Poiner and Harris (1996), Queensland Museum (2012), Vanden Berghe (2007)

Note: Nesting locations are not shown. See Figure 7-5 for the Flatback Turtle nesting locations

South of Embley Project

Fig. 7-9:
Flatback Turtle Records
(eastern Gulf of Carpentaria)

N

0 150km

Datum/Projection: GDA94/MGA Zone 54 Date: 01/11/2012

The pressure analysis assessment presented in The Species Group Report Card – Marine Reptiles: Supporting the Marine Bioregional Plan for the North Marine Region (DSEWPaC 2012n), assesses "marine debris and invasive species (feral pigs)" as of concern for the Flatback Turtle. DSEWPaC (2012n) concludes that:

> *"Uncontrolled predation, particularly by feral pigs, is therefore a significant issue for marine turtles in the North Marine Region, especially in the western Cape York Peninsula area."*

7.3.2.4 Loggerhead Turtle (Caretta caretta)

Regional Distribution and Population

The Loggerhead Turtle is listed as endangered and migratory under the EPBC Act.

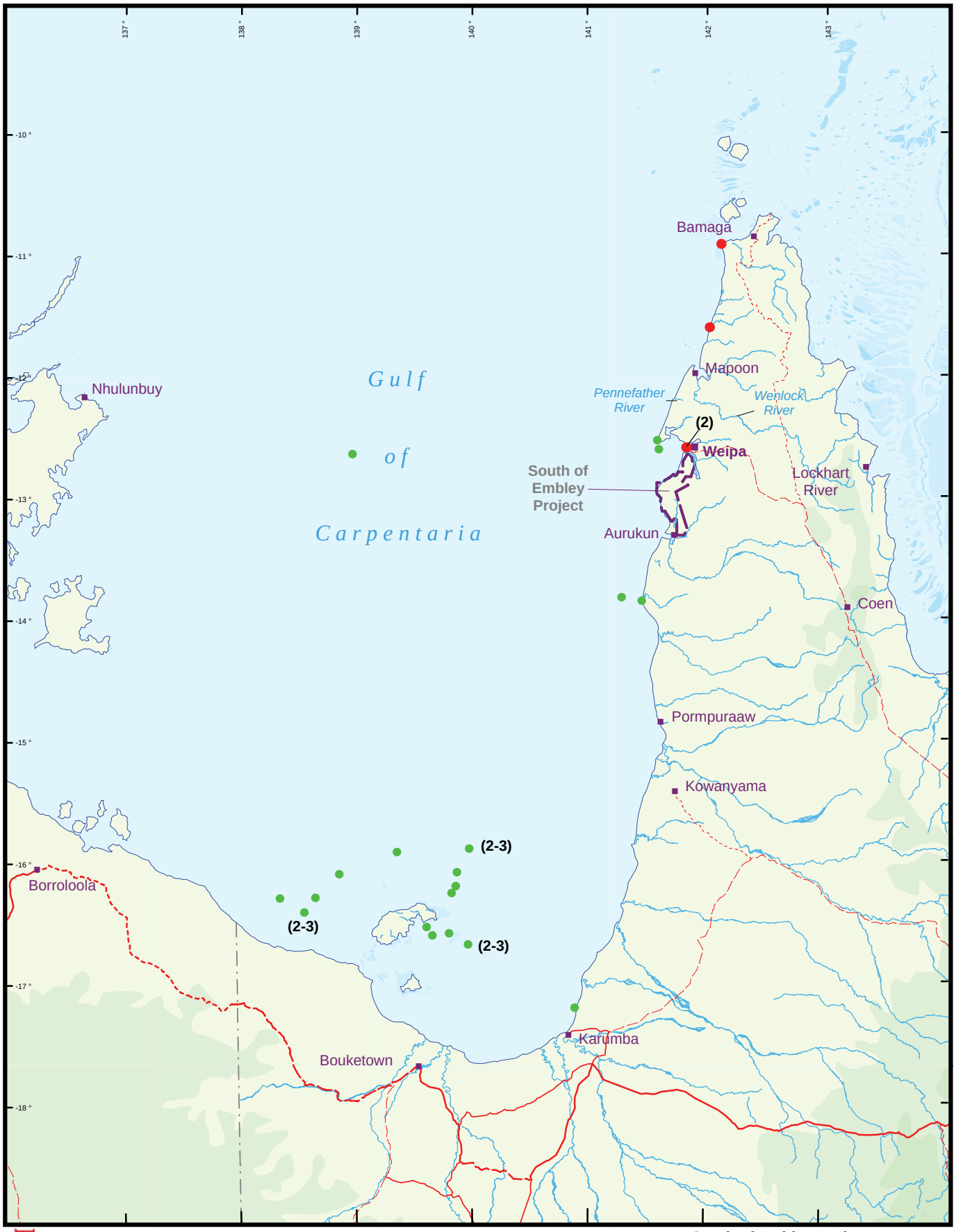
The Loggerhead Turtle has a global distribution throughout tropical, sub-tropical and temperate waters. There are no accurate estimates of global population or annual numbers of nesting females for the Loggerhead Turtle, but the two largest nesting aggregations (in the tens of thousands of nesting females per year) occur in Oman and Florida (SWOT 2007). In the Indian Ocean there are breeding aggregations in South Africa-Mozambique, Oman, Sri Lanka and Western Australia (Baldwin *et al.* 2003). In the Pacific Ocean there are breeding aggregations centred on Japan and south Queensland-New Caledonia (Limpus and Limpus 2003). There are no records of Loggerhead Turtle nesting from across northern Australia between Lizard Island in Queensland and the Ashmore Reefs in north-western Australia (Limpus 2009c).

In Australia, there are two unique breeding populations of Loggerhead Turtles. The eastern Australian population nests on the southern Great Barrier Reef and adjacent mainland coastal areas. Major nesting areas for the Western Australian population include the Muiron Islands, Ningaloo Coast south to about Carnarvon, and islands near Shark Bay. These western and eastern Australian populations are two distinct genetic stocks. In 2000, it was estimated that there were 500 nesting females per year of the eastern Australian population (DSEWPaC 2012f). The known nesting locations of Loggerhead Turtles in Australia are shown in **Figure 7-5** and non-nesting records of the species, from the Marine Wildlife Stranding and Mortality Database annual reports and other sightings, in eastern Gulf of Carpentaria are shown in **Figure 7-10**.

Ecology and Habitat

The species prefers a range of habitats including subtidal and intertidal reefs, seagrass meadows and soft-bottomed habitats. The juvenile diet includes algae, pelagic crustaceans, and molluscs, but adult and large immature Loggerhead Turtles are carnivorous, specialised for feeding on hard-bodied, slow-moving invertebrate prey. In eastern Australian coastal waters they feed principally on gastropod and bivalve molluscs, portunid crabs and hermit crabs (Limpus and Chaloupka 2001, Moodie 1979). In Queensland, nesting is concentrated in the south-east, particularly along the Bundaberg coast at Mon Repos (Limpus 2009c). Loggerhead Turtles are known to display fidelity to their feeding and breeding areas (Limpus *et al.* 1984).

Critical habitat is habitat that the Minister has listed in the Register of Critical Habitat (prepared under Section 207A of the EPBC Act) in relation to an EPBC-listed species or ecological community. DSEWPaC's Register of Critical Habitat does not identify any critical habitat for the Loggerhead Turtle.



Project Boundary
Locality
River / Creek
Road / track

Loggerhead Turtle *(Caretta Caretta)*

- Stranding Mortality Database Record
- Recorded Location
- (2) Number of records at location

SOURCES: Greenland *et al.* (2002), Haines *et al.* (1999), Haines and Limpus (2000), Poiner and Harris (1996), Queensland Museum (2012)

Note: Nesting locations are not shown. See Figure 7-5 for the Loggerhead Turtle nesting locations

South of Embley Project

Fig. 7-10: Loggerhead Turtle Records (eastern Gulf of Carpentaria)

N

0 150km

Datum/Projection: GDA94/MGA Zone 54 Date: 04/09/2012

Threats

In Australia, the current main threats to Loggerhead Turtles are disturbance (e.g. light disturbance) and habitat damage due to coastal development and infrastructure, commercial and recreational fishing, feral animal predation on nests, vessel strikes, entanglement and ingestion of marine debris and, in some areas, Indigenous harvesting (DSEWPaC 2012q). It is estimated that hundreds of nests in eastern Queensland are destroyed because of feral animals. Limpus (2008a) suggested that the decline in recruitment of immature Loggerhead Turtles along the eastern Australian coast is consistent with the increase of European Red Fox (*Vulpes vulpes*) predation of eggs (DSEWPaC 2012q).

7.3.2.5 Olive Ridley Turtle (Lepidochelys olivacea)

Regional distribution and population

The Olive Ridley Turtle is listed as endangered and migratory under the EPBC Act.

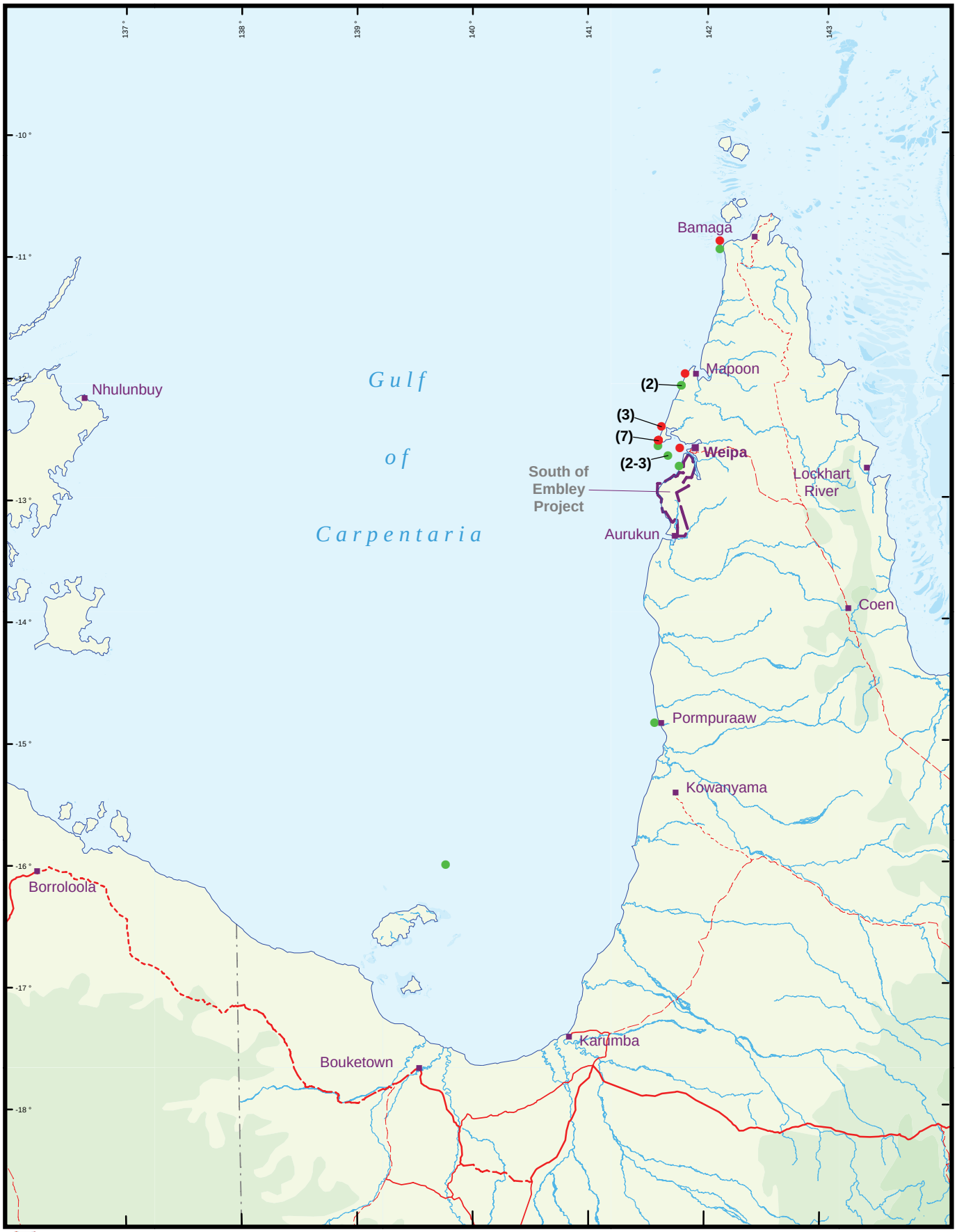
The Olive Ridley Turtle is the most numerous of all marine turtles in the world, largely due to a few very large nesting aggregations. Large nesting aggregation areas occur in Mexico, Costa Rica and India. However, in Australia, no major synchronous breeding aggregations have been recorded and the species appears to undertake solitary nesting. Nesting occurs in nearly 60 countries worldwide. In Australia, nesting has been historically recorded from a number of locations including the eastern Gulf of Carpentaria, Northern Territory, and north-western Cape York Peninsula, Queensland, between Weipa and Bamaga. Migratory movements of the Olive Ridley Turtle are known to involve the coastal waters of over 80 countries (DSEWPaC 2012f). With very few exceptions, they are not known to move between ocean basins or to cross from one ocean border to the other (Abreu-Grobois and Plotkin 2008).

The DSEWPaC (2012q) SPRAT database identifies two studies that estimate global annual nesting populations to be 852,000 and 2,000,000 respectively. Detailed information on the size of nesting and foraging populations in Australia and Western Cape is unknown, although the Australian nesting population is expected to be in the order of a few thousand annually. The nesting locations of Olive Ridley Turtles in Australia are shown in **Figure 7-6** and non-nesting records of the species, from the Marine Wildlife Stranding and Mortality Database annual reports and other sightings, in eastern Gulf of Carpentaria are shown in **Figure 7-11**.

Ecology and habitat

The Olive Ridley Turtle nests throughout tropical waters and migrates through tropical and sub-tropical areas of the world. Olive Ridley Turtles lay clutches of eggs on sandy beaches (Musick and Limpus 1997) and typically nest one to three times per season, with clutches of about 100 to 110 eggs. The median age at sexual maturity is 13 years with a range of 10 to 18 years (Plotkin 2007). Olive Ridley Turtles are present all year round over soft bottomed habitats in northern Australian continental shelf waters, and foraging in shallow benthic habitats from northern Western Australia to south-east Queensland (Harris 1994 cited in Limpus 2008b). Olive Ridley Turtles have been recorded in both benthic and pelagic foraging habitats ranging from depths of several metres to over 100m (DSEWPaC 2012q).

The Olive Ridley Turtle primarily feeds on bivalve molluscs and gastropods in Australian waters. However, outside of Australia they have been found to feed on crabs, shrimp, lobsters, jellyfish, molluscs, and tunicates (DSEWPaC 2012f).



Olive Ridley Turtle *(Lepidochelys olivacea)*

- Project Boundary
- Locality
- River / Creek
- Road / track
- Stranding Mortality Database Record
- Recorded Location
- (2) Number of records at location

SOURCES: Greenland *et al.* (2002), Greenland and Limpus (2003, 2004), Haines *et al.* (1999), Haines and Limpus (2000), Poiner and Harris (1996), Queensland Museum (2012)

Note: Nesting locations are not shown. See Figure 7-6 for the Olive Ridley Turtle nesting locations

South of Embley Project

Fig. 7-11:
Olive Ridley Turtle Records
(eastern Gulf of Carpentaria)

N

0 150km

Datum/Projection: GDA94/MGA Zone 54 Date: 01/11/2012

Rio Tinto Alcan

Critical habitat is habitat that the Minister has listed in the Register of Critical Habitat (prepared under Section 207A of the EPBC Act) in relation to an EPBC-listed species or ecological community. DSEWPaC's Register of Critical Habitat does not identify any critical habitat for the Olive Ridley Turtle.

Threats

In Australia, the main current threats to Olive Ridley Turtles are disturbance (e.g. light disturbance) and habitat damage due to coastal development and infrastructure, commercial and recreational fishing, feral animal predation on nests, vessel strikes, entanglement and ingestion of marine debris and, in some areas, Indigenous harvesting (DSEWPaC 2012q). It is estimated that hundreds of nests in eastern Queensland are destroyed by feral animals.

The pressure analysis assessment presented in The Species Group Report Card – Marine Reptiles: Supporting the Marine Bioregional Plan for the North Marine Region (DSEWPaC, 2012n), assesses "marine debris and invasive species (feral pigs)" as of concern for the Flatback Turtle. DSEWPaC (2012n) concludes that:

> *"Uncontrolled predation, particularly by feral pigs, is therefore a significant issue for marine turtles in the North Marine Region, especially in the western Cape York Peninsula area."*

7.3.2.6 Leatherback Turtle (Dermochelys coriacea)

Regional Distribution and Population

The Leatherback Turtle is listed as endangered and migratory under the EPBC Act.

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. The Leatherback Turtle is distributed worldwide in tropical and temperate waters of the Atlantic, Pacific, and Indian Oceans. It is also found foraging as far north as British Columbia, Newfoundland, and the British Isles, and as far south as Australia, Cape of Good Hope, and Argentina.

The global number of breeding females was estimated at 35,800 females in 2004 (DSEWPaC 2012q). The Pacific populations have collapsed substantially with most recent data indicating that only 1,000 breeding females comprise the eastern Pacific population (Spotila *et al.* 2000). In the western Pacific, the major nesting beaches occur in Papua New Guinea, West Papua-Indonesia, and the Solomon Islands, with lesser nesting reported in Vanuatu. Compiled nesting data for the western Pacific region estimated approximately 5,000 to 9,200 nests annually since 1999, with 75% of the nests being recorded in West Papua-Indonesia.

The Australian population is likely to comprise individuals from the Papua New Guinea – West Papua stock, based on satellite tracking of individuals nesting there (Benson *et al.* 2007). Lower capture rates of Leatherback Turtles in the Queensland Shark Control program may reflect the decline in Australian populations from a number of threats (mainly longline by catch in fisheries). There are no population estimates for Leatherback Turtles that forage in Australian waters. Leatherback Turtles are rarely found in Queensland and have not been recorded as nesting in eastern Australia since 1996. The known nesting locations of Leatherback Turtles in Australia are shown in **Figure 7-6** and non-nesting records of the species, from the Marine Wildlife Stranding and Mortality Database annual reports and other sightings, in eastern Gulf of Carpentaria are shown in **Figure 7-12**. As a predominantly pelagic species, it is expected that the abundance of Leatherback Turtles in the Project area would be very low and comprise only transient individuals.

Project Boundary
Locality
River / Creek
Road / track

Leatherback Turtle ***(Dermochelys coriacea)***

Recorded Location

SOURCES: Source: Limpus (2009)

Note: Nesting locations are not shown. See Figure 7-6 for the Leatherback Turtle nesting locations

South of Embley Project

Fig. 7-12:
Leatherback Turtle Records
(eastern Gulf of Carpentaria)

N

0 150km

Datum/Projection: GDA94/MGA Zone 54 Date: 01/11/2012

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Ecology and Habitat

The Leatherback Turtle is a pelagic feeder, found in tropical, subtropical and temperate waters throughout the world. They principally feed upon soft-bodied invertebrates. Jellyfish are the main staple of the Leatherback Turtle's diet, but they are also known to feed on colonial ascidians, sea urchins, squid, crustaceans, tunicates, fish, blue-green algae, and floating seaweed.

Adult females nest on sandy beaches backed with vegetation and sloped sufficiently so the distance to dry sand is limited, preferentially with proximity to deep water and generally rough seas. Hatchlings live off an internalised yolk sac until they reach deep ocean waters (DSEWPaC 2012q).

Critical habitat is habitat that the Minister has listed in the Register of Critical Habitat (prepared under Section 207A of the EPBC Act) in relation to an EPBC-listed species or ecological community. DSEWPaC's Register of Critical Habitat does not identify any critical habitat for the Leatherback Turtle.

Threats

A number of threats faced by other marine turtles, such as coastal infrastructure and development, feral animal predation and Indigenous harvest are not significant threats to Leatherback Turtles in Australian waters due to their pelagic foraging habits and the low incidence of Leatherback Turtle nesting on Australian beaches (DSEWPaC 2012q). The current main threats to Leatherback Turtles in Australia arise from accidental catch or entanglement in commercial fishing nets (Hamann *et al*. 2006).

7.3.3 Marine Turtle Survey Methodology and Results

Previous studies of nesting activity in the vicinity of the Project area were undertaken in August to September 2003 (Bell 2004) and May to July 2007 (GHD 2007b). 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). The 2003 survey focused along 38km of beach from Boyd Point south to False Pera Head. It recorded 41 Flatback Turtle nests and two Olive Ridley/Hawksbill Turtle nests over a four day survey. Nesting beaches were accessed by water or land and observations of nesting tracks were documented and an assessment of the impact of feral pig predation on individual nests was recorded. 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

The methodology for the marine turtle nesting activity survey for the Project was developed based on advice from Dr. Colin Limpus (Chief Scientist, Freshwater and Marine Sciences, EHP). 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. The survey was led by Dr Daryl McPhee (Worley Parsons) and included Traditional Owner representatives. 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, with peak nesting in Australia occurring from April to June (DSEWPaC 2011b).

Nesting activity recorded during the 2007 and 2008 surveys is summarised in **Table 7-6** with the nesting locations illustrated in **Figure 7-13**. Of identifiable nests, 85% were Flatback Turtles, with Olive Ridley or Hawksbill Turtles also present. Specific locations and details from the 2003 study have not been provided as that report only summarises the total nesting activity for each species. An example of a Flatback Turtle nesting track is shown in **Plate 7-7**.

Table 7-6 Marine 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	Large body pit, single egg shell, evidence of predation.
May 2007	S12°54'693" E141°38'107"	Flatback Turtle	Body pit with several egg shell fragments, evidence of predation.
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 with several egg shell fragments, evidence of predation. No tracks.
May 2007	S12°54'721" E141°38'135"	Unidentified	False crawl, no associated body pit or nest. Old track.
May 2007	S12°54'613" E141°38'110"	Unidentified	False crawl, no associated body pit or nest. Old track.
June 2007	S12°54'060" E141°40'000"	Unidentified	Small body pit, shell fragments, evidence of feral pig predation. No tracks.
June 2007	S12°54'619" E141°38'128"	Unidentified	Small body pit, shell fragments evidence of feral pig predation. No tracks.
June 2007	S12°54'693" E141°38'107"	Unidentified	Large body pit, several egg shell fragments, evidence of predation of eggs. No tracks.
June 2007	S12°54'859" E141°37'910"	Unidentified	Small body pit, shell fragments evidence of feral pig predation. No tracks.
June 2007	S12°54'875" E141°37'852"	Flatback Turtle	Body pit/nest. No signs of feral pig predation.
July 2007	S12°54'598" E141°38'106"	Unidentified	Small body pit, shell fragments evidence of feral pig predation.
July 2007	S12°54'662" E141°38'090"	Unidentified	Small body pit, shell fragments evidence of feral pig predation.
July 2007	S12°54'836" E141°37'921"	Flatback Turtle	No evidence of egg predation.
July 2007	S12°54'875" E141°37'857"	Unidentified	Small body pit, shell fragments, evidence of feral pig predation. No tracks.
July 2007	S12°55'095" E141°37'672"	Olive Ridley or Hawksbill Turtle	Small body pit and narrow alternating tracks. No signs of predation. Multiple nest attempts.
July 2007	S12°55'209" E141°37'618"	Flatback Turtle	No signs of predation. Multiple nest attempts.
April 2008	S12°55'777" E141°37'299"	Flatback Turtle	Very fresh tracks and nest. No sign of disturbance or predation. Nest shallow.
April 2008	S12°56'513" E141°36'795"	Flatback Turtle	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	Old track. Nesting against fallen timber. Predation of nest. Quad bike tracks to and from nest.
April 2008	S12°56'913" E141°36'500"	Flatback Turtle	Old track. Nesting against cliff and under fallen timber. Predation of nest by feral pigs/dogs.

Survey Date	Coordinates (WGS 84)	Species	Nest and Track Descriptions
April 2008	S12°56'957" E141°36'461"	Flatback Turtle	Old track. Predation of nest by feral pigs.
April 2008	S12°56'990" E141°36'455"	Unidentified	Old track. Predation of nest.
April 2008	S12°59'230" E141°35'320"	Flatback Turtle	Nest adjacent to cliff edge.
April 2008	S12°59'608" E141°35'111"	Hawksbill Turtle	Fresh track probably from previous night. Several attempts made to nest on the side of a vegetated dune.
April 2008	S12°54'704" E141°38'047"	Flatback Turtle	False crawl with no associated nest.
April 2008	S12°54'635" E141°38'133"	Unidentified	Old nest with no tracks but fragments of egg shell present.

Figure 7-13 Location of Turtle Nesting Activity from May – July 2007 and April 2008

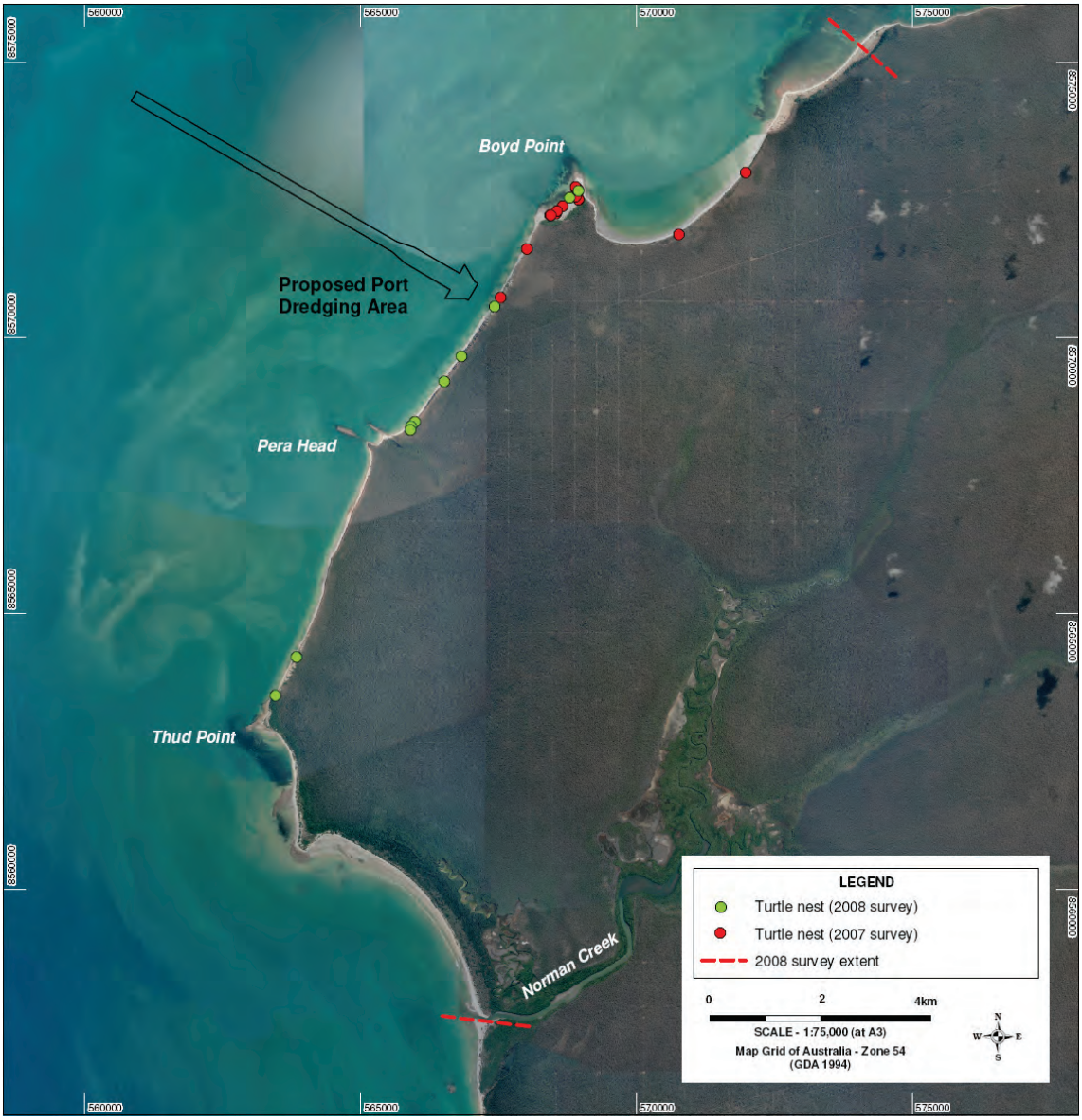


Plate 7-7 Flatback Turtle Nest (left) and Turtle Tracks between Boyd Point and Pera Head

As identified during the review of available secondary source information (refer **Section 7.3.2**), scattered nesting of Flatback Turtles occurs along most beaches of western Cape York, including the Project area. Nesting of the Olive Ridley and Hawksbill Turtles in the vicinity of the Project area 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 (refer **Section 7.3.2.5**).

The known locations of high density Flatback Turtle nesting for the Torres Strait/Gulf of Carpentaria management unit are Crab Island, Deliverance Island, Kerr Island and Wellesley Islands where the nesting densities of females is measured in the thousands (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 marine 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. Based on available data, the Crab Island rookery can be considered to have high density nesting population and the proposed Port area can be considered to have a low density nesting population of Flatback Turtles (of the order of one fiftieth of the nesting density at Crab Island).

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 Project, produce predominantly female offspring (Dr C. Limpus, pers. comm.).

Incidental observations while undertaking boat-based marine ecology fieldwork identified that marine turtles (predominantly Flatback Turtles) were frequently seen surfacing within the area surveyed. These qualitative observations did not reveal any apparent preference for one part of the study area over the other.

Field surveys identified significant destruction of marine turtle nests by feral pigs, at and adjacent to the area of the proposed Port. The marine turtle nest data in the Project area for 2007-2008 shows that 70% of nests were predated (**Table 7-6**), consistent with the reports of Doherty (2005). 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 marine turtle nest excavation, was observed just above the high tide mark at Boyd Point.

7.3.4 Likelihood of Occurrence within the Project Area

The likelihood of occurrence of marine turtles in the Project area and along Project-related shipping routes is presented in **Table 7-7**.

The potential habitat of marine turtles is presented in **Figure 7-14** to **Figure 7-19** respectively.

Table 7-7 Profile Summaries – Marine Turtles

Species	Habitat Preferences			Preferred habitat in the Weipa / Cape York region	Likelihood of Occurrence
	Foraging	Nesting / Breeding	Migratory		
Green Turtle *(Chelonia mydas)* (Vulnerable)	Shallow coastal seagrass and seaweed, driftlines and *Sargassum* rafts. Suitable seagrass habitat was identified within the Project area.	Nests on sandy beaches. Remains close to the nesting site between nesting intervals. Mates near-shore in vicinity of the nesting ground. Nesting not identified in the Project area.	Pelagic.	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.	**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 New Spoil Ground** **Possible**: This species prefers to forage in shallow coastal areas or within seagrass beds. The proposed new spoil ground would be too deep (-25m LAT) to provide preferred foraging habitat for this species and it c ontains no seagrass beds. While the proposed new 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 new 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**: This species is known to forage within shallow coastal areas and seagrass beds. Foraging habitat for this species is present in the estuaries. **Balance of Project Area not disturbed** **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. **Shipping Routes** **Likely**: This species is common, both feeding and nesting throughout the GBR and in tropical Australian waters including Torres Strait and the Arafura Sea.
Hawksbill Turtle *(Eretmochelys imbricata)* (Vulnerable)	Intertidal and subtidal rocky and coral reefs. Suitable foraging habitats were identified within the Project area.	Nests on sandy beaches. Mates near-shore or offshore from the nesting beach. Hawksbill nesting identified in the Project area.	Pelagic.	Hawksbill Turtle nesting sites occur on islands adjacent to Arnhem Land and north-eastern Cape York.	**Proposed Port Site** **Likely**: Near shore fringing reef communities occur within the vicinity of the proposed Port area 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.

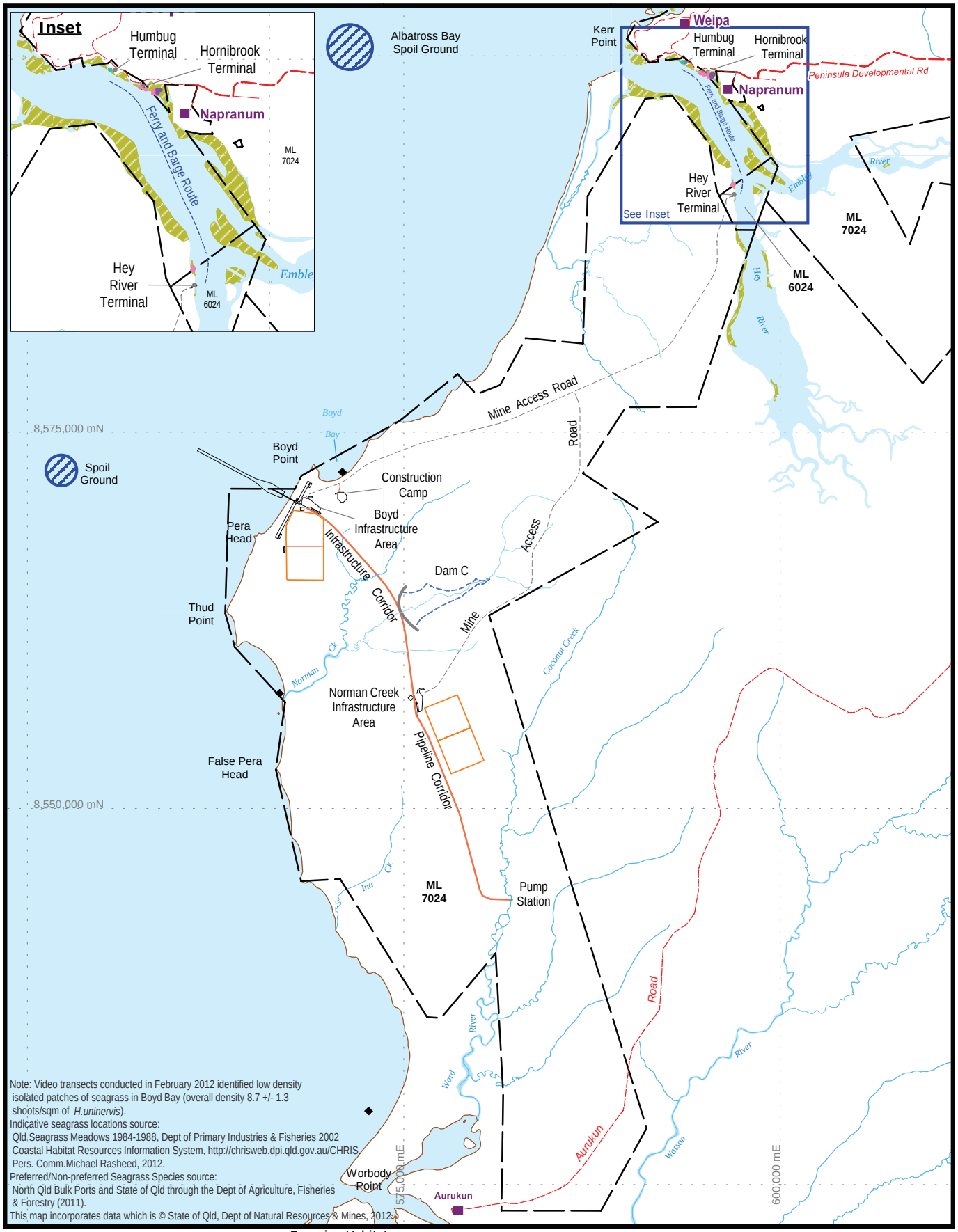
Species	Habitat Preferences			Preferred habitat in the Weipa / Cape York region	Likelihood of Occurrence
	Foraging	Nesting / Breeding	Migratory		
				The main feeding habitat for the species tends to be tidal and sub-tidal reefs. Hawksbill Turtles also commonly inhabit seagrass flats and mangrove habitats.	Therefore it may be assumed that the footprint of the proposed Port site may also contain suitable nesting habitat for this species. **Proposed New Spoil Ground** **Possible**: No seagrass beds or seabed features e.g. patch reefs were identified within the footprint of the proposed new spoil ground. Drop camera surveys indicate that this area is largely unvegetated, however, Hawksbill Turtles may feed on sea cucumbers or jellyfish in this area. As Nine Mile Reef, which includes suitable foraging habitat for this species, is located approximately 6km south-south-west of the proposed new spoil ground, this species may traverse the proposed new 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 currently actively used for disposal of spoil dredged annually by North Queensland Bulk Ports. 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** **Possible**: The Hey and Embley Rivers contain seagrass and mangrove habitats which may be utilised by this species. **Balance of Project Area not disturbed** **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 and they are also likely to inhabit seagrass flats and mangrove habitats. **Shipping Routes** **Likely**: This species is common, both feeding and nesting throughout the GBR and in tropical Australian waters including Torres Strait and the Arafura Sea.

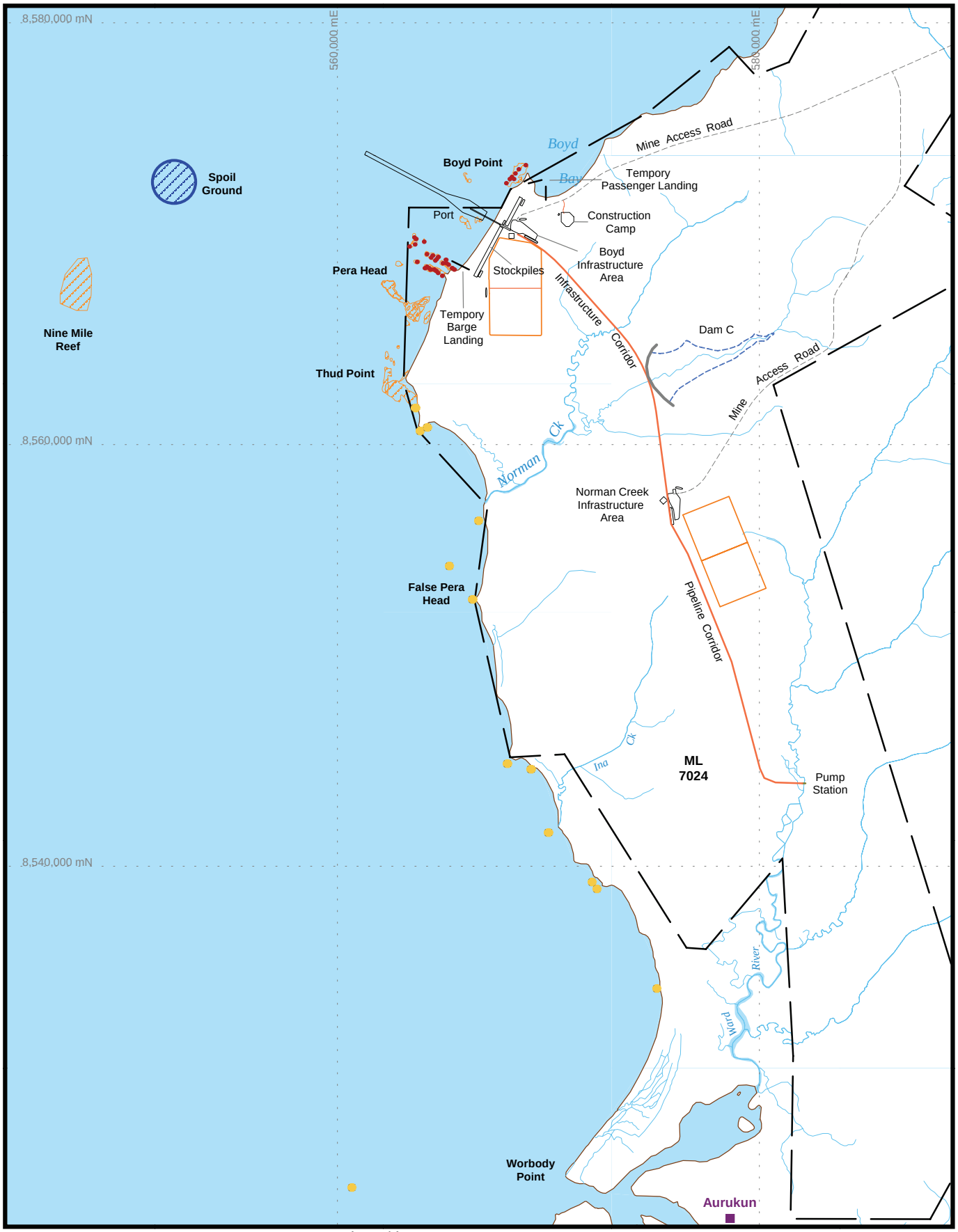
Species	Habitat Preferences			Preferred habitat in the Weipa / Cape York region	Likelihood of Occurrence
	Foraging	Nesting / Breeding	Migratory		
Flatback Turtle *(Natator depressus)* (Vulnerable)	Soft-bottom, coastal waters and rocky reefs. Wide depth range. Suitable foraging habitat within the Project area.	Nests on sandy beaches in dunes or a steep seaward slope. Mates offshore from the nesting ground. Known to nest in the Torres Strait and NW Gulf of Carpentaria. Some nesting identified in the Project area.	Coastal waters and surface waters of the continental shelf.	Soft-bottom, coastal waters including but not limited to shallow water habitats. Nesting is confined to Australia.	**Proposed Port Site** **Known to Occur**: Nesting has been regularly recorded within and surrounding the proposed Port site footprint and is best described as low 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 be considered foraging habitat for this species. **Proposed New Spoil Ground** **Possible**: No seagrass beds or seabed features e.g. patch reefs were identified within the footprint of the proposed new spoil ground. Drop camera surveys indicate that this area is largely unvegetated; however, Flatback Turtles may feed on sea cucumbers or jellyfish in this area. **Albatross Bay Spoil Ground** **Possible:** The Albatross Bay spoil ground does not contain or is not close to any reef communities. It is currently actively used for disposal of spoil dredged annually by North Queensland Bulk Ports. 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** **Likely**: The proposed footprints of the ferry/barge terminals are within an estuarine environment which may be considered foraging habitat for this species. **Balance of Project Area not disturbed** **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 low density nesting. The area is not a major location for breeding aggregations of the species. **Shipping Routes** **Likely:** Nesting for this species is centred in the southern GBR and in western Torres Strait. The species is found foraging around Australia including through Torres Strait.

Species	Habitat Preferences			Preferred habitat in the Weipa / Cape York region	Likelihood of Occurrence
	Foraging	**Nesting / Breeding**	**Migratory**		
Loggerhead Turtle *(Caretta caretta)* (Endangered)	Intertidal and subtidal coral and rocky reefs, seagrass, unvegetated sand or mud. Suitable foraging habitat occurs within the Project area.	Nests on open, sandy beaches in southern Queensland and Western Australia. Nesting not identified within the Project area.	Pelagic, but migrates from rookeries in coastal waters suitable for foraging.	Coastal waters including subtidal and intertidal coral and rocky reefs and seagrass meadows as well as soft-bottomed habitats.	**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 New Spoil Ground** **Likely:** This species is likely to occur within the proposed new 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. **Balance of Project Area not disturbed** **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. **Shipping Routes** **Likely**: This species is commonly observed within the GBR and is known to migrate through the Gulf of Carpentaria, Torres Strait, Arnhem Land and Papua New Guinea. Nesting occurs in the southern GBR.

Species	Habitat Preferences			Preferred habitat in the Weipa / Cape York region	Likelihood of Occurrence
	Foraging	**Nesting / Breeding**	**Migratory**		
Olive Ridley Turtle *(Lepidochelys olivacea)* (Endangered)	Benthic unvegetated coastal waters but also some pelagic foraging over a wide depth range. Suitable foraging habitat within the Project area.	Nest on sandy beaches. The beaches of the Project area assumed to support nesting based on previous records. Inshore habitat near nest beach during inter-nesting periods.	Hatchlings pelagic then juveniles return to coastal waters. Adults utilise coastal water and out to the continental shelf.	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 Gulf of Carpentaria.	**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 New Spoil Ground** **Possible**: Unvegetated sediments may provide foraging habitat for Olive Ridley Turtles, as this species has been known to forage within these depths. This species may also transit the site. **Albatross Bay Spoil Ground** **Possible**: Unvegetated sediments may provide foraging habitat for Olive Ridley Turtles, as this species has been known to forage within these depths. This species may also 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. **Balance of Project Area not disturbed** **Known to Occur**: Low density nesting has previously been recorded from a number of locations from False Pera Head to Boyd Bay, and nesting has also been recorded further north between Weipa and Bamaga. **Shipping Routes** **Likely**: This species nests in the Northern Territory and the Gulf of Carpentaria. Although uncommon in the GBR, Olive Ridley Turtles are found around northern Australia.

Species	Habitat Preferences			Preferred habitat in the Weipa / Cape York region	Likelihood of Occurrence
	Foraging	Nesting / Breeding	Migratory		
Leatherback Turtle *(Dermochelys coriacea)* (Endangered)	Pelagic feeder in tropical, subtropical and temperate waters. Suitable foraging habitat occurs within the Project area, and Albatross Bay.	Nest on sandy beaches although only a very small proportion of the global population nest in Australia. Nesting not identified within the Project area. Mates offshore.	Pelagic.	Pelagic environment. The Albatross Bay area is identified as a potential foraging area for the species.	**Proposed Port Site** **Likely**: The species is likely to occur sporadically in the vicinity of the proposed Port site, using it for foraging. **Proposed New Spoil Ground** **Likely**: The species is likely to occur sporadically in the vicinity of the proposed new 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. **Balance of Project Area not disturbed** **Likely**: The species is likely to occur in the Project area, using it for foraging. Leatherback Turtles are rarely found in Queensland, however they have been reported on the Western Cape York peninsula coast (EHP pers. comm.). **Shipping Routes** **Likely**: Although seen only in low densities in Australia, the species is known to occur in the GBR and nests in the Northern Territory and to the north of Australia, including in Papua New Guinea.


Inset
Humbug Terminal
Hornibrook Terminal
Napranum
Ferry and Barge Route
ML 7024
Hey River Terminal
ML 6024
Albatross Bay Spoil Ground
Kerr Point
Weipa
Peninsula Developmental Rd
See Inset
Spoil Ground
Boyd Point
Boyd Bay
Mine Access Road
Construction Camp
Boyd Infrastructure Area
Pera Head
Infrastructure Corridor
Access Road
Dam C
Mine
Thud Point
Norman Ck
Coconut Creek
Norman Creek Infrastructure Area
Pipeline Corridor
False Pera Head
8,575,000 mN
8,550,000 mN
Ina Ck
Pump Station
Word River
Aurukun Road
Watson River
Worbody Point
Aurukun
575,000 mE
600,000 mE
Note: Video transects conducted in February 2012 identified low density isolated patches of seagrass in Boyd Bay (overall density 8.7 +/- 1.3 shoots/sqm of H.uninervis).
Indicative seagrass locations source:
Qld Seagrass Meadows 1984-1988, Dept of Primary Industries & Fisheries 2002
Coastal Habitat Resources Information System, http://chrisweb.dpi.qld.gov.au/CHRIS.
Pers. Comm.Michael Rasheed, 2012.
Preferred/Non-preferred Seagrass Species source:
North Qld Bulk Ports and State of Qld through the Dept of Agriculture, Fisheries & Forestry (2011).
This map incorporates data which is © State of Qld, Dept of Natural Resources & Mines, 2012.
RTA Mining Lease boundary
Locality
Road/track
River
Freshwater dam
Tailings storage facility
Foraging Habitat
Potential seagrass foraging habitat
Indicative seagrass locations
Seagrass Survey February 2012
Seagrass (Halophila ovalis)
Seagrass (Enhalus acoroides)
Seagrass leaves (Enhalus acoroides), no rhizomes
RioTintoAlcan
South of Embley Project
Fig 7-14:
Potential Habitat of Green Turtle (Project Area)
N
5 0 5km
Datum/Projection: GDA94/MGA Zone 54
Date: 31/10/2012



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

Foraging Habitat

Reefal Habitat

Potential reefal foraging habitat
Unconfirmed reef locations
Live cover

Note: A video transect conducted in February 2012 identified reef supporting hard coral near Boyd Point.

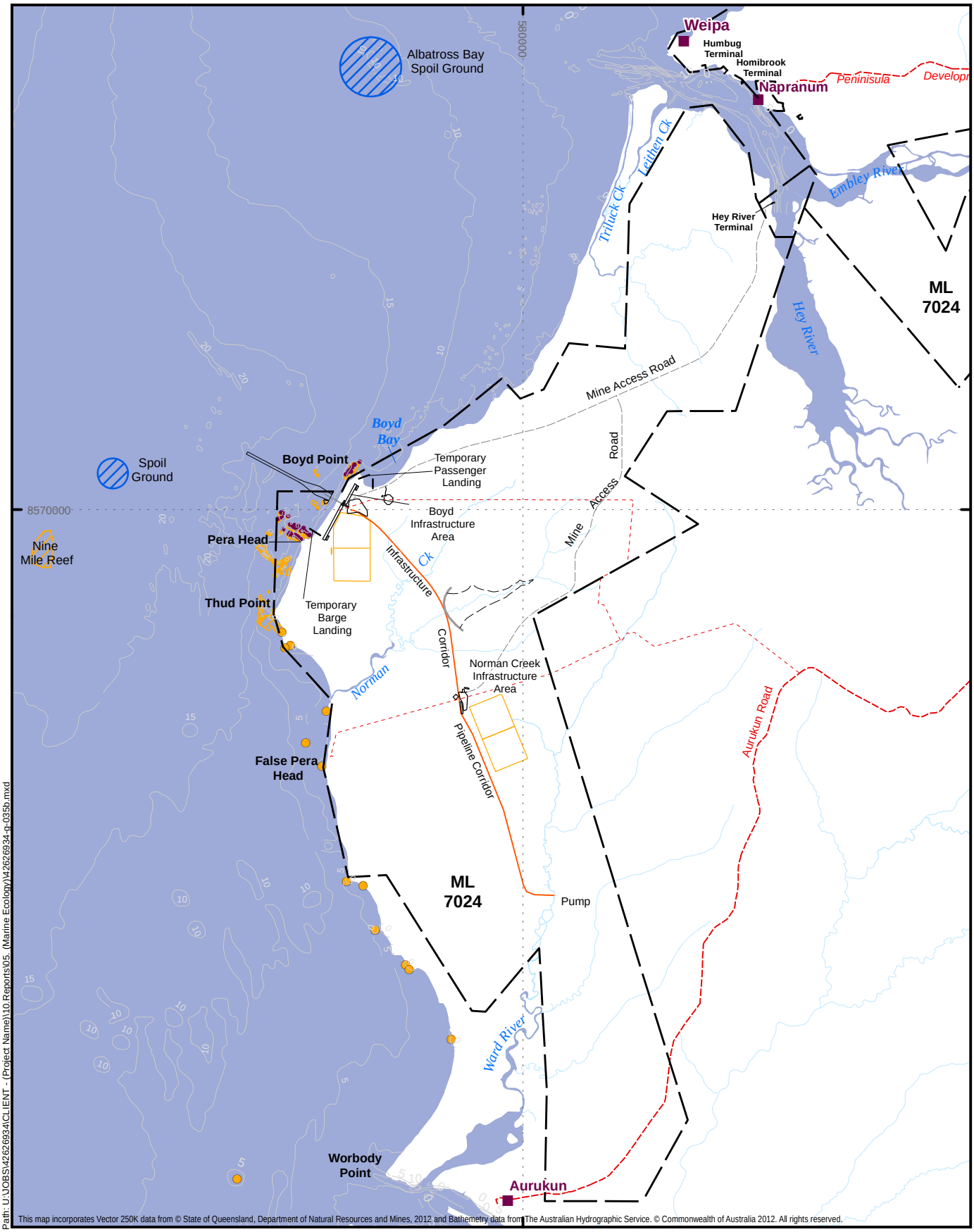
South of Embley Project

Fig 7-15: Potential Habitat of Hawksbill Turtle (Project Area)

N

5 0 5km

Datum/Projection: GDA94/MGA Zone 54 Date: 31/10/2012



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RTA mining lease boundary
Locality
Roads/ track
River
Freshwater dam
Tailings storage facility

Note: Video transect conducted in February 2012 identified reef substrate supporting hard coral near Boyd Point.

Habitat
Potential foraging habitat (0 - 40m deep)

Reefal Habitat
Potential reefal foraging habitat
Unconfirmed reef locations
Live coral cover
(hard coral and/or soft coral/sponges)

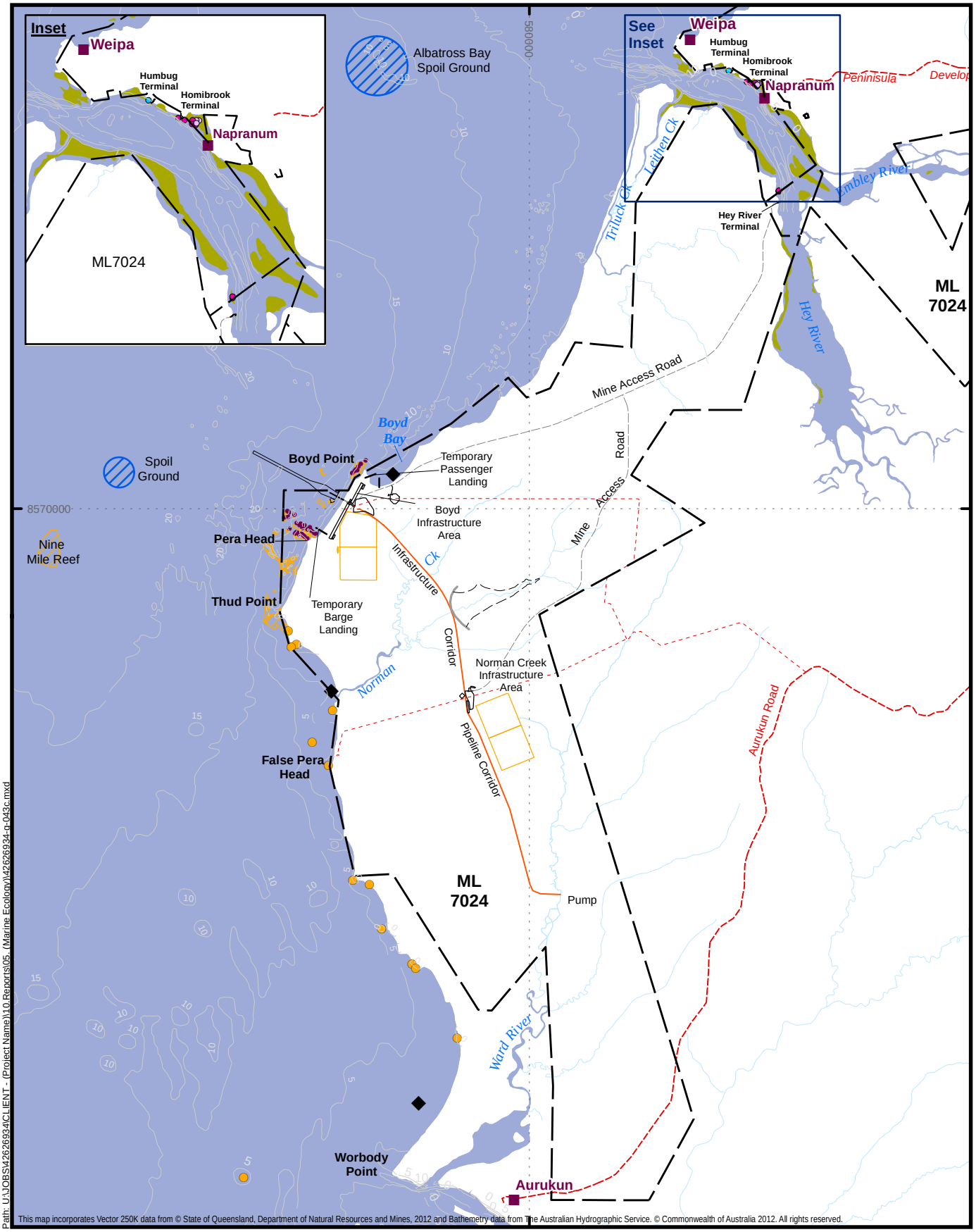
South of Embley Project

Fig. 7-16: Potential Habitat of Flatback Turtle (Project Area)

N

0 2.25 4.5 9 km

Datum/Projection: GDA94/MGA Zone 54 Date: 06/11/2012



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Rio Tinto Alcan

- RTA mining lease boundary
- Locality
- Roads/ track
- River
- Freshwater dam
- Tailings storage facility

Note: Video transect conducted in February 2012 identified low density isolated patches of seagrass in Boyd Bay (overall density 8.7 +/- 1.3 shoots/sqm of *H. uninervis*) and reef supporting hard coral near Boyd Point.

Seagrass Cover:
Source: North Qld Bulk Ports and State of Qld through the Department of Agriculture, Fisheries and Forestry (2011)

Habitat
- Potential foraging habitat

Reefal Habitat
- Potential reefal foraging habitat
- Unconfirmed reef locations
- Live coral cover (hard coral and/or soft coral/sponges)

Seagrass Habitat
- Potential seagrass foraging habitat
- Indicative seagrass locations

Seagrass Survey Results 2012
- Seagrass *(Halophila ovalis)*
- Seagrass *(Enhalus acoroides)*
- Seagrass *(Enhalus acoroides)*, no rhizomes

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, 2012

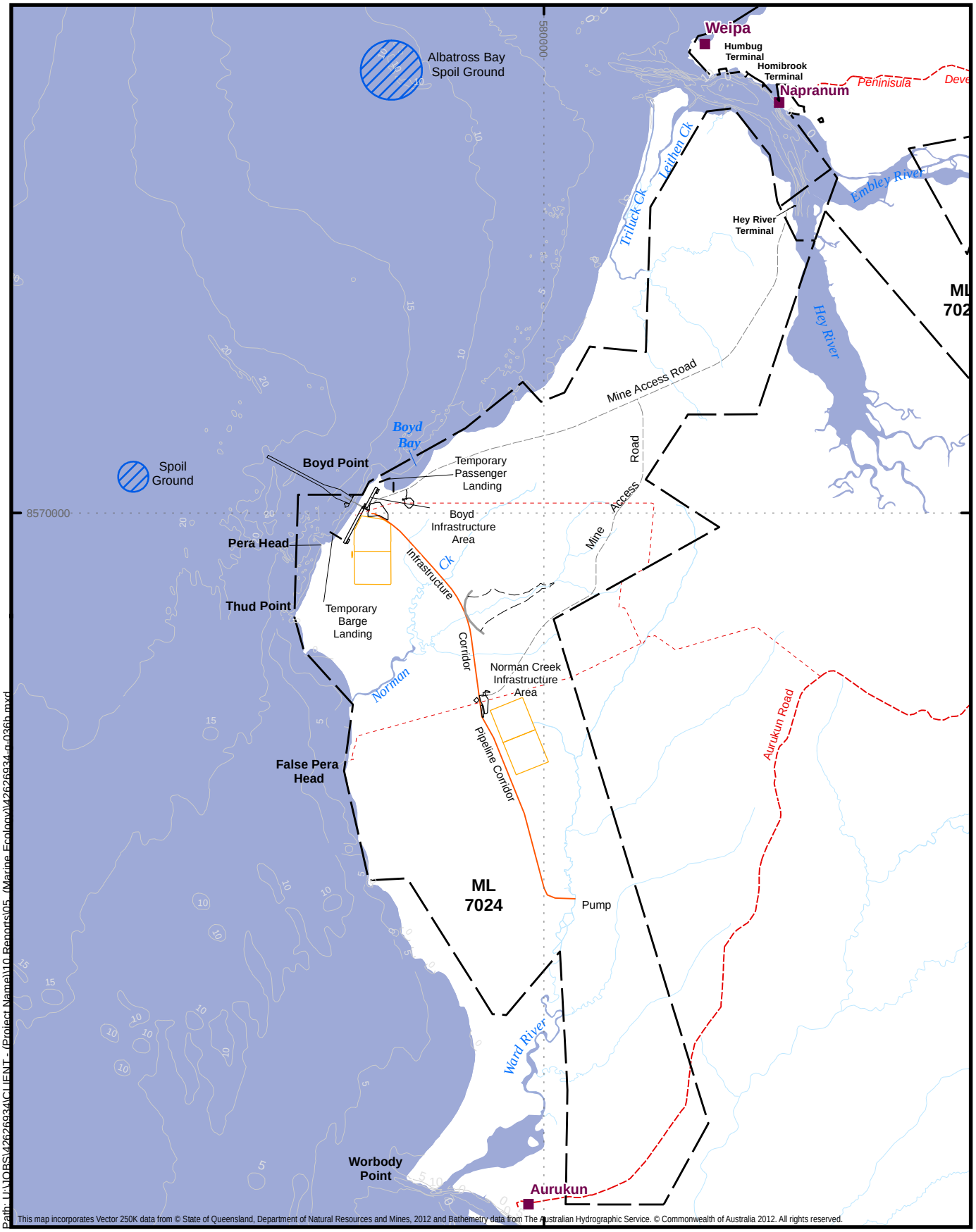
South of Embley Project

Fig. 7-17: Potential Habitat of Loggerhead Turtle (Project Area)

N

0 2.25 4.5 9 km

Datum/Projection: GDA94/MGA Zone 54 Date: 06/11/2012



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RTA mining lease boundary
Locality
Roads/track
River
Freshwater dam
Tailings storage facility

Habitat
Potential foraging habitat (0 - 100m deep)

Rio Tinto Alcan

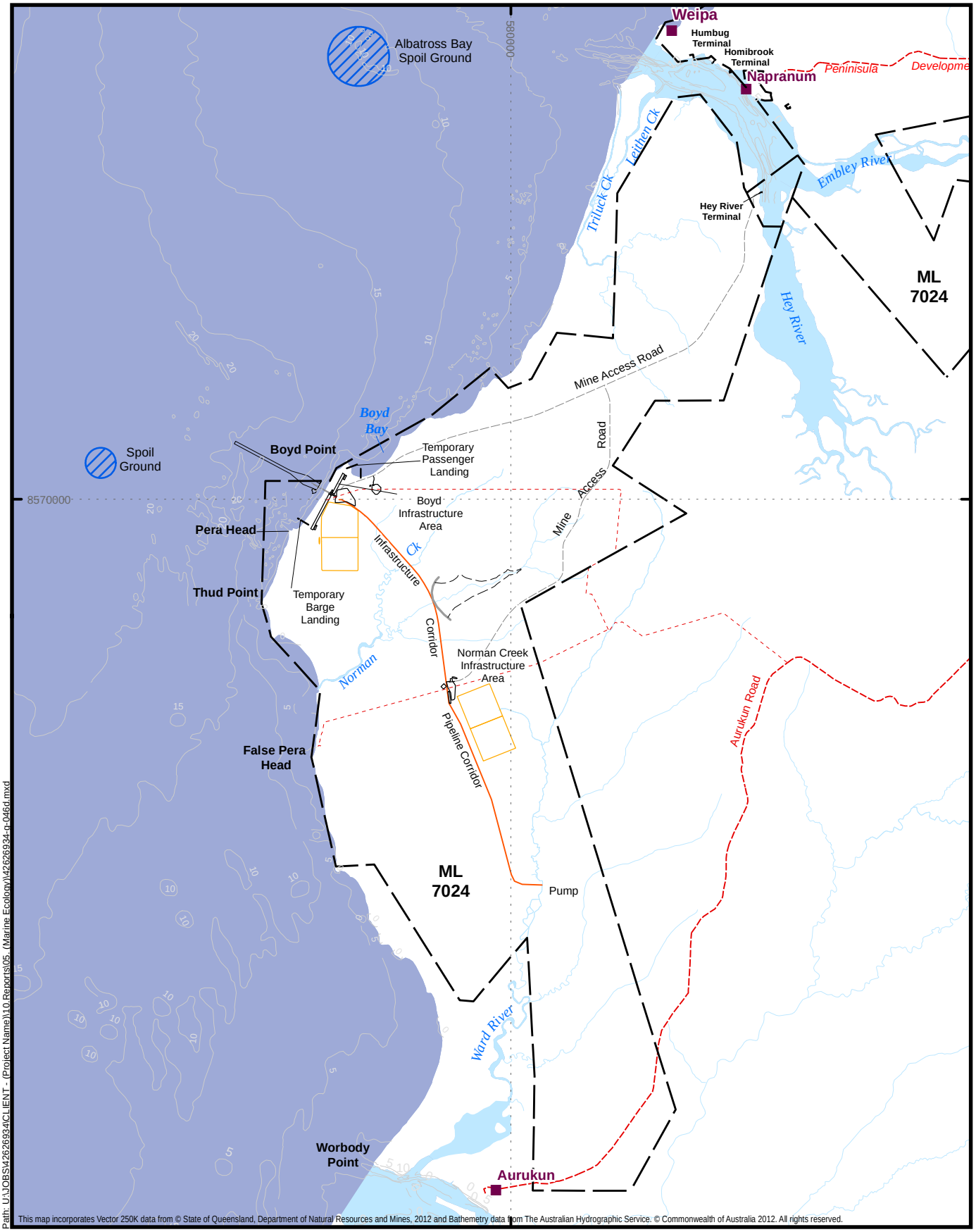
South of Embley Project

Fig. 7-18: Potential Habitat of Olive Ridley Turtle (Project Area)

N

0 2.25 4.5 9 km

Datum/Projection: GDA94/MGA Zone 54 Date: 06/11/2012



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RTA mining lease boundary
Locality
Roads/ track
River
Freshwater dam
Tailings storage facility

Habitat
Potential foraging habitat

Rio Tinto Alcan

South of Embley Project

Fig. 7-19: Potential Habitat of Leatherback Turtle (Project Area)

N

0 2.25 4.5 9 km

Datum/Projection: GDA94/MGA Zone 54 Date: 27/02/2013

7.3.5 Relevant Impacts on Marine Turtles

Potential impacts on marine turtles during the construction and operational stages of the Project may result from dredging and offshore spoil disposal, construction and operation of the marine and river facilities (i.e. Port, temporary seaborne access and the barge/ferry terminals) and from Project-related shipping activities.

The potential unmitigated relevant direct and indirect impacts on marine turtles during the construction and operational stages of the Project are discussed in **Sections 7.3.5.1** to **7.3.5.4** and **Table 7-8** provides cross references to the sections where they are described. The specific avoidance, mitigation and enhancement measures that would be implemented to reduce the potential impacts on marine turtles are presented in **Section 7.3.6**.

Table 7-8 Cross References to Impacts on Marine Turtles

	CONSTRUCTION ACTIVITIES			OPERATIONAL ACTIVITIES		
POTENTIAL IMPACT PRIOR TO MITIGATION	**Dredging and offshore spoil disposal**	**Marine and river facilities**	**Project-related shipping**	**Dredging and offshore spoil disposal**	**Marine and river facilities**	**Project-related shipping**
DIRECT IMPACTS						
Physical disturbance to benthic or intertidal habitats	**7.3.5.1**	**7.3.5.2**		**7.3.5.1**	**7.3.5.2**	
Creation of turbidity plume	**7.3.5.1**			**7.3.5.1**		
Deposition of dredged sediments on benthic habitat	**7.3.5.1**			**7.3.5.1**		
Entrainment in dredge	**7.3.5.1**			**7.3.5.1**		
Physical disturbance to beach habitats from piling or temporary beach access		**7.3.5.2**			**7.3.5.2**	
Altered light regime	**7.3.5.1**	**7.3.5.2**	**7.3.5.3**	**7.3.5.1**	**7.3.5.2**	**7.3.5.3**
Underwater acoustic impacts	**7.3.5.1**	**7.3.5.2**	**7.3.5.3**	**7.3.5.1**	**7.3.5.2**	**7.3.5.3**
Marine oil spill			**7.3.5.3**			**7.3.5.3**
Vessel discharges			**7.3.5.3**			**7.3.5.3**
Vessel strike			**7.3.5.3**			**7.3.5.3**
INDIRECT IMPACTS						
Changes to recreational use of beaches		**7.3.5.2**			**7.3.5.2**	
Changes to coastal processes (erosion and deposition)	**7.3.5.1**			**7.3.5.1**		

7.3.5.1 Dredging and Offshore Spoil Disposal

Capital dredging is required for the proposed Port, including berth pockets, swing basin and departure channel. Further minor dredging is required for the Hornibrook terminal, Humbug terminal and Hey River terminal. It is expected that the Port dredging would be carried out by a cutter suction dredge (CSD). Dredged material would either be pumped to several split hopper barges (SHB) for disposal or re-deposited on the sea bottom and retrieved by a trailing suction hopper dredge (TSHD). Dredging for the river facilities is anticipated to be undertaken using a barge-mounted backhoe/dipper dredge, with a bucket up to approximately 13m^3 or a small non propelled CSD pumping to a SHB (**Table 7-9**).

Dredge spoil would be disposed offshore at either the proposed new spoil ground offshore of Boyd Point (spoil from the Port) or at the existing Albatross Bay spoil ground (spoil from the river facilities). Dredging activities would be conducted 24 hours a day, seven days a week. At the Hey River, Humbug and Hornibrook terminals, dredging would be conducted for a maximum of fourteen consecutive days with a pause of three days between dredging periods at each site.

Capital dredging and offshore spoil disposal activities are described in detail in **Section 3.8**. The total volume of capital dredging required for Stage 1 of the wharf is 6.5 million cubic metres, however, this work would be done in phases and no individual dredging campaign would exceed 2.6 million cubic metres.

Table 7-9 Summary of Capital Dredging Activities for the Project

Project Area	Dredging Volume (m^3)	Dredged Area (m^2)	Duration (weeks)	Dredging Method	Disposal Area
Port	Max 2,600,000 in any campaign	Initial capital dredge area: 642,000 Max (Stage 2 wharf): 1,921,500	[1]24 in any campaign	CSD and SHB/TSHD	Proposed new spoil ground
Humbug Wharf	15,600	8,100	1 – 2	Barge-mounted backhoe/CSD and SHB/TSHD	Albatross Bay spoil ground
Hey River	37,380	25,000	2 – 4		
Hornibrook Point	57,600	23,300	3 – 5		

Subsequent capital and maintenance dredging would be undertaken as required under a separate Sea Dumping Permit. The initial capital dredge volume for the Port (2.6 million cubic metres) would require (on average) annual maintenance dredging of approximately 490,000m^3 to maintain under keel clearance for ships. Based on the maximum 6.5 million cubic metres of capital dredging for Stage 1 of the wharf, average annual maintenance dredging of approximately 890,000m^3 is expected to be required. Once the wharf is extended (Stage 2), an extra 2.4 million cubic metres of capital dredging and 280,000m^3 of average annual maintenance dredging would be required.

Material dredged during the maintenance programs would be disposed of at the proposed new spoil ground west of Boyd Point.

Capital and maintenance dredging and offshore spoil disposal have the potential to impact on marine turtles and their habitat. The potential direct and indirect impacts from these activities on marine turtles include:

- physical disturbance to benthic or intertidal habitats from dredging;
- creation of a turbidity plume;

[1] This estimate does not allow for any delays that may occur due to breakdowns or stand-downs which could result from cyclonic weather if dredging during the wet season.

- deposition of dredged sediments on benthic habitat;
- entrainment in dredge;
- altered light regime;
- underwater acoustic impacts; and,
- changes to coastal processes (erosion and deposition).

These potential direct and indirect impacts are discussed in detail below.

Physical disturbance to benthic or intertidal habitats

Benthic habitats in the dredge footprints of the proposed Port and river facilities would be completely removed until such time as they recolonise (although recolonisation would be limited by subsequent maintenance dredging). Benthic surveys have identified that the development footprint for the proposed Port consists primarily of soft sediment habitats that is likely to support sparse epifauna, including prey species of the Hawksbill and Loggerhead Turtle.

No seagrass beds are known to occur within the footprint of the proposed Port, temporary barge landing area or anchorages. No seagrass was detected within the proposed Humbug terminal footprint, and only patchy seagrass was found in nearby areas. No seagrass was detected within the proposed Hornibrook terminal dredging footprint in 2012 surveys. Seagrass was confirmed as present at Boyd Bay within the likely impact distance of the temporary jetty option in Boyd Bay. Seagrass monitoring between 2000 and 2009 (Chartrand and Rasheed 2009, McKenna and Rasheed 2010) in the vicinity of the Hey River terminal location has occasionally reported a very thin patch of isolated seagrass. Drop camera surveys undertaken over the Hey River terminal dredge footprint in October 2007, November 2008 and June 2009 and grab samples in February 2012 did not record any seagrass. Overall, it is considered that if any seagrasses do occur at or within the vicinity of the proposed Hey River terminal site from time to time, they are likely to contribute minimally to primary productivity in the area.

Coral reefs provide foraging habitat for Hawksbill and Flatback Turtles. At Boyd Point, total hard coral cover is estimated at 2.1ha and total soft coral cover is estimated at 1.3ha. At Pera Head, total hard coral cover is estimated at 4.5ha and total soft coral cover is estimated at 4.5ha (refer **Section 4.2.1.5**). Hard and soft coral is absent from the footprint of the proposed Port, although an estimated area of <0.2ha of live soft coral-sponges would be impacted if Stage 2 of the wharf were constructed.

As there are a number of alternate suitable foraging habitats in the area, the potential unmitigated impacts of physical disturbance to benthic habitats on marine turtles from capital dredging would be negligible and short term. Potential unmitigated impacts from maintenance dredging activities at the proposed Port and river facilities would also be negligible, but would continue throughout the duration of the Project as a result of annual maintenance dredging, and so would be long term.

Creation of turbidity plume

Impacts from dredging and offshore spoil disposal would include turbidity plumes and the potential suspension of sediments that may reduce water quality. These impacts have the potential to impact the benthic foraging habitats and foraging behaviour of all marine turtle species.

The chemical and physical characteristics of material that would be dredged from the proposed Port area and the barge/ferry terminals were assessed in accordance with *National Assessment Guidelines for Dredging 2009*, Annex 2 of the London Protocol, and the *Waste Specific Guidelines for Assessment of Dredged Material* (IMO 2000b) (refer **Section 7.2.10** and **Appendix 7-B** for additional information). The assessment, including elutriate and bioavailability testing, indicated that all dredge

spoil is suitable for unconfined ocean disposal, and testing did not identify any constituents present at contaminant levels of environmental concern that would persist in the water column during dredging or offshore spoil disposal.

Dredging in the Embley and Hey Rivers would involve placement of dredge spoil at the existing Albatross Bay spoil ground. A previous study (GHD 2005) has assessed the impacts of turbidity generated by dredging operations in the same area. The study examined impacts from a dredging campaign involving a much larger volume (greater than 3,000,000m^3) of maintenance and capital material than would be required in the Embley and Hey Rivers for the Project. It concluded that changes in water quality in sensitive areas, such as seagrass meadows to the north east, from the migration of material would be negligible because plumes are predicted to migrate south towards the South Channel.

Erftemeijer and Lewis (2006) have reviewed the available literature on the impacts of dredging on seagrasses, including, peer-reviewed scientific literature, grey literature in the form of Environmental Impact Assessments, consultancy and technical reports and additional information obtained from internet sources. This review highlights the following important factors in relation to duration, frequency and magnitude of turbidity impacts that are relevant to the seagrass meadows in the Embley and Hey Rivers.

- For seagrasses, the critical threshold for turbidity and sedimentation, as well as the duration that seagrasses can survive periods of high turbidity or excessive sedimentation vary greatly among species.
- Larger, slow-growing climax species with substantial carbohydrate reserves, such as Enhalus acoroides which is the dominant species in the seagrass meadows of the Embley River (McKenna and Rasheed 2010), show greater resilience to such events than smaller opportunistic species.
- Turbidity changes induced by dredging will only result in adverse environmental effects when the turbidity generated is significantly larger than the natural variation of turbidity and sedimentation rates in the area. The seagrass meadows in the Port of Weipa (including the Embley and Hey Rivers) are continually exposed to naturally high and variable turbidity (Carter et al. 2012).
- Erftemeijer and Lewis (2006) state that "Laboratory experiments have shown that some seagrasses can survive in light intensities below their minimum requirements for periods ranging from a few weeks to several months (**Table 7-10**). The survival period of seagrass below its minimum light requirement is shorter in smaller species with low carbohydrate storage capacity than in larger species. It is clear that species with larger below-ground biomass are better adapted to longer periods of sub-minimal light."

The dominant seagrass species in the Embley River is *E. acoroides*, a structurally large species (long strap-like leaves 1 to 1.5cm wide and up to 150cm long) with large below ground biomass, that would have the capacity to store substantial carbohydrate reserves. *E. acoroides* is larger than any of the species listed in **Table 7-10**. **Table 7-10** shows that *Halodule pinifolia,* a substantially smaller species of seagrass with low carbohydrate storage capacity and relatively small below-ground biomass, was able to survive for up to three months with zero light availability.

Posidonia sinuosa, structurally not as large as *E. acoroides*, has a high capacity to store carbohydrates as reserves in low light conditions and can survive up to 12 months at very low light levels (Collier 2006, Gordon *et al*. 1994). *Thalassia testudinum*, similar size to *P. sinuosa*, can survive up to 10 months at very low light levels, being able to withstand environmental stress for extended periods of time because of stored starch in rhizomes (Czerny and Dunton 1995, Zieman 1975). The results of the studies shown in **Table 7-10** suggest that *E. acoroides* would survive for at least several months under very low light conditions.

Table 7-10 Duration of Time that Seagrass Species can Survive in Light Intensities Below their Minimum Light Requirements

Species	Size (leaf width x length cm)	Light availability	Period survived (Month)	Reference
Halodule pinifolia	0.05 x 20	0	3	Longstaff and Dennison (1999)
Halodule wrightii	0.03 -0.15 x5-20	13-16% SI	9	Czerny and Dunton (1995)
Halophila ovalis	0.5 – 2 cm long	0	<1	Longstaff and Dennison (1999); Longstaff *et al.* (1999)
Heterozostera tasmanica	0.3 x 30	9% ambient	<10	Bulthius (1983)
Heterozostera tasmanica	0.3 x 30	2% ambient	2-4	Bulthius (1983)
Posidonia sinuosa	0.8 x 70	9% ambient	6 - 12	Collier (2006); Gordon *et al.* (1994)
Thalassia testudinum	0.4 -1.2 x 10-60	10% SI	<10	Czerny and Dunton (1995)
Zostera capricomi	0.25 -0.5 x 7-25	5% SI	1	Grice *et al.* (1996)
Zostera noltii	0.05 -0.15 x 6-22	<2% SI	0.5	Peralta *et al.* (2002)

SI = surface irradiance.
Adapted from Erftemeijer and Lewis (2006).

The proposed capital dredging program for the river facilities would involve small dredge volumes and short durations at each of three river facilities (**Table 7-9**). Whilst dredging may cause a very short-term and transient above average elevation of turbidity over seagrass meadows in the Embley River, it is expected that these elevations would be within the long term background range for the area and short-lived when compared to the frequent and naturally occurring elevated turbidity in the Embley and Hey Rivers and estuary (Carter *et al.* 2012). Despite this assessment which shows that there would be a minimal impact on the seagrass meadows, The Queensland Coordinator General proposed a conservative approach by providing stated conditions requiring a three day pause in dredging after 14 consecutive days dredging.

Water quality at the proposed Port, proposed new spoil ground, and ferry/barge terminals exhibits significant natural fluctuations in suspended sediment (reflected in the turbidity measurements). The migration and dispersion of turbid plumes during capital dredging and disposal at the proposed new spoil ground has been predicted through modelling (refer **Appendix 7-A**). Modelling results identified a median TSS concentration of approximately 2mg/L above background. The disposal plumes at the proposed new spoil ground are predicted to disperse along a south south-easterly trajectory due to tidal currents and would not reach Nine Mile Reef, which is located approximately 6km south-west of the proposed new spoil ground. The modelling predicted that 80th percentile TSS concentrations outside the immediate vicinity of the proposed new spoil ground would be only 2 to 3mg/L above background.

Turbidity plumes from dredging are predicted to reach sponge and coral habitats from Boyd Point to Pera Head, and further south towards Thud Point. Reefs in this area are predicted to be sediment tolerant, experiencing naturally high turbidity and sedimentation rates over extended periods of time. Therefore the impact of sediment plumes and sedimentation from capital dredging on marine turtle foraging habitat is expected to be minor to negligible. In addition, alternative foraging habitat for marine turtles, which is similar to the area that may be affected, occurs between Pera Head and Thud Point, at inshore reef areas south of Thud Point, and north of Boyd Point extending to Albatross Bay.

The presence of a turbidity plume may cause marine turtles to avoid foraging in areas where dredging is occurring, however no empirical data exist relating to the extent that marine turtles avoid turbidity plumes caused by dredging. Marine turtle species are often seen foraging in inshore tropical marine waters characterised by high levels of natural turbidity and may still be able to forage in areas characterised by high levels of turbidity associated with dredge operations.

Although marine turtles may avoid foraging in areas affected by a turbidity plume, the absence of contaminated material in the sediments that would be dredged, the predicted minor to negligible level of impact on foraging habitat, and the availability of alternative foraging habitat, indicate that the potential unmitigated impact on marine turtles from turbidity plumes associated with dredging and spoil disposal activities during construction and operation would be minor, and short term as they would only eventuate during dredging campaigns.

Deposition of dredged sediments on benthic habitats

Disposal and spillage of dredge spoil may directly smother benthic habitat during disposal. Spoil may also be remobilised and re-deposited during extreme events such as cyclones. The proposed new spoil ground and Albatross Bay spoil ground are both characterised as flat, unvegetated soft sediments. The proposed new spoil ground has been identified as containing sparse epifauna, including potential prey species for Flatback Turtles or Loggerhead Turtles. The Albatross Bay spoil ground has been used for disposal of dredged sediments since 1998. Deposited spoil in Albatross Bay has been shown be recolonised by benthos within several years (GHD 2005).

The spoil disposal grounds represent a very small proportion of the area of soft bottom benthic habitats available in Gulf waters of western Cape York and the impact on marine turtles from the deposition of dredged sediments on benthic habitats are considered to be negligible. The smothering of offshore soft bottom habitats as result of spoil disposal would be localised but would continue throughout the duration of the Project so would be long term.

Entrainment in dredge

Dredging activities using TSHD may injure or kill individual marine turtles as a result of accidental intake and entrainment as the TSHD head moves along the seabed. The use of turtle exclusion devices on the dredge heads is generally standard equipment on TSHD dredges operating in Australia and these minimise the potential for entrainment. Entrainment by CSDs is less likely due to the slow rate of progress of dredging. The barge-mounted backhoe/dipper dredge does not pose an entrainment hazard to marine turtles.

Entrainment would only eventuate during dredging campaigns, and so the potential unmitigated impact on marine turtle populations would be short term. Moreover, the risk of entrainment is reduced as the locations where dredging activities would occur are not considered to be important foraging habitat for marine turtles. However, in the event of entrainment, serious injury or mortality of an individual would be likely. The potential unmitigated impact on marine turtles would be considered to be minor.

Altered light regime

The Boyd Bay area is currently not impacted by anthropogenic lighting. It is therefore assumed that the baseline condition where dredging would occur for the proposed Port is that of natural ambient conditions, which are as follows:

- 0.00004lux (moonless, overcast sky);
- 0.002lux (moonless, clear night sky); and,
- 0.27-1.0lux (full moon on a clear night).

If hatchlings congregate under a dredge's lights they may be at increased risk of predation by fish and also delay night-time hours of offshore migration. However, studies have shown that marine turtle hatchlings are less influenced by light sources once they are under the influence of near-shore waves and magnetic fields (Lohmann 1991). Dredgers would be lit in accordance with the minimum requirements for navigational safety and safe operations at night. The lighting required for dredging would only be a small proportion of the total lighting required during the construction of the Project. The proposed Port area has a low density nesting population of Flatback Turtles and low density nesting population of Olive Ridley and Hawksbill Turtles. These species may potentially be impacted by any alterations to the light regime from dredging operations associated with construction and operation of the Port.

Altered light regimes from dredging operations would only eventuate during dredging campaigns, and so would be short term. Dredging operations would occur offshore, generally in excess of 500m from land, and would require a relatively low level of lighting. Therefore, given the low density of marine turtle nesting in the vicinity of proposed dredging operations for the Port, the potential unmitigated impact of lighting specifically related to the dredging activities on marine turtle hatchlings would be negligible.

Underwater acoustic impacts

Very little is known about the underwater noise source levels and associated frequencies that cause physical injury or behavioural responses in marine turtles. Available data on marine turtle hearing suggests a highest auditory sensitivity at frequencies of 250 - 700Hz, and some sensitivity to frequencies at least as low as 60Hz (Moein-Bartol *et al.* 1999, Ridgeway *et al.* 1969).

Dredging is at the lower end of the scale with regards to emitted sound pressure levels in aquatic environments, therefore injury by noise from dredging activities may occur if individuals are in the immediate vicinity of a dredger and are exposed for a long time, which is unlikely (CEDA 2011).

The main noise anticipated during dredging operations would be the noise from TSHD and CSD, which are reported to create higher underwater noise than the noise associated with grab dredges (CEDA 2011, Nedwell and Howell 2004). The sound pressure level of underwater noise from TSHD ranges from 186 - 188dB re 1µPa with peak intensity between 100 to 500Hz. The sound pressure level of underwater noise from CSD ranges from 172 - 185dB re 1µPa, with peak intensity between 100-500Hz (CEDA 2011). These levels are comparable to that of vibratory pile driving (refer **Section 15.3**).

Underwater noise has the potential to impact all marine turtle species in the vicinity of dredging activities including those feeding in the area, transiting through the area, or nesting. Marine turtles are unlikely to experience injury or hearing loss from dredging noise but may show behavioural responses and avoid the area, although there is also a possibility that they become habituated to the noise and remain within the vicinity (Smolowitz and Weeks 2006). Avoidance of underwater noise may impact on foraging or nesting behaviour of marine turtles in the immediate area.

Underwater acoustic impacts from dredging operations would only eventuate during dredging campaigns, and would be short term and only occur at close range to the dredge operations. Given the availability of preferred foraging habitat outside the dredging areas and low density of nesting in the vicinity of the Port dredge footprint, the potential unmitigated impacts of noise on all species of marine turtles from dredging activities would be negligible.

Changes to coastal processes (erosion and deposition)

Changes to coastal processes and hydrodynamics may facilitate beach erosion and potentially reduce the availability of nesting habitat for marine turtles. Coastal processes and the hydrodynamics around the proposed Port development area were assessed via hydrodynamic modelling, and analysis of collected field data (refer **Section 7.2.1** and **Appendix 7-A**). Currents, water levels, wave heights, and plumes were predicted and compared against recorded data where practical. Results of modelling indicated that for even the largest of the modelled storms, along-shore sediment transport occurred within 350m of the shoreline and that negligible impact on coastal morphology from the dredge area is expected. Modelling results also indicated that wave heights are not expected to change by more than 4% as a result of the dredging works and therefore minimal increase in beach and cliff erosion would be expected, even in extreme weather events (e.g. cyclones).

Although the altered coastal processes resulting from dredging activities for the proposed Port would be long term, they would have negligible impacts on nesting marine turtle species in the vicinity of the Project area.

7.3.5.2 Marine and River Facilities Construction and Operations

The construction works (excluding capital dredging and spoil disposal) for the Port and the barge/ferry terminals are described in detail in **Sections 3.6.2** and **3.7.2**. Construction of a temporary seaborne access, including a beach landing ramp for barges and small boats and a passenger jetty, may also be required during the construction phase of the Project (refer **Section 3.6.5**). The temporary seaborne access facilities would be removed when no longer required after permanent facilities have been constructed.

Construction of the Port facilities would initially include the construction of an approach jetty, a wharf and two berths. Separate berths would be provided for tugs and line boats. The Port would be equipped with the navigational aids.

Construction works for the Humbug terminal would include a floating ramp and mooring dolphins. An area of about 400m^2 would be reclaimed behind a sheet pile wall. Construction works for the Hornibrook terminal would include a pontoon and floating ramp.

The Hey River terminal would include construction of a pontoon and floating ramp, with an area of approximately 4,400m^2 reclaimed and supported by rock revetment and/or sheet piles.

Marine and river facility operations would generally be a continuous activity during the operational phase of the Project. Both construction and operational activities associated with the marine and river facilities have the potential to impact on marine turtles and their habitat. The potential direct and indirect impacts include:

- physical disturbance to benthic or intertidal habitats;
- physical disturbance to beach habitats from piling or temporary beach access;
- altered light regime;
- underwater acoustic impacts; and,
- changes to recreational use of beaches.

These potential direct and indirect impacts are discussed in detail in the sections below.

Physical disturbance to benthic or intertidal habitats

Construction works for the Humbug terminal would include a floating ramp, mooring dolphins, and a sheet pile wall. Marine construction works for the Hornibrook terminal would include a pontoon and floating ramp. The Hey River terminal would include construction of a pontoon, floating ramp, and rock revetment and/or sheet piles. Impacts on foraging habitat of Green, Hawksbill, Flatback, Loggerhead, and Olive Ridley Turtles within these areas are not considered to be significant relative to the overall availability of alternate foraging habitat in the Project area.

The wharf for the Port would require the installation of up to 274 piles mostly within intertidal/tidal areas (approximately 266 piles below the highest astronomical tide). A small area ($20m^2$) of very low density seagrass cover within Boyd Bay may be impacted by piles installed for the temporary passenger jetty. The alternate option for the temporary passenger jetty near Boyd Point would impact a small area of reef habitat. The disturbance of benthic habitat due to pile installation would have a negligible impact on the foraging habitat of Green, Hawksbill, Flatback, Loggerhead, Leatherback and Olive Ridley Turtles given the overall availability of alternate foraging habitat in the Project area.

Although the physical disturbance to benthic or intertidal habitats associated with construction activities of marine and river facilities would be long term, the potential unmitigated impact on marine turtle species would be negligible.

Physical disturbance to beach habitats from piling or temporary beach access

The proposed Port is situated adjacent to an area of low density Flatback Turtle nesting habitat, and Olive Ridley and Hawksbill Turtle nesting habitat. The wharf for the Port would require the installation of six piles on the beach above highest astronomical tide, resulting in direct disturbance to marine turtle nesting habitat of approximately $150m^2$ of the 5.8km beach between Boyd Point and Pera Head. This disturbance is considered negligible and long term.

The temporary barge landing area would be located on the beach a few hundred metres north of Pera Head. The concrete vehicle access for the temporary barge landing area would be 7.5m wide and vehicles and equipment would be restricted to this pathway. The temporary passenger jetty option in Boyd Bay would be only 2m wide and would have a raised pathway over the beach and scaffold stairs. The Boyd Point temporary passenger jetty option would not disturb any beach suitable for nesting as the landing would be onto rocky foreshore.

Consequently, the potential unmitigated impacts to marine turtles from the physical disturbance of beach habitats from piling or temporary beach access would be negligible and short term due to the low density of marine turtle nesting in the Port area, and the small proportion of beach areas from which marine turtles would be excluded.

Once the jetty for the Port is constructed, marine turtles would still have access to the area under the jetty for nesting (except where the foundations for the piles are placed on the beach), therefore potential unmitigated operational impacts associated with disturbance of beach habitats would be negligible and long term.

Altered light regime

The Boyd Bay area is currently not impacted by anthropogenic lighting. It is therefore assumed that the baseline condition where dredging would occur for the proposed Port is that of natural ambient conditions, which are as follows:

- 0.00004lux (moonless, overcast sky);
- 0.002lux (moonless, clear night sky); and,
- 0.27-1.0lux (full moon on a clear night).

The provision of night-time lighting is required to enable safe construction and operation of the proposed Port and associated on-shore facilities. The proposed Port area is considered to have a low density nesting population of Flatback, Olive Ridley and Hawksbill Turtles. Altered above-water light regimes have the potential to cause disorientation and interfere with nesting marine turtles and the ability of hatchlings to move offshore. Adult female marine turtles return to nest on their natal beach with a high degree of precision and appear to be pre-conditioned to emerge from the water on darker, more protected beaches than those in front of major urban and industrial areas (Limpus *et al.* 1984; Salmon *et al.* 2000 and references therein). Hatchlings may be attracted to light, and shore based lighting has the potential to prevent them finding the water immediately following emergence from the nest, increasing the risk of predation (Gyuris 1994, Mann 1977, Philibosian 1976). Light pollution was considered a pressure of potential concern in The Species Group Report Card – Marine Reptiles: Supporting the marine bioregional plan for the North Marine Region (DSEWPaC 2012n).

It is therefore possible that nesting activities and hatchlings may be impacted by shore-based lighting from construction and operation of the Port and associated onshore facilities where light spill would affect marine turtle nesting beaches. Given that the beach located between Thud Point and Boyd Point is considered to have only a low density of marine turtle nesting, the potential unmitigated impact of light on nesting marine turtles and hatchlings during the construction phase of the Port would be minor and short term, and from operations would be moderate and long term.

Acoustic and vibration impacts

Underwater noise during construction of marine and river facilities would be principally generated by pile driving activities at the proposed Port, river facilities and temporary seaborne access. Construction of the Port facilities and the Humbug, Hornibrook and Hey River terminals are described in detail in **Sections 3.6.2**, **3.7.2** and **3.8**. The Port facilities would initially include the construction of an approach jetty, a wharf and two berths. Separate berths would be provided for tugs and pilot boats. The Port would be equipped with navigational aids.

Construction works for the Humbug terminal would include floating pontoons and ramps as well as mooring dolphins. An area of about 400m^2 may be reclaimed behind a sheet pile wall or alternatively a concrete abutment supported by piles would be constructed. Construction works for the combined Hornibrook terminal and tug berths would include piling for pontoon's for each facility and with a floating ramp common to both facilities. The Hey River terminal would include construction of floating pontoons and ramps. An area of approximately 4,400m^2 would be reclaimed and supported by rock revetment and/or sheet piles, or a concrete abutment may be constructed.

Temporary seaborne access, including a beach landing ramp for barges and small boats near Pera Head and a passenger jetty at Boyd Point/Boyd Bay, may also be required during the construction phase of the Project (refer **Section 3.6.5**). The temporary seaborne access facilities would be removed when no longer required after permanent facilities have been constructed.

Modelling of underwater noise from pile driving activities (detailed in **Section 15.3.2.3** and **Appendix 15-A**) concluded that noise emissions from the Project piling activities may cause injury to marine turtles only within the immediate vicinity of the piling rig. Potential distances of ecologically meaningful behaviour disturbance for marine turtles from piling activities (pipe piles) are presented below for the largest piles at each facility (**Table 15-2**). Potential distances of ecologically meaningful behaviour disturbance from smaller piles would be less and are presented in the tables indicated

below for each facility. The potential distance of ecologically meaningful behaviour disturbance would be 470m from the Port for the 1,500mm piles (see **Table 15-6**), 340m from the Hornibrook terminal for the 1,050mm piles (see **Table 15-8**), 210m from the Humbug terminal for the 900mm piles (see **Table 15-7**), 470m from the Hey River terminal for the 1,050mm pile (see **Table 15-9**), and 360m from the 1,050mm piles at the navigation aids to be installed in the Embley and Hey Rivers (see **Table 15-10**). Marine turtles may be disturbed up to 630m at the Port for a scenario where three piling rigs are operating simultaneously (one rig piling a 1,500mm pile and two rigs piling 1,050mm piles) (see **Table 15-6**). This is the largest potential impact if three piling rigs are utilised; however, impacts would likely be less if three rigs were operating on a different combination of piles or less than three rigs were operating simultaneously.

Ecologically meaningful behaviour disturbance for vibratory piling (sheet piles) activities may occur at a distance of up to 110m from the Hey River terminal (see **Table 15-7**) and up to 60m from the Humbug terminal (see **Table 15-9**). Vibratory piling would also be used at the temporary seaborne access facilities. Potential behaviour disturbance distances from these facilities were not modelled. However, the lower impact of this method compared to piling driving and the limited duration of acoustic impacts in the vicinity of the temporary seaborne access, given the small number of piles that would be installed (eight at the temporary barge landing area and between 16 and 32 at the temporary passenger jetty), would mitigate the potential for behaviour disturbance to marine turtles in this area. Ecologically meaningful behaviour disturbance associated with drilling activities and may occur at less than 10m from the drill rig at all facilities and therefore behaviour disturbance from drilling would be unlikely.

At the Port, the distance where marine turtle behaviour may be adversely impacted would extend to the area of soft coral / sponge reef habitat immediately adjacent to the Port. Reef habitat is present at Pera Head approximately 400m from the temporary barge landing area (**Section 7.2.4.1**). Shallow coastal sedimentary habitats surround these facilities. Hawksbill, Flatback, Olive Ridley, Loggerhead and Leatherback Turtles may forage within the reef habitat and surrounding shallow coastal sedimentary habitats.

No seagrass beds are known to occur within the footprint of the proposed Port or temporary barge landing area at Pera Head. No seagrass was detected within the proposed Hornibrook and Humbug terminal footprints during 2012 surveys, however seagrass was found in nearby areas. No seagrass was detected within, or adjacent to, the proposed Hey River terminal dredging footprint during surveys. Samples collected in the bay to the north of the terminal, in an area previously known to have seagrass, recorded seagrass (*E. acoroides*) leaves (no attached rhizomes). Seagrass was confirmed as present at Boyd Bay within the likely distance of behaviour disturbance of the temporary jetty option in Boyd Bay. Green and Loggerhead Turtles may feed on and forage in these seagrass habitats.

Therefore, the foraging habitat of each marine turtle species may potentially be impacted by underwater noise from piling operations. Alternative reef habitat for marine turtles similar to the area that may be affected occurs between Boyd Point and Thud Point, and at inshore reef areas south of Thud Point, and north of Boyd Point extending to Albatross Bay. Alternative seagrass habitat for marine turtles similar to the area that may be affected occurs at multiple locations throughout the Hey and Embley River estuaries and south of Thud Point.

The proposed Port area has a low density nesting population of Flatback, Olive Ridley and Hawksbill Turtles. Behaviour impacts on marine turtles from underwater noise from piling activities may cause avoidance responses of animals attempting to use the beach for nesting or hatchlings migrating offshore. However, impact distances would only affect a small proportion of the adjacent beach and

nesting marine turtles would be expected to avoid the noise source and access the beach outside of the impact distance.

A literature review of the potential impact of pile driving on marine turtle nests conducted for the Cape Lambert Port B development in Western Australia (*Effects of Noise, Vibration and Blasting on Marine Fauna: literature Review*, Oceania Consulting Pty Ltd (2008)) found no empirical studies of the impact of pulsed vibrations upon marine turtle egg or hatchling mortality within nests.

While in theory very high levels of audible noise could adversely affect marine turtle egg development and survival, in practical terms the sound levels required to cause an impact would not be experienced in a marine turtle nest buried under the sand, since the sand would effectively attenuate any potential sound impacts and there would be negligible impact on developing marine turtle eggs (M. Terlich, pers. comm.). Only six piles would be driven on the beach at the proposed port.

Ground vibration monitoring at the Cape Lambert port has shown that marine turtles have successfully bred for decades in area subject to vibrations in the order of 2mm/s (*Vibration Assessment Report for Pile Driving Operation at Cape Lambert*, SVT (2008)). This level of vibration would only be experienced in the construction area where piling activities were within approximately 100m of nests (A. Moore, pers. comm.).

Marine turtles may be transient in the vicinity of piling activities and underwater noise from piling may cause marine turtles to avoid the area. While it is possible that marine turtles foraging, nesting and migratory behaviors may be affected by underwater pile driving noise, the impact distances are localised around the facilities and alternative habitats exist outside the impact distances. The potential unmitigated impact of underwater noise from piling activities on marine turtles either foraging or nesting would be minor and short term.

Changes to recreational use of beaches

The construction workforce based at the onsite temporary construction camp 2km north-east of the proposed Boyd infrastructure area (refer **Section 3.6.4**) is anticipated to peak at 1,400 people.

The only potential relevant impact on nesting marine turtles associated with workers accessing the beach at night would be light interference from torches. This could lead to marine turtles abandoning nesting attempts and returning to the water. However, it is noted that opportunities for employees to spend their recreational time outside the camp would be restricted. Access to the beach by the Project workforce at night for recreational purposes would not be permitted. Recreational use of the beach by Project workers would not result in disturbance of nests and vehicles would not be permitted on the beach

The operational workforce would be transported to and from the Project area at the beginning and end of shift. Due to the progressive reduction in operations at the existing RTA Weipa operations north of the Embley River, the population of Weipa would remain relatively stable when production commences at SoE. It would increase gradually as production increases (subject to market demand) and at maximum production, the population of Weipa is projected to rise to approximately 400 above the peak of 2007-2008 (approximately 4,000).

Consequently, the potential unmitigated impacts of light interference associated with the increased use of the beach by the workforce during the construction and operation phases of the Project would be considered to be short term for construction, and long term for operation phases, but would have a negligible impact on Flatback, Olive Ridley and Hawksbill Turtles nesting in the area.

7.3.5.3 Project-related Shipping

During the construction phase, the Port of Weipa would receive deliveries of fuel, cargo, and equipment for the Project at the Humbug, Evans Landing, and Lorim Point wharves. These materials would be transported from domestic ports (predominantly from the Port of Cairns) using the existing Cairns-Weipa barge service (which caters for the transport requirements of the existing Weipa operations) as well as chartered shipments. Materials would then be transferred either to vehicles or smaller barges as required for transport to the Project area.

A small number of large vessels would be involved in construction activities. An estimated 30 international chartered ship voyages are currently planned to offload at the Port of Weipa or directly to the Boyd Port facility (refer **Section 3.9**). Between 30 and 75 Roll-On-Roll-Off barges per week would transfer supplies between river wharf facilities.

The existing weekly service performed by the Cairns to Weipa Barge is estimated to have free capacity over the duration of the construction period to carry 84,000 Revenue Tons (168 round voyages at 500 Revenue Tons per voyage). The balance of 496,000 Revenue Tons would require approximately 120 Project-specific chartered voyages over the duration of the construction period. This is expected to peak at approximately 40 shipments per annum on average (80 average ship trips per annum).

The barge is owned and operated by a third party and operates within the requirements of the *Great Barrier Reef Marine Park Act 1975* and its operator has developed a range of environmental management plans for vessel and shore side activities.

During construction, barges and boats would generally run as required. 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. For more detailed information refer to **Sections 3.6.2**, **Section 3.9.1** and **Section 11.3.2.**

Bauxite is currently shipped from Lorim Point terminal at the Port of Weipa. In 2015, prior to the commencement of shipments from the proposed Boyd Port, it is predicted that there would be approximately 270 bauxite shipments sailing from the Port of Weipa to the Port of Gladstone (i.e. 540 shipping movements through the GBR per annum) with the remaining shipments likely to be to international ports (refer **Section 3.9.2.2**).

Bauxite shipping leaving the proposed Port would travel north past the existing Port of Weipa and through the Gulf of Carpentaria. Bauxite shipping supplying international export markets (e.g. China) would typically pass to the west of West Papua then east of the Philippines and would not route through the GBR (**Figure 2-3**). Bauxite shipping supplying the Australian market would travel to Gladstone via the Torres Strait shipping route and the inner GBR Designated Shipping Area. Within Gladstone Harbour, bauxite shipping would be subject to the controls of the Gladstone Harbour Master and ship traffic management schemes, including constraints on speed and route. Once vessels have passed the Port of Weipa they would travel via the same shipping routes that have been used by bauxite shipping from Weipa for over 40 years.

Under the maximum production scenario (50Mdptpa) up to 700 ships per year are predicted to be loaded at the Boyd Port and approximately 400 of these would be bound for export markets not passing through the GBR. The remaining balance of a predicted average of 300 shipments per year (600 ship movements) would be required to supply bauxite to two existing alumina refineries in Gladstone. The shipments through the GBR following commencement of production for the Project would continue to be the shipments required to meet the needs of the existing Gladstone refineries, and would use the same inner route of the GBR as is used at present (the inner GBR Designated Shipping Area). If the maximum production scenario (50Mdptpa) was reached by 2020, the potential

fluctuation in shipment numbers beyond that occurring prior to the commencement of the Project would be an average of 60 GBR bauxite ship movements annually, which includes possible fluctuations in the future of shipment numbers due to variation in bauxite grade quality and in alumina production at the Gladstone refineries, within the scope of the existing approvals for the refineries. The predicted additional bauxite shipping would represent approximately 0.4% of the GBRMPA (2012b) long term shipping forecast in the inner GBR Designated Shipping Area for 2020. The predicted additional Project-related shipping associated with Project operations is estimated at 152 movements per annum through the GBR (bauxite and cargo). This equates to approximately 1.0% of long term shipping forecast in the inner GBR Designated Shipping Area.

Overall impacts of Project-related shipping are considered further in **Section 4.5**. The potential impacts on the CMA from Project-related shipping activities are also considered in **Section 10.4**. The potential impacts on the GBRMP from Project-related shipping activities are considered in **Section 11.4**.

Project-related shipping activities have the potential to impact on marine turtles and their habitat. The potential direct and indirect impacts include:

- altered light regime;
- underwater acoustic impacts;
- marine oil spill;
- vessel discharges; and,
- vessel strike.

These potential direct and indirect impacts are discussed in detail below.

Altered light regime

All vessels would be lit in accordance with the minimum requirements for navigational safety and safe operations at night. The lighting required for Project-related shipping activities would only be a small proportion of the total lighting during the construction period of the Project. Given the low density of Flatback, Olive Ridley and Hawksbill Turtle nesting in the vicinity of the Project, the potential unmitigated impacts of lighting specifically related to Project-related shipping during construction would be negligible and short term.

Minimum lighting requirements for navigational safety on Project-related shipping are regulated by international convention and the *Navigation Act 1912* (Cth). Additional to navigation lights, lighting directed onto the deck of bulk carriers, barges and ferries would be required to facilitate safe loading and unloading of cargo and passengers, potentially resulting in some light spill onto the water surface. Given that the beach located between Thud Point and Boyd Point is considered to have only a low density of marine turtle nesting, the potential unmitigated impact of light associated with Project-related shipping during Project operations on nesting marine turtles would be negligible and long term.

Lighting from ships that are moving or anchored are predominantly projected horizontally as sky glow and direct light spill on the marine environment is limited. The anchorage area to be used by the Project is the one currently used for the Port of Weipa and is more than 17km from the proposed Port (refer **Figure 3-8**) and 16km from the nearest marine turtle nesting habitat and therefore presents negligible impact on nesting marine turtles or hatchlings and does not require monitoring.

Operational vessels further offshore, including those transiting through the GBR, would generally be underway except when waiting at anchor outside Gladstone Harbour, making the impact of light transitory. The designated shipping routes are also offshore and not in close proximity to marine turtle

nesting beaches so nesting marine turtles and any hatchlings are unlikely to be disturbed or disorientated. Therefore, the potential unmitigated impact of light on marine turtles from Project-related shipping would be negligible and long term.

Underwater acoustic impacts

Underwater noise from shipping principally originates from propeller action and cavitation, movement of the water across the hull, and the transmission of on-board machinery noise as vibration through the hull of the vessel (IMO 2009, Southall 2005). Underwater noise from shipping varies between different classes of vessels, and the speed, design and condition of the vessel will further influence noise generation. In general, the sound pressure of underwater noise from small to mid-size vessels (recreational vessels up to barges and workboats) is in the range of 165 – 180dB re 1µPa, and for large vessels such as bulk carriers is 180 – 190dB re 1µPa (CEDA 2011, OSPAR 2009). The predominant sound frequencies associated with large vessels are in the range of 10Hz to 1kHz (OSPAR 2009).

Underwater noise has the potential to impact marine turtle species in the vicinity of the Project area including those foraging in the area, transiting through the area, or nesting. The effects of underwater shipping noise on marine turtles are difficult to quantify as few controlled experimental data exist.

Marine turtles are unlikely to experience injury or hearing loss from noise associated with Project-related shipping during Project construction and operations, but may show behavioural responses and avoid the area. There is also a possibility that marine turtles may become habituated to the noise and remain within the vicinity of the area (Smolowitz and Weeks 2006), noting that shipping operations from Humbug and Hornibrook terminals would be located within an existing operating port.

Given the availability of alternate foraging habitats in the area and the low density of marine turtle nesting in the vicinity of the Port, the potential unmitigated impacts on all species of marine turtles from underwater acoustic impacts associated with Project-related shipping activities during construction would be negligible and short term.

Operational vessels further offshore would generally be underway, except when waiting at anchor (at which time there would be no noise from propeller cavitation associated with propulsion), making any impact of underwater noise transitory. Therefore, the potential unmitigated impact of underwater noise on marine turtles from Project-related shipping during Project operational phases would be negligible and long term.

Marine oil spill

The threat and likelihood of impacts from marine oil spills associated with bauxite shipping activities and barges, including the results of stochastic oil spill modelling, are discussed in **Sections 4.5.3.4** and **4.5.3.5**. The impact of marine oil spills in the CMA and GBRMP are also assessed in **Sections 10.4.6** and **11.4.6**.

Marine oil spills from Project-related shipping activities during construction and operation phases of the Project have the potential to significantly impact marine turtles, including adults and hatchlings, by smothering or toxicity if they are directly exposed, or by degrading foraging and/or nesting habitat. Marine oil spills also release toxic hydrocarbon vapours at the sea surface which may potentially harm marine turtles when they surface to breath.

In Australia, the greatest risk of oil spills, in terms of both frequency and costs, relates to incidents occurring in ports via fuel and oil transfer spills (for spills exceeding one tonne in volume) (DNV 2011). However, collisions of Project vessels with other vessels, stationary objects such as port

structures and grounding on benthic substrates have the potential to cause marine oil spills of a greater volume (refer **Section 4.5.3.3**).

Total predicted bauxite shipping (600 movements per annum at maximum production) equates to approximately 4.0% of long term shipping forecast in the inner GBR Designated Shipping Area. The predicted additional bauxite shipping at maximum production would represent approximately 0.4% of the GBRMPA (2012b) long term shipping forecast in the inner GBR for 2020. However, in 40 years of bauxite shipping from the Port of Weipa to the Port of Gladstone, there has been no reported collision or grounding incidents that have resulted in environmental harm. Project-related shipping (including the small increase at maximum production) is therefore not likely to increase the risk of collision or grounding and therefore a marine oil spill.

Stochastic spill modelling (refer **Appendix 4-D**) was undertaken for the following 12 scenarios at the South Trees Wharf and the Fisherman's Landing terminals:

- a $5m^3$ release of fuel oil at each of the two locations for two seasons (four scenarios);
- a $5m^3$ release of diesel at each of the two locations for two seasons (four scenarios); and,
- a $25.25m^3$ release of fuel oil at each of the two locations for two seasons (four scenarios).

The spill modelling reflects a situation where a spill is assumed to have occurred and the model estimates the probability of a spill reaching a particular location. The model does not estimate the probability of a spill occurring. The probability of a spill occurring is related to the number of vessels currently utilising the Port of Gladstone, including existing RTA shipping. The modelled results suggested that, if a $25.25m^3$ spill occurred, there would be up to 2% and up to 6% possibility of 0.01mm or thicker water-surface slicks entering the GBRMP from a spill at Fisherman's Landing and South Trees Wharf respectively if such a spill occurred. For the modelled cells within the GBPMP that have a possibility for oil on water, there is a maximum probability of 2% and 6% for a slick to occur from a spill at Fisherman's Landing and South Trees Wharf respectively. The model results for a $5m^3$ spill at both Fisherman's Landing and South Trees Wharf would not result in any water-surface oil slicks of 0.01mm or thicker being transported into the GBRMP. Based on the DNV (2011) estimate of the annual probability of a spill (>10t) in the GBRMP being 0.0511, the probability of an oil spill greater than 10t from a Project-related vessel (bauxite or cargo) traversing the GBR is 0.0174 (1.74%) and the increase in the annual probability of a spill due to the predicted increase in Project-related shipping is estimated to be 0.0058 (or 0.58%). Given a similar increase in spill probability in the Port of Gladstone, the small potential increase in Project-related shipping at maximum production would only increase the risk of an oil or fuel spill entering the GBRMP to a negligible extent.

It should be noted the modelling is based on a spill without any control measures. When operating in Australia, the bauxite ships would only take on bunker fuel at Gladstone, working under the existing controls and procedures of the Gladstone Ports Corporation. There would be no bunkering of bulk carriers at the Project's Boyd Port facilities.

The constraints on vessel speeds in the proposed Port and construction areas as well as the Port of Gladstone and the management initiatives that have been implemented along the shipping routes such as recommended pilotage regimes, means that the risk of a marine oil spill occurring due to collision or grounding is considered to be unlikely. The deeper water through the majority of the shipping routes also makes grounding of vessels unlikely. While the probability of a marine oil spill occurring is unlikely, such an incident may result in serious injury or mortality to marine turtles in the vicinity of the spill. Therefore, the potential unmitigated impact on marine turtles would be minor and short term.

Vessel discharges

Discharges from Project-related shipping, including garbage, sewage, and oily water may impact marine turtle species if they are directly exposed. All Project-related shipping would operate in strict accordance with international and domestic regulations relating to marine discharges and no discharges from vessels (including sewage, garbage or oily water from machinery spaces) would occur while vessels are in port limits. Outside of port limits and in the CMA, the only permitted discharges would be food waste and oily water in accordance with international and domestic regulations while the vessel is en-route. There would be no vessel discharges in the GBRMP or parts of Torres Strait designated as "nearest land" under MARPOL. The potential unmitigated impact on marine turtles associated with vessel discharges from construction shipping would therefore be negligible and short term and from operational shipping would be negligible and long term.

Vessel strike

Project-related shipping activities are discussed in **Section 4.5.3.13** and the impact of vessel strikes on marine fauna in the CMA and GBRMP are assessed in detail in **Sections 10.4.3** and **11.4.2**. Marine turtles may be unable to avoid vessels when they come to the surface to breathe and therefore can be vulnerable to vessel strike. Flatback Turtles were observed surfacing within the Project area during field investigations. Based on the proportion of reported marine turtle deaths from vessel strike in Queensland, the average mortality in Western Cape waters from vessel strike was 1.1 per annum over the period 1999 to 2010 (Marine Wildlife Stranding and Mortality Database annual reports, QPWS).

Vessel strikes are most likely when there are a large number of fast, small vessels operating in shallow water where avoidance by marine fauna is effectively reduced (Laist *et al.* 2001). The Project involves operating a passenger vessel and a barge transport for the workforce and cargo from the north side of the Embley River to the Project area. The passenger vessel is likely to operate at speeds of up to 22-30 knots (depending on the vessel used) in the main transit lane and would cross the river approximately 8-10 times per day at maximum production. The vessel would slow in shallower water as it approaches berth (refer **Section 3.9.1** for further description of these vessel movements). The cargo barge would have a top speed of 10-12 knots (depending on the vessel used), cross the river approximately 11 times per day at maximum production and would have a much lower risk of impact. The operation of the passenger vessel and barge may increase the risk of vessel strike on marine turtles in the Embley River estuary where seagrass beds are present. Transit lanes would be defined to reduce the overall area of disturbance from vessel activities, which would also follow the greatest water depths to further avoid significant meadows of seagrass beds (refer **Figure 4-3** to **Figure 4-7)** unless directed otherwise by the Regional Harbour Master. As such, the Hey/Embley River are 2.5–3.5km wide and the nearest defined seagrass bed to the transit lane would be approximately 500m (refer **Figure 4-7**). For marine turtles that forage in soft sediment habitats, the barge/ferry terminal and transit lanes represent only a negligible proportion of available habitat in the Hey/Embley estuary and the wider area. As such, the likelihood of a vessel strike associated with the operation of the barge/ferry in the Hey/Embley estuary on marine turtles is considered to be unlikely.

During construction, barges would transport materials from Cairns (or other east coast ports) to the Port of Weipa and then to the Project area. Slow moving displacement vessels such as barges and tugs would be mostly operating in deeper water and are considered to pose a lower risk of vessel strike. In the operational phase of the Project, bulk carriers would be used for bauxite transport. Bulk carriers are large and slow moving (14 knots being the usual cruising speed) and would be travelling more slowly and under pilotage in shallow or confined marine areas. Bauxite has been shipped from the Port of Weipa to the Port of Gladstone via the inner GBR Designated Shipping Area for over 40

years, and there have been no reported incidents of vessel strike on marine fauna by these vessels. Therefore, Project-related shipping (including the small increase at maximum production) is not considered to significantly increase the risk of vessel strike on marine turtles.

While the probability of a vessel strike involving Project-related shipping is unlikely, such an incident is likely to result in serious injury or mortality of an individual. However, given the low reported rate of vessel strikes on marine turtles, it is anticipated that the potential unmitigated impact on marine turtle species from vessel strike during the Project construction would be negligible and short term, and negligible and long term during Project operations.

During the operational phase of the Project, it is anticipated that there would be a relatively small increase in the overall population of Weipa and therefore the potential unmitigated impact of vessel strike from recreational vessels in the operational phase of the Project would be negligible and long term.

7.3.5.4 Summary of Relevant Impacts on Marine Turtles Prior to Mitigation

The main potential unmitigated impact on marine turtles would be from altered light regimes associated with the operation of the proposed Port. If unmitigated, this impact is considered to be moderate due to the amount of light required to operate the proposed Port safely.

Other potential unmitigated impacts on marine turtles that are minor or greater include:

- creation of turbidity plume;
- entrainment in the dredge causing injury or mortality to an individual animal;
- altered light regimes during construction of the proposed Port and associated onshore facilities;
- underwater noise associated with pile driving during construction of the proposed Port; and,
- marine oil spill associated with Project-related shipping activities during construction and operational phases of the Project.

These potential unmitigated impacts are considered minor as they do not impact on an important population of marine turtles, but impact either a small area of potential habitat or impact a small number of individuals in no more than a few discrete locations (refer **Section 7.1.2** for definitions of impact criteria).

All other impacts associated with dredging and offshore spoil disposal, construction and operation of marine and river facilities and Project-related shipping would be negligible prior to mitigation.

7.3.6 Avoidance, Mitigation, Enhancement Measures and Residual Impacts

The following sections outline the specific avoidance, mitigation and enhancement measures that would be implemented to reduce the potential impacts on marine turtles associated with dredging activities and offshore spoil disposal, construction and operation of marine and river facilities, and Project-related shipping activities (described in **Section 7.3.4**). An environmental management plan outline for marine turtles that summarises these avoidance, mitigation and enhancement measures is provided in **Appendix 7-E.**

7.3.6.1 Dredging and Offshore Spoil Disposal

Draft DMP's for capital dredging for the proposed Port and river facilities have been prepared (refer **Appendix 7-C** and **Appendix 7-D** respectively). The draft DMPs propose mitigation and monitoring measures for capital dredging and offshore spoil disposal activities. The mitigation and monitoring

measures that would be implemented will be in accordance with the final DMP's, which will be approved by DSEWPaC and EHP. DMP's for subsequent capital or maintenance dredging activities for both the Port and river facilities would be developed and submitted to EHP and DSEWPaC when required. DMP's for subsequent capital or maintenance dredging would also include relevant mitigation measures.

Physical disturbance to benthic or intertidal habitats from dredging

Negligible impacts on marine turtles are anticipated as a result of physical disturbance to benthic or intertidal habitats associated with dredging activities and therefore no specific mitigation is warranted. However, a summary of proposed mitigation measures as outlined in the draft DMP's is provided below (subject to further consultation with DSEWPaC and EHP), which would further reduce the impact on marine turtles:

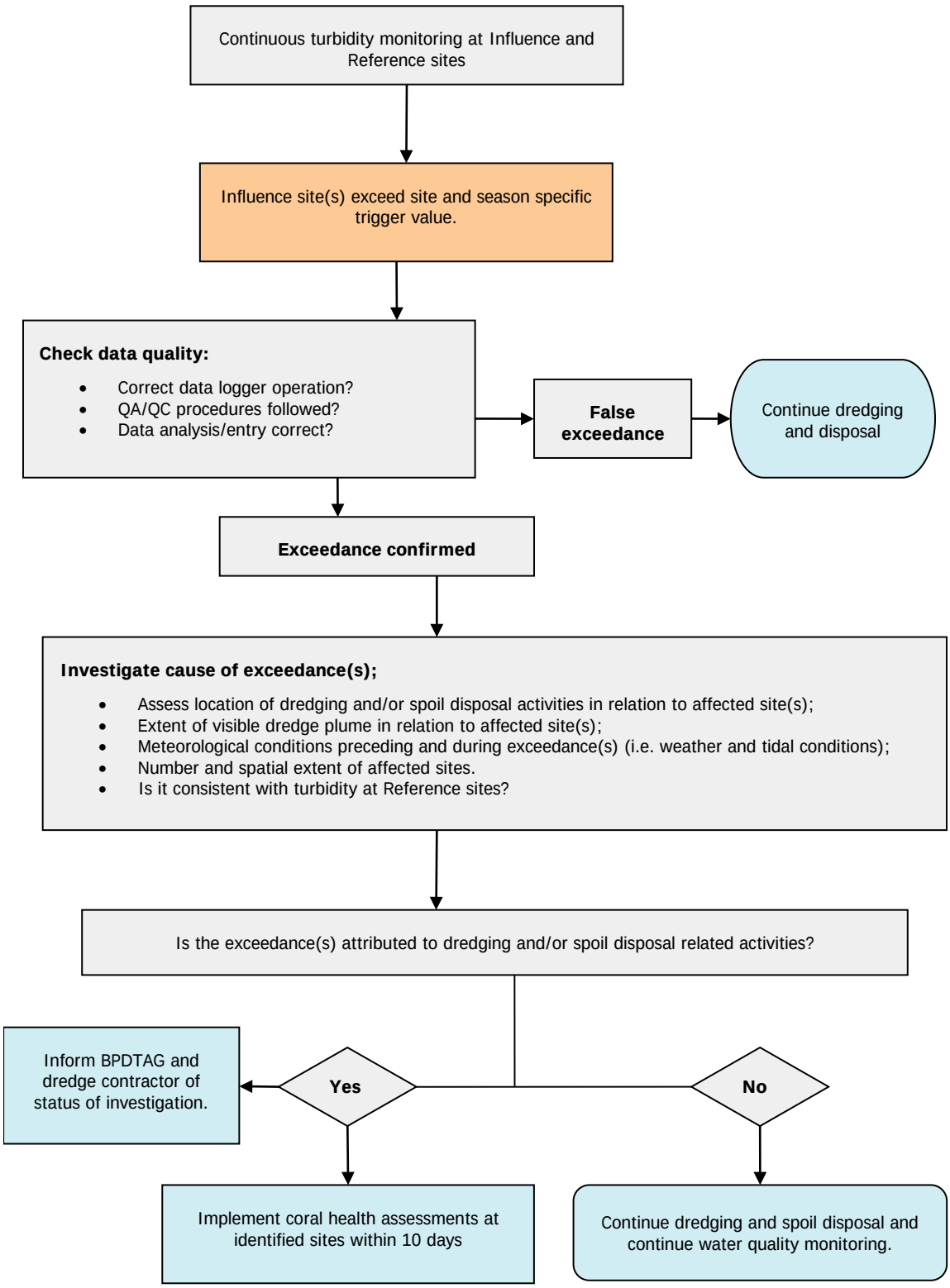
- accurate positioning systems to ensure dredging and disposal occur in approved areas;
- dredging activities would be restricted to locations shown on the dredging plan(s); and,
- dredging activities would be conducted using equipment that is in survey and registered, and complies with the conditions of relevant approvals.

Creation of a turbidity plume

A summary of proposed mitigation measures as outlined in the draft DMPs is provided below (subject to further consultation with DSEWPaC and EHP), which would further reduce the impact on marine turtles related to the creation of turbidity plumes from capital dredging activities and offshore spoil disposal:

- mechanical devices, such as turbidity-reducing valves within overflow pipes on the TSHD, would be used;
- hopper doors would be kept in good condition to minimise loss of sediment during transport;
- the TSHD would be equipped with below keel discharge of tail waters via an anti-turbidity control ("green") valve;
- accurate positioning systems would be used on dredges to ensure direct impacts are restricted to the approved dredging and disposal areas;
- direct sailing routes to and from the relevant spoil disposal ground would be selected to minimise the impact of propeller wash;
- water quality monitoring and trigger levels, as well as coral health monitoring (if required - refer **Appendix 7-C** for details) for dredging activities at the Port (refer **Figure 7-20**);
- current and forecasted meteorological and oceanographic information would be considered in the daily work plan; and,
- adaptive management measures would be implemented as required depending on the level of impact and may include:
  - moving the dredge operations and vessels to other areas within the development footprint to reduce potential impacts on the affected corals;
  - reducing or ceasing overflow during periods when the dredge plume is considered likely to lead to further impacts; or,
  - reducing dredging activities from 24 hours a day to a period timed to reduce impacts (e.g. to 12 hours/day or night).

Figure 7-20 Water Quality (Turbidity) Management Process



DMPs submitted for subsequent capital or maintenance dredging activities would include similar mitigation measures, where appropriate.

With the implementation of these mitigation measures, residual impacts on marine turtles from the creation of a turbidity plume associated with dredging activities and offshore spoil disposal would be minor, and would eventuate only during dredging campaigns so would be short term.

Deposition of dredged sediments on benthic habitats

Negligible impacts on marine turtles are anticipated as a result of the deposition of dredged sediments on benthic habitats and therefore no specific mitigation is warranted. However, a summary of proposed mitigation measures as outlined in the draft DMP's for capital dredging is provided below (subject to further consultation with DSEWPaC and EHP), which would further reduce the impact on marine turtles relating to deposition of dredged sediments on benthic habitats:

- mechanical devices, such as turbidity-reducing valves within overflow pipes on the TSHD would be used;
- hopper doors would be kept in good condition to minimise loss of sediment during transport;
- the TSHD would be equipped with below keel discharge of tail waters via an anti-turbidity control valve; and,
- accurate positioning systems to ensure dredging and disposal occur in approved areas.

DMPs submitted for subsequent capital or maintenance dredging activities would include similar mitigation measures, where appropriate.

Entrainment in dredge

A summary of proposed mitigation measures as outlined in the draft DMP's is provided below (subject to further consultation with DSEWPaC and EHP), which would further reduce the impact on marine turtles from dredge entrainment:

- all persons engaged in conducting dredging activities including but not limited to employees and contract staff would be trained in procedures and practices necessary to:
  comply with the conditions of the relevant regulatory approvals; and,
  prevent environmental harm during normal operation and emergencies; or,
  be under the close supervision of a trained person.
- the TSHD would have dredge heads with depth control, and where appropriate, fitted with marine wildlife protection or fauna exclusion devices (e.g. turtle deflector, deflector plates, tickler chains on dredge heads prior to and during operation);
- during daylight hours, operators of specified vessels would have a trained Marine Fauna Observer on watch during dredging operations;
- a log would be maintained on all dredge vessels detailing marine turtle sightings;

- mobile dredging operations:
  would not commence if marine turtles are observed within 300m of the dredge; and,
  where underway, would alter course if marine turtles are likely to be struck or captured.
- stationary dredging operations:
  would not commence if marine turtles are observed within 300m of the dredge; and,
  would cease if marine turtles are observed within 50m of the dredge head.
- marine turtle monitoring would be carried out as follows:
  daily monitoring for impacted marine turtles would be undertaken at the dredge and at the shoreline down-current from the dredging operation; and,

if monitoring indicates that more than two marine turtles are killed within a 24 hour period as a result of dredging, the dredge would be relocated from the area until an incident investigation has been carried out and relevant preventative actions implemented (refer **Table 7-10**).

- operating procedures that minimise the risk of marine turtle capture by the dredge head, and the risk from all activities of injury to marine species of conservation significance, must be developed prior to the commencement of dredging activities;
- the administering authority is to be immediately notified of any marine turtle captures by the dredge or injury to any marine species of conservation significance; and,
- an incident response strategy would be implemented during dredging activities and offshore spoil disposal. Adaptive management responses that relate to marine turtle incidents (injury or mortality) associated with dredging and spoil disposal activities would follow an incident investigation and action process aligned with a series of tiered response principles as outlined in **Table 7-11**.

The dredging and offshore spoil disposal marine turtle and marine mammal management procedure flowcharts are shown **Figure 7-21** and **Figure 7-22** respectively.

DMPs submitted for subsequent capital and maintenance dredging activities would include similar mitigation measures, where appropriate.

With the implementation of these mitigation measures, the risk of dredging causing injury or death via entrainment of marine turtles would be reduced. Although the risk would be lower, if entrainment of an individual marine turtle were to occur it would still likely result in injury or death of that individual. As such, the residual impact on marine turtles from dredge entrainment would still be minor and short-term as the risk would only occur during dredging campaigns.

Altered light regime

Negligible impacts on nesting marine turtles and their hatchlings are anticipated as a result of altered light regimes associated with dredging activities and spoil disposal, therefore no specific mitigation is warranted. However, proposed mitigation measures as outlined in the draft DMP's (subject to further consultation with DSEWPaC and EHP), which would further reduce the impact on marine turtles relating to altered light regimes from dredging operations includes minimisation of light levels from the dredging works to those lights that are necessary for their safe operation.

The feral pig control program would also be implemented to further reduce the impact on nesting marine turtles and their hatchlings (refer **Section 7.3.5**). The program which aims to reduce feral pig numbers along nesting beaches is expected to reduce the level of predation on marine turtle nests and hence increase hatchling survivorship in the Project area (refer to **Section 7.3.6.4** for more details).

Table 7-11 Adaptive Management Responses to Marine Turtles Incidents (injury or death) and Trigger Levels

Level 1

An injured or dead marine turtle is found and is attributable to dredging and/or spoil disposal activities.

Should it be determined that proposed management measures were not being followed, appropriate action would be taken to correct this deficiency. If management measures were being followed, an increased level of "off dredge" observation for further injured or dead marine turtles would be implemented over the following week. For example, additional monitoring of beaches or the reclamation area as appropriate.

Level 2

Three injured or dead marine turtles attributable to dredging and/or spoil disposal activities are found per seven day period, or six per 28 day period.

RTA would undertake a review of proposed management measures to identify alternative or additional practicable management measures that could be undertaken. At the same time interim management measures would be implemented to prevent possible sources of harm, where practicable, to reduce the risks of further marine turtle injury or mortality.

Level 3

Four injured or dead marine turtles attributable to dredging and/or spoil disposal activities are found per seven day period, or nine per 28 day period.

Immediate action would be taken to implement alternative and/or additional management measures to prevent likely sources of harm, including temporary relocation or suspension of activities. A review of management measures would be undertaken to identify longer-term alternative or additional management measures to reduce the risks of further marine turtle injury or mortality. Following the implementation of management action or actions associated with an event, the effectiveness of the process and actions taken would be reviewed periodically. The results of the review would guide adaptive management decisions and further actions as required.

Figure 7-21 Marine Turtle and Marine Mammal Management Procedure – Dredging

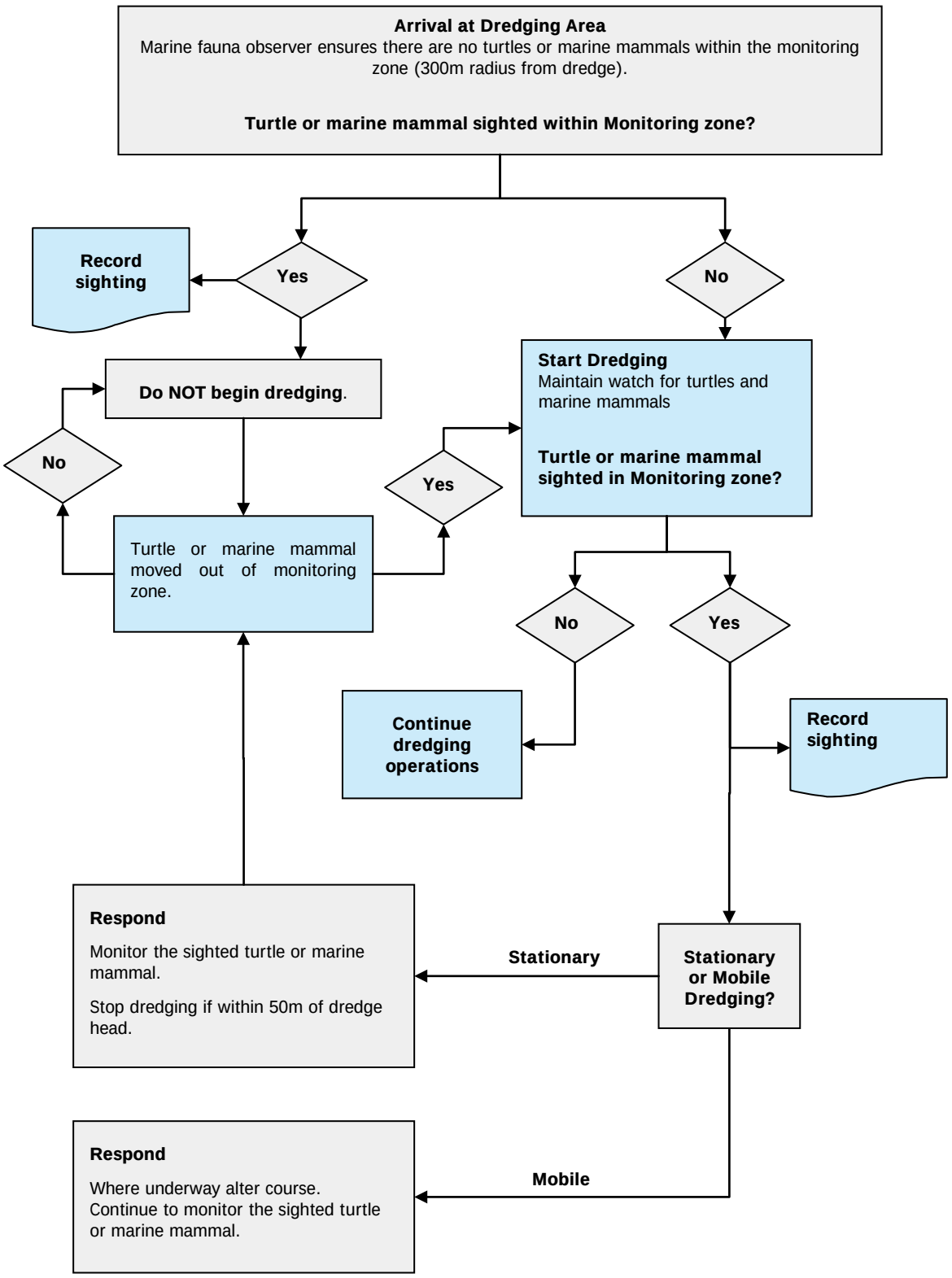
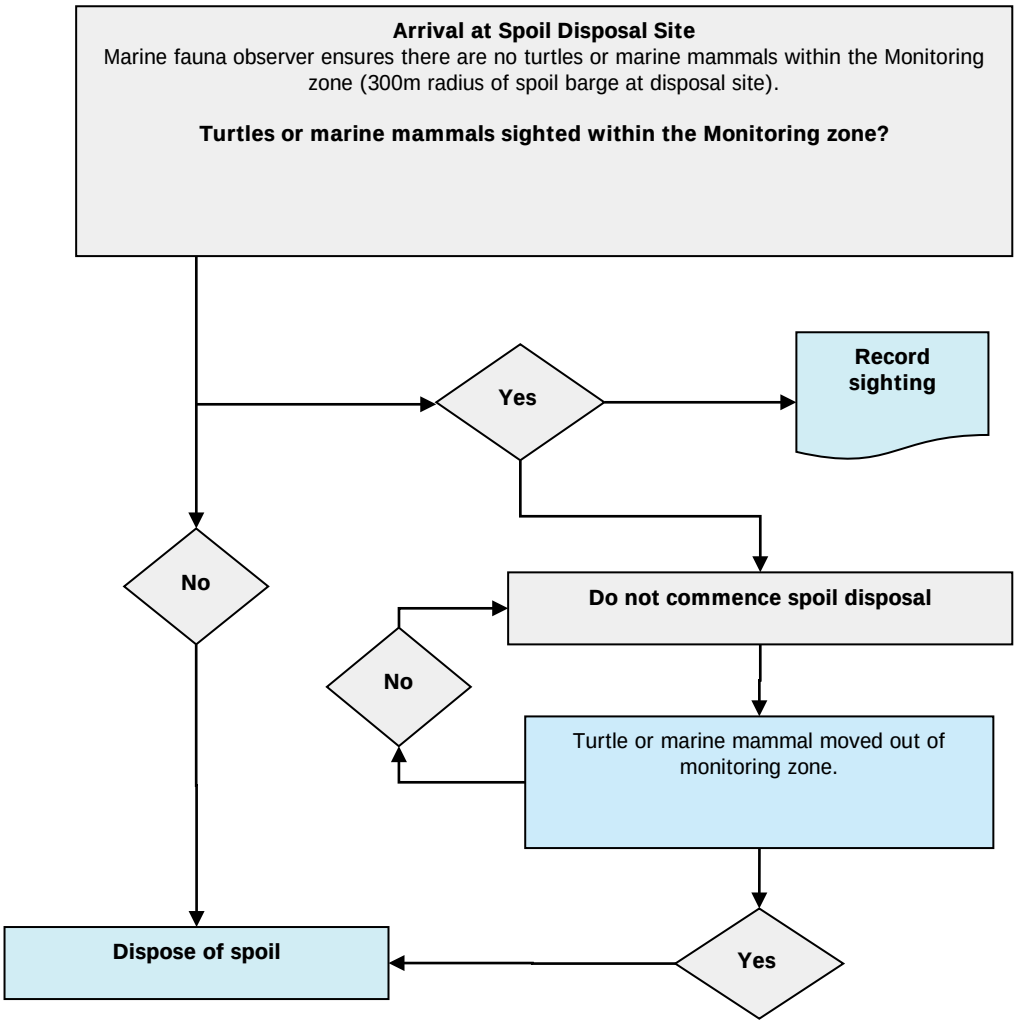


Figure 7-22 Marine Turtle and Marine Mammal Management Procedure – Offshore Disposal



Underwater acoustic impacts

Negligible impacts on marine turtles are anticipated as a result of underwater noise associated with dredging activities and spoil disposal therefore no specific mitigation is warranted. However, the marine turtle and marine mammal management procedure (**Figure 7-21**) provides observation and exclusion distances to prevent adverse behaviour or injury from underwater noise arising from dredging activities. A summary of proposed mitigation measures as outlined in the draft DMPs is provided below (subject to further consultation with DSEWPaC and EHP), which would further reduce the impact on marine turtles relating to underwater acoustic impacts from dredging:

- all vessels would operate in accordance with appropriate industry and equipment noise and vibration standards;
- regular maintenance of vessels would be conducted to the manufacturers' specifications; and,
- where possible, leaving engines, thrusters and auxiliary plants in stand-by or running mode unnecessarily would be avoided.

Changes to coastal processes (erosion and deposition)

Negligible impacts on nesting marine turtles are anticipated as a result of changes to coastal processes associated with dredging activities therefore no specific mitigation is warranted. However, impact to the longshore beach profile and cliffs due to the increased depth of the proposed berth and departure area of the Port would be limited to a reasonably short distance both sides of the wharf trestle structure (refer **Section 7.2.1** and **Appendix 7-A**). Potential impacts would be monitored and mitigation undertaken if cliff erosion is exacerbated.

7.3.6.2 Marine and River Facilities Construction and Operation

Physical disturbance to benthic or intertidal habitats

Negligible impacts on marine turtles are anticipated as a result of physical disturbance to benthic or intertidal habitats associated with the construction and operation of marine and river facilities and therefore no specific mitigation is warranted. However, the following mitigation measure would be implemented to further reduce the impact on marine turtles:

- all temporary seaborne access infrastructure facilities would be removed when no longer required.

Physical disturbance to beach habitats from piling or temporary beach access

Negligible impacts on nesting marine turtles are anticipated as a result of physical disturbance to beach habitats from piling or temporary beach access associated with the construction and operation of marine and river facilities and therefore no specific mitigation is warranted. However, the following mitigation measures would be implemented to further reduce the impact on marine turtles:

- prior to commencement of construction of the Port or temporary seaborne access facilities, an inspection for the presence of marine turtle nests would be conducted and, if there are nests that have not been predated by feral pigs, RTA would consult with EHP to evaluate options for the relocation of nests to a distance outside the potential zone of impact;
- the concrete matting for the temporary barge landing access would provide a 7.5m wide access for vehicles directly up the beach. This pathway would remove a very small proportion of the available 5.8km marine turtle nesting habitat available between Boyd Point and Pera Head. The provision of the concrete pathway would provide a defined pathway to prevent vehicles from disturbing marine turtle nests;

- bunting and/or signage would be used along pathways and landing area to minimise disturbance to adjacent potential marine turtle nesting areas; and,
- all temporary seaborne access infrastructure facilities would be removed when no longer required and the plateau at the temporary barge landing area reinstated as close as possible to original contours.

The feral pig control program would also be implemented to further reduce the impact on nesting marine turtles and their hatchlings (refer **Section 7.3.5**). The program which aims to reduce feral pig numbers along nesting beaches is expected to reduce the level of predation on marine turtle nests and hence increase hatchling survivorship in the Project area (refer to **Section 7.3.6.4** for more details).

Altered light regime

A number of mitigation measures would be implemented to reduce the impact on marine turtles from altered light regimes associated with construction and operation of the Port.

A lighting plan (refer **Table 7-12**) for the Port would be implemented to mitigate the potential effects of lighting on marine turtle hatchlings. RTA would work with EHP 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 Port;
- installation of timer switches or movement sensors where applicable;
- shielding and/or recessing of lights to minimise light spill;
- installation of long wavelength lights or other lighting demonstrated to have a low impact on the relevant marine turtle species; and,
- any other lighting options that further reduce impacts to marine turtles while allowing for the safe and efficient operation of the Port facility.

With the implementation of these mitigation measures, residual impacts to marine turtles from altered light regimes associated with construction of the Port would remain minor and short term. Residual impacts to marine turtles from altered light regimes associated with operation of the Port would be minor and long term.

The feral pig control program would also be implemented to further reduce the impact on nesting marine turtles and their hatchlings (refer **Section 7.3.5**). The program which aims to reduce feral pig numbers along nesting beaches is expected to reduce the level of predation on marine turtle nests and hence increase hatchling survivorship in the Project area (refer to **Section 7.3.6.4** for more details).

Monitoring of marine turtle nesting and hatching success would be undertaken throughout the Project, including observation of the behaviour of marine turtle hatchlings as part of the feral pig control program (refer to **Section 7.3.6.4**). Monitoring would include monitoring emerging hatchlings moving up the beach towards land, the re-emergence of hatchlings from the water and any aggregation of hatchlings around a light source. If the above behaviour is detected, within the limits set by the safe operation of the port, lighting modification or other solutions would be investigated and implemented if necessary.

Table 7-12 Proposed Lighting Plan

Facility	Description	Mitigation measures
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 or other lighting demonstrated to have a low impact on the relevant marine turtle species 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 or other lighting demonstrated to have a low impact on the relevant marine turtle species 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 or other lighting demonstrated to have a low impact on the relevant marine turtle species 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 or other lighting demonstrated to have a low impact on the relevant marine turtle species 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 moorings at Port	The access berth and walkways would be illuminated as needed.	• Long wave length lighting or other lighting demonstrated to have a low impact on the relevant marine turtle species 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.
Temporary seaborne access	Navigational safety lights would be installed on any structures in accordance with Maritime Safety Queensland (MSQ) requirements.	• Night time barge deliveries would only be required during high tide. • Lighting would only be utilised when barges are loading or unloading for safe access. • The passenger jetty would only be utilised in daylight hours except in the event of an emergency.
Tug boat	Sufficient lighting would be allowed for to ensure safe movement around deck of the tug.	• The design would ensure that there would be limited usage of lights which have a major impact outside of the vessel yet which are required for safe operation.

Facility	Description	Mitigation measures
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 which have a major impact outside of the vessel yet which are required for safe operation.
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 or other lighting demonstrated to have a low impact on the relevant marine turtle species 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 Darwin Stringybark 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 Darwin Stringybark forests estimated at up to 25 - 30m high at 200m width (between beneficiation plant and Port).
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: The Embley River and Hey River are not nesting areas for marine turtles, so lighting impacts from barge/ferry terminals are not potential impacts.

Acoustic and vibration impacts

The following mitigation measures which have been derived from the assessment outlined in **Section 15.3.3.1** would be implemented to reduce the impacts on marine turtles related to underwater noise associated with the construction and operation of marine and river facilities:

- for marine and river pile driving activities, the soft start approach would be used to disperse marine and migratory fauna (including marine turtles) prior to normal pile driving activities commencing;
- continual marine fauna observations (including marine turtles) would be conducted for 30 minutes prior to and during marine and river pile driving activities;

- observation zones would be maintained over the distances shown in **Table 15-6** to **Table 15-10** with a minimum observation distance of 300m maintained at all times;
- the observation zone for the likely worst case scenario (1 x 1500mm and 2 x 1050mm pipe piles at the Port) would be the largest zone required if three piling rigs are utilised. If a different combination is used which may result in a lower impact an appropriate observation zone may be determined in consultation with DSEWPaC;
- marine and river pile driving activities would be stopped if marine turtles enter within an exclusion zone of 100m and remain within the zone for greater than five minutes;
- no piling activities (including soft start) would commence if marine turtles are observed within the exclusion zone during visual observations prior to start-up;
- prior to commencement of construction of the Port or temporary seaborne access facilities, an inspection for the presence of marine turtle nests would be conducted and, if there are nests that have not been predated by feral pigs, RTA would consult with EHP to evaluate options for the relocation of nests to a distance outside the potential zone of impact; and,
- all equipment and machinery would be maintained in accordance with manufacturer's recommendations and excessive underwater noise would be investigated and remedied.

With the implementation of these mitigation measures, the residual impacts to marine turtles from underwater noise associated with marine and river facilities construction would still be minor and short term.

Changes to recreational use of beaches

Negligible impacts on nesting marine turtles are anticipated as a result of changes in the recreational use of beaches therefore no specific mitigation is warranted. However, the following mitigation measure would be implemented to further reduce the potential impact on marine turtles associated with the recreational use of the beach by the workforce:

- an access permit system would be developed in consultation with the Traditional Owners with the objective of minimising impacts on nesting marine turtles, nests and hatchlings by the construction and operational workforce. The detail within the permit system is subject to ongoing consultation with Traditional Owners; however it is likely to include the following aspects for recreational access by construction workers:

  access to the marine turtle nesting beach would be forbidden without a permit;
  recreational access to the marine turtle nesting beach would not be permitted at night;
  no access above high tide mark except in designated walk way areas to avoid nesting sites;
  inductions would include appropriate behaviours for beach access to prevent impacts to nesting marine turtles or nests; and,
  awareness program would also include signage, posters in the camp, and consideration of educational tours and/or involvement in the proposed marine turtle nesting monitoring program (refer **Section 7.3.6.4** for details).

Enforcement of the access permit system would be through enforcement of the following measures that would be included in the code of conduct for the construction camp:

- implement workforce induction and awareness sessions to communicate requirements relating to safety, security, behaviour and land access both on and off the mining lease;
- implement a complaints system and incident management process whereby any reported incidents of unacceptable behaviour are investigated and incidents responded to; 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 contractors in the Project area and emphasise need for appropriate behaviour at all times. Monitoring of the access permit system would be conducted through the Project health, safety and environment management system including corrective actions for any breaches of the access permit system implemented through the incident management system.

The feral pig control program would also be implemented to further reduce the impact on nesting marine turtles and their hatchlings (refer **Section 7.3.5**). The program which aims to reduce feral pig numbers along nesting beaches is expected to reduce the level of predation on marine turtle nests and hence increase hatchling survivorship in the Project area (refer **Section 7.3.6.4** for more details).

7.3.6.3 Project-related Shipping

Altered light regime

Negligible impacts on nesting marine turtles and their hatchlings are anticipated as a result of an altered light regime associated with Project-related shipping activities therefore no specific mitigation is warranted. However, the following mitigation measures would be implemented to further reduce the impact on marine turtles:

- lighting on board vessels at sea and in port would be minimised to that necessary to comply with navigational safety regulations and provide for safe working while personnel are on deck; and,
- vessels waiting to berth at ports would only anchor in existing offshore anchorage areas as prescribed by the relevant Harbour Master.

Underwater acoustic impacts from vessel movements

Negligible impacts on marine turtles are anticipated as a result of underwater noise associated with Project-related shipping activities therefore no specific mitigation is warranted. However, the following mitigation measure would be implemented to further reduce the impact on marine turtles:

- all vessels would operate in accordance with appropriate industry and equipment noise and vibration standards;
- RTA owned Project vessels, including on board machinery and equipment, would be maintained to a high standard and any source of excessive underwater noise would be investigated and remedied;
- regular maintenance of RTA owned vessels would be conducted to the manufacturers' specifications; and,
- where possible, leaving engines, thrusters and auxiliary plants in stand-by or running mode unnecessarily would be avoided.

Marine oil spill

The risk of marine oil spills from Project-related shipping would be reduced by measures to reduce the risk of collisions or groundings. This includes the use of tugs in port areas, qualified bridge personnel, bridge management systems including fatigue management, pilotage and Vessel Tracking Systems. The following additional mitigation measures would be implemented to reduce the potential unmitigated impacts on marine turtles from oil spills associated with Project-related shipping activities:

- bauxite vessels, including the hull and fuel tanks, would be kept in a good state of repair and the fleet used would consist of modern ships that are subject to an environmental and safety vetting system;
- all RTA owned vessels would have spill kits on board, and spill kits would be located at the Port, with vessel and shoreside oil spill contingency plans in place;
- no oil discharges from vessels would occur from Project-related shipping while in Australian waters other than the discharge of treated oily water from machinery spaces (oil content not exceeding 15ppm in accordance with MARPOL Annex I);
- all bauxite vessels would have IMO approved oily water separators and high oil content alarm systems, as well as the capacity to immediately shut down any non-compliant oily water discharge and to redirect oily water to holding tanks for discharge ashore; and,
- no bulk chemicals or hydrocarbons would be stored at the proposed Port.

Although these measures reduce the risk of a marine oil spill occurring to unlikely, any incident may result in injury or mortality of a marine turtle if they are exposed. Therefore, although the risk is unlikely, the residual impact of a marine oil spill from Project-related shipping activities throughout the life of the Project would still be minor and short term.

Vessel discharges

Negligible impacts on marine turtles are anticipated as a result of vessel discharges associated with Project-related shipping activities therefore no specific mitigation is warranted. However, the following mitigation measure would be implemented to further reduce the impact on marine turtles:

- all vessels would operate in full compliance with international and Australian regulations with respect to the treatment and discharge of operational wastes;
- no garbage or sewage would be discharged in the Port area and on-board garbage management plans and systems would reduce the risk of accidental loss of waste overboard;
- no operational discharges from vessels would occur from Project-related shipping while in Australian waters other than the discharge of treated oily water from machinery spaces (oil content not exceeding 15ppm in accordance with MARPOL Annex I);
- Project vessels would not discharge any garbage while at sea within the Port area, GBRMP or parts of the Torres Strait defined as “nearest land”;
- Project vessels would have on-board garbage management plans and systems to minimise the risk of accidental loss overboard of garbage, particularly plastics; all Project vessels would have an on-board sewage treatment plant that is IMO approved, holding tanks and discharge connections to allow discharge at shore facilities or holding until the vessel is outside Australian Waters;
- all sewage waste from bauxite ships working on the domestic route between Boyd Port and Gladstone would be discharged to a shore-based facility in Gladstone;
- a sewage log book for bauxite vessels would be maintained in accordance with the provisions of MARPOL Annex IV – Sewage, and the Transport Operations (Marine Pollution) Act; and,
- on-board sewage treatment systems would be included in bauxite vessel’s planned maintenance system, and compliance with sewage treatment and discharge regulations would be included in Port State Control inspections.

Vessel strike

Negligible impacts on marine turtles are anticipated as a result of vessel strike associated with Project-related shipping activities therefore no specific mitigation is warranted. However, the following mitigation measures would be implemented to further reduce the impact on marine turtles:

- all vessels would strictly adhere to port controls;

- the passenger vessel operating on the Hey and Embley Rivers would use a transit lane which follows the greatest water depths to avoid significant seagrass meadows;
- any injury or death of marine turtles would be reported to EHP for inclusion in the Wildlife Stranding database and those that may be attributable to RTA operations would be investigated to determine appropriate mitigation measures;
- large vessels would travel more slowly and under pilotage in shallow or confined marine areas where susceptible marine fauna including marine turtles are more commonly found; and,
- the passenger vessel would be limited to a speed of 6 knots in water of less than 2.5m in depth when approaching berth.

7.3.6.4 Enhancements - Feral Pig Control Program

The primary factor currently impacting marine turtle nesting success at the proposed Port site is predation by feral pigs (refer **Section 7.3.1**). The feral pig control program would cover the coastal zone between Ina Creek and Winda Winda Creek and associated riparian hinterland areas. The feral pig control program would be developed in consultation with EHP and shall be further refined and implemented in consultation with the Traditional Owners. The program, which would focus on reducing feral pig numbers, would reduce feral pig damage to riparian and wetland areas within the management zone and reduce nest predation by feral pigs and hence increase marine turtle hatchling survivorship in the Project area.

As such, the proposed feral pig control program will constitute an offset under the Queensland Biodiversity Offsets Policy (DERM 2011b). The implementation of this offset is a condition of the Queensland Coordinator General's approval of the Project. The program would have two components as follows.

1. Marine Turtle Monitoring:

Objectives:

- Determine the abundance of nests on specific sections of beach over specified time intervals for Olive Ridley and Flatback Turtles (and other species if present).
- Identify the significance of sections of the beach to each species.
- Establish the level of predation on nests and determine the extent of predation by feral pigs.

Monitoring Methods:

- A baseline survey of two days each month (after spring hide tides where high tides occur late in the evening (after 20:00 hours) designed to detect peak nesting patterns would be conducted. In addition during the initial baseline year, two 14 day intensive surveys in July and October (during potentially the peak nesting periods) would be conducted.
- From year two onwards, annual monitoring over two 14 day periods during peak of the nesting season (between July and October, to be confirmed from initial baseline year data).
- The extent of beach that would be monitored would include from Ina Creek in the south to the ML7024 boundary in the north (**Figure 7-23**).
- Monitoring teams would include Traditional Owner representatives (if Traditional Owners are available) and would occur in daylight hours. Sections of beach where marine turtles could not physically nest would be excluded from the survey.
- The annual monitoring program would be reviewed each year and may be amended based on earlier results.

- Monitoring would include monitoring emerging hatchlings moving up the beach towards land, the re-emergence of hatchlings from the water and any aggregation of hatchlings around a light source.
- Monitoring details that would be recorded include:

total number of nests;
location of nests (GPS);
species nested;
number of false crawls (mark all marine turtle tracks with GPS);
number and location of disturbed nests and potential cause of disturbance; and,
record all hatched nests.

2. Feral Pig Control:

Objectives:

- To reduce feral pig numbers along nesting beaches.
- To reduce the level of predation on marine turtle nests.

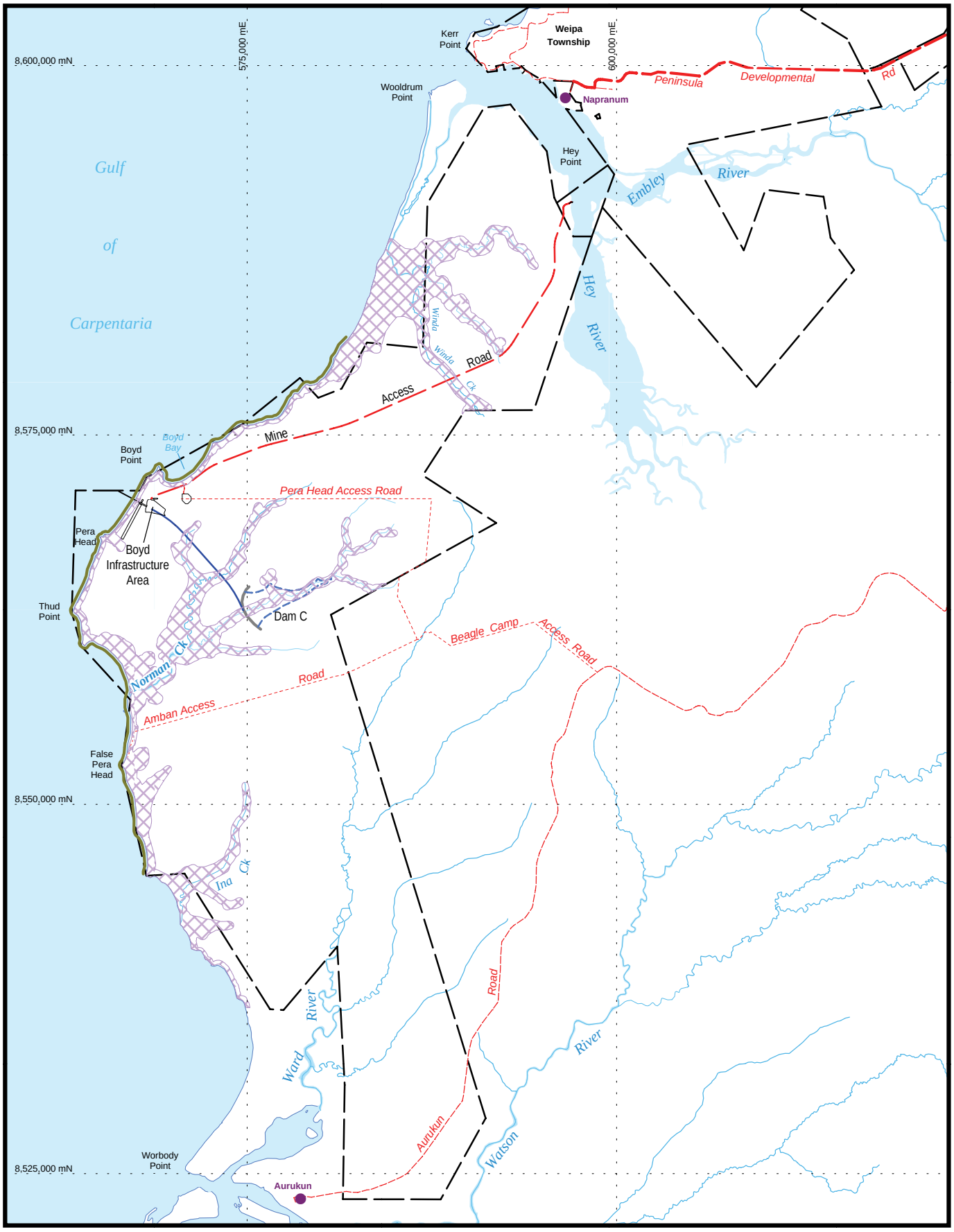
Feral Pig Control Methods:

- An annual feral pig control program would be implemented using shooting (helicopter or ground based methods) prior to the peak of marine turtle nesting season (timing to be confirmed subject to results of initial baseline survey). Specific details of control methods to be employed are subject to safety considerations and availability of equipment.
- The feral pig control program would cover the coastal zone between Ina Creek and Winda Winda Creek and associated riparian hinterland areas.
- The feral pig control program would commence after the year 1 baseline marine turtle monitoring program and continue to the extent necessary while RTA operates the Boyd Port.
- The marine turtle offset plan shall provide for the annual monitoring of beaches for marine turtle nesting and nest predation rates.

7.3.6.5 Summary of Residual Impacts on Marine Turtles Following Mitigation

Table 7-13 summarises the potential unmitigated construction and operational impacts that are minor or greater, the relevant mitigation measures to be implemented and the resulting residual impacts on marine turtles.

Table 7-14 to **Table 7-19** summarises the potential impacts on marine turtles resulting from the Project considering proposed mitigation measures and in relation to the significant impact criteria for matters of NES (DEWHA 2009c).



RTA Mining Lease boundary
Locality
Road/track
Freshwater dam
Turtle monitoring beach
Feral pig control area

South of Embley Project

Fig. 7-23: Turtle Monitoring and Feral Pig Control for Turtle Management

N

5 0 5km

Datum/Projection: GDA94/MGA Zone 54 Date: 01/11/2012

Table 7-13 Summary of Potential Impacts, Mitigation and Enhancement Measures, and Residual Impacts on Marine Turtles

Potential Impact	Impacted Species	Unmitigated Impact Magnitude		Relevant Mitigation and Enhancement Measures	Residual Impact Magnitude	
		Construction	Operation		Construction	Operation
Creation of turbidity plume	All marine turtle species	Minor and short term (Capital Dredging)	Minor and short term (Maintenance Dredging)	Dredge design and operation controls to minimise spillage of dredged material. No dredging outside approved areas (dredge track monitored). Dredge spoil dumped evenly and only in designated spoil grounds. Planning of dredge operations in line with weather constraints to minimise turbidity. Adaptive management based on water quality monitoring trigger values.	Minor and short term (Capital Dredging)	Minor and short term (Maintenance Dredging)
Entrainment in dredge	All marine turtle species	Minor and short term (Capital Dredging)	Minor and short term (Maintenance Dredging)	Marine fauna observers on watch. An exclusion area of 300m would be applied, with operations not commencing if a marine turtle is observed within this zone, and stationary operations being ceased if a marine turtle is observed within 50m or mobile operations must alter course if marine turtles are likely to be struck. Dredge design controls, e.g. turtle exclusion devices and deflectors on dredge head. Use of suction only once the dredge head is close to the seabed.	Minor and short term (Capital Dredging)	Minor and short term (Maintenance Dredging)
Altered light regime	Flatback Turtle, Olive Ridley Turtle, Hawksbill Turtle	Negligible and short term (Offshore lighting) Negligible and long term (Project-related shipping) Minor and short term (Onshore lighting)	Negligible and short term (Offshore lighting) Negligible and long term (Project-related shipping) Moderate and long term (Onshore lighting)	Lighting management plan including shielding, placement, timers and long-wavelength other lighting demonstrated to have a low impact on the relevant marine turtle species would be included in the design for the Port. Lighting on shore and vessel lighting limited as far as possible while allowing for safe operations. Enhancement - Feral pig control program.	Negligible and short term (Offshore lighting) Negligible and long term (Project-related shipping) Minor and short term (Onshore lighting)	Negligible and short term (Offshore lighting) Negligible and long term (Project-related shipping) Minor and long term (Onshore lighting)

Potential Impact	Impacted Species	Unmitigated Impact Magnitude		Relevant Mitigation and Enhancement Measures	Residual Impact Magnitude	
		Construction	Operation		Construction	Operation
Underwater acoustic impacts from pile driving and vessel movements	All marine turtle species	Negligible and short term (Dredging, Project-related shipping) Minor and short term (Pile driving)	Negligible and short term (Dredging) Negligible and long term (Project-related shipping)	The soft start approach would be used to disperse marine and migratory fauna (including marine turtles, cetaceans and Dugongs) prior to normal pile driving activities commencing. Continual marine fauna observations within designated observation zones would be conducted prior to and during marine and river pile driving activities. Marine and river pile driving activities would be stopped if marine turtles enter within an exclusion zone of 100m and remain within the zone for greater than five minutes. No piling activities (including soft start) would commence if marine turtles are observed within the exclusion zone during visual observations prior to start-up. All equipment and machinery would be maintained in accordance with manufacturer's recommendations and excessive underwater noise would be investigated and remedied.	Negligible and short term (Dredging, Project-related shipping) Minor and short term (Pile driving)	Negligible and short term (Dredging) Negligible and long term (Project-related shipping)
Marine oil spill	All marine turtle species	Minor and short term (Project-related shipping)	Minor and short term (Project-related shipping)	Oil spill risk reduced by operational controls to minimise the risk of collisions or grounding as well as vessel maintenance. Oil spill contingency planning and equipment to minimise the amount of oil spilled and facilitate rapid response. No oil discharges in accordance with MARPOL.	Minor and short term (Project-related shipping)	Minor and short term (Project-related shipping)

Table 7-14 Impact Assessment Summary - Green Turtle

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 and as such belong to a larger geographical unit spread over a much greater region than the Gulf of Carpentaria. Project-related shipping activities would not impact on important populations of this species. The Project aspect with the greatest potential for long-term impact and decrease in local Green Turtle activity is dredging. The proposed mitigation measures for dredging would minimise the risk of any long term population decline. 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, including predicted Project-related shipping activities, 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, including predicted shipping activities, 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. Predicted Project-related shipping activities are not anticipated to adversely impact any critical habitat areas for this species.
....disrupt the breeding cycle of an important population?	Surveys have found no nests in the Project area and 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?	Significant seagrass meadows for Green Turtle foraging habitat occur elsewhere in the Weipa region. Predicted Project-related shipping activities are not anticipated to adversely impact any critical habitat areas for this 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 Green Turtles would be introduced due to the development or operation of Project marine infrastructure or predicted Project-related shipping.
.....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 or predicted Project-related shipping.
....interfere substantially with the recovery of the species?	Proposed mitigation measures for dredging would minimise potential for entrainment of marine turtles during development and maintenance dredging of the Port area. The Project, including predicted Project-related shipping activities, is not expected to interfere with the recovery of the species.

Table 7-15 Impact Assessment Summary – Hawksbill Turtle

Will the proposed works...	**Hawksbill Turtle (*Eretmochelys imbricata*): 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, including predicted Project-related shipping activities, 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, including predicted Project-related shipping activities, 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, including predicted Project-related shipping activities, 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 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 that are not as sensitive to light or suspended solids changes (e.g. sponges, seagrass and algae). Predicted Project-related shipping activities are not anticipated to adversely impact any critical habitat areas for this species.
....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. 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 may be impacted as a result of a turbidity plume from proposed Port dredging activities, the impact is not of a sufficient scale to affect the survival of any marine turtle species. Project-related shipping activities are not anticipated to adversely impact any critical habitat areas for this species.
....result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?	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 or predicted Project-related shipping.
.....introduce disease that may cause the species to decline?	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 or predicted Project-related shipping.
....interfere substantially with the recovery of the species?	Use of turtle deflectors on trailing suction hopper dredges would minimise potential for entrainment. Implementation of a lighting plan would minimise the risks of local breeding impacts from hatchling disorientation. Recovery of marine 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, including predicted Project-related shipping activities, is not expected to interfere with the recovery of the species.

Table 7-16 Impact Assessment Summary – Flatback Turtle

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. Predicted Project-related shipping activities would not impact on important populations of this 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 mitigation measures proposed for dredging 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, including predicted Project-related shipping activities, 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, including predicted Project-related shipping activities, would not create any barriers to movement for Flatback Turtles.
....adversely affect habitat critical to the survival of a species?	Some local feeding habitat may be impacted in the short-term by dredging of the proposed Port area, suitable feeding habitats are found throughout coastal areas of the Gulf of Carpentaria. Predicted Project-related shipping activities are not anticipated to adversely impact any critical habitat areas for this species.
....disrupt the breeding cycle of an important population?	Low density Flatback Turtle nesting occurs in the Project area but it does not represent a critical breeding area. 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. Predicted Project-related shipping activities are not anticipated to adversely impact any critical habitat areas for this species.
....result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?	It is considered unlikely that a disease harmful to the Flatback Turtle would be introduced due to the development or operation of Project marine infrastructure or predicted Project-related shipping.
.....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 Project marine infrastructure or predicted Project-related shipping.
....interfere substantially with the recovery of the species?	Mitigation measures proposed would minimise potential for entrainment of marine turtles during development and maintenance dredging for the Port area. Recovery of marine 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, including predicted Project-related shipping activities, is not expected to interfere with the recovery of the species.

Table 7-17 Impact Assessment Summary – Loggerhead Turtle

Will the proposed works...	**Loggerhead Turtle (*Caretta caretta*): Endangered**
....lead to a long-term decrease in the size of a population of a species?	It is likely that this species would only be an infrequent or transient in the Project area. Any 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. Predicted Project-related shipping activities would not impact on populations of this species.
....reduce the area of occupancy of the species?	Globally, the Loggerhead Turtle is a circum-tropical species. The Project, including predicted Project-related shipping activities, 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, including predicted Project-related shipping activities, would not create any barriers to movement for Loggerhead Turtles.
....adversely affect habitat critical to the survival of a species?	While some potential 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. Predicted Project-related shipping activities are not anticipated to adversely impact any critical habitat areas for this species.
....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. Project-related shipping activities are not anticipated to adversely impact any critical habitat areas for this 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 Loggerhead Turtle would be introduced due to the development or operation of Project marine infrastructure or predicted Project-related shipping.
.....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 or predicted Project-related shipping.
....interfere with the recovery of the species?	Mitigation measures proposed would minimise potential for entrainment of marine turtles during development and maintenance dredging for the Port area. The Project, including predicted Project-related shipping activities, is not expected to interfere with the recovery of the species.

Table 7-18 Impact Assessment Summary – Olive Ridley Turtle

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, it is unknown if 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 (if marine turtle nesting occurs in the vicinity of the Port area). Predicted Project-related shipping activities would not impact on important populations of this species. The use of mitigation measures proposed for dredging 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, including predicted Project-related shipping activities, 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, including predicted Project-related shipping activities, 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 may be impacted as a result of dredging of the proposed Port area, suitable feeding habitats are found throughout coastal areas of the Gulf of Carpentaria. The Project impact would not be of a sufficient scale to affect the survival of any marine turtle species. Predicted Project-related shipping activities are not anticipated to adversely impact any critical habitat areas for this species.
... disrupt the breeding cycle of a population?	There is uncertainty whether Olive Ridley Turtle 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. Predicted Project-related shipping activities are not anticipated to adversely impact any critical habitat areas for this 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 Olive Ridley Turtle would be introduced due to the development or operation of Project marine infrastructure or predicted Project-related shipping.
... 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 or predicted Project-related shipping.
... interfere with the recovery of the species?	Mitigation measures proposed would minimise potential for entrainment of marine turtles during development and maintenance dredging for the Port area. Recovery of marine 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, including predicted Project-related shipping activities, is not expected to interfere with the recovery of the species.

Table 7-19 Impact Assessment Summary – Leatherback Turtle

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 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. Predicted Project-related shipping activities would not impact on important populations of this species.
....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, including predicted Project-related shipping activities, 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, including predicted Project-related shipping activities, would not create any barriers to movement for Leatherback Turtles.
....adversely affect habitat critical to the survival of a species?	While some foraging habitat may be disturbed as a result of the 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. Predicted Project-related shipping activities are not anticipated to adversely impact any critical habitat areas for this species.
....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 foraging habitat may 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. Predicted Project-related shipping activities are not anticipated to adversely impact any critical habitat areas for this 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 or predicted Project-related shipping.
.....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 or predicted Project-related shipping.
....interfere with the recovery of the species?	Mitigation measures proposed would minimise potential for entrainment of marine turtles during development and maintenance dredging for the Port area. The Project, including predicted Project-related shipping activities, is not expected to interfere with the recovery of the species.

7.3.6.6 National Recovery Plans

There are national recovery plans for all six marine turtles. **Table 7-20** outlines the consistency of the Project with the national recovery plans. A number of threat abatement plans are listed on the SPRAT database as being relevant to marine turtles, namely the *Threat Abatement Plan for the Predation by the European Red Fox* (DEWHA 2008c) for the Green Turtle, Leatherback Turtle and Loggerhead Turtle, the *Threat Abatement Plan for Predation Threat Abatement Plan for Predation, Habitat Degradation, Competition and Disease Transmission by Feral Pigs* (DEH 2005) for the Flatback Turtle, Loggerhead Turtle and Hawksbill Turtle, the *Threat Abatement Plan for the Impacts of Marine Debris on Vertebrate Marine Life* (DEWHA 2009d) for the Leatherback Turtle, Loggerhead Turtle and Olive Ridley Turtle. No foxes were identified during field surveys for the EIS (refer **Section 4.2.1.7**) and are unlikely to occur on Cape York. **Table 7-21** and **Table 7-22** outline the consistency of the Project with the feral pig and marine debris threat abatement plans.

7.3.7 Offsets

Under the *EPBC Act Environmental Offsets Policy* (DSEWPaC 2012b), offsets are not required where the residual impact is not likely to be significant (when assessed against the *Matters of National Environmental Significance: Significant Impact Guidelines 1.1* (DEWHA 2009c)).

Section 7.3.5 and **Section 7.3.6** of this report document the results of the impact assessment process and concludes that with the implementation of the proposed mitigation measures, the residual impacts associated with the construction and operation of the Project on marine turtles would be negligible to minor and therefore not significant as per the definition in **Section 7.1.2**. As such, offsets relating to marine turtles are not required under the Commonwealth offsets policy.

However, the feral pig control program proposed in **Section 7.3.6.4** does constitute an offset under the *Queensland Biodiversity Offsets Policy* (DERM 2011b) and the implementation of this offset is a condition of the Queensland Coordinator General's approval of the Project.

Table 7-20 Consistency of SoE Project with National Recovery Plans for Marine Turtle Species

Action	Sub-Action	Consistency of SoE Project with the National Recovery Plan
Objective: To reduce the mortality of marine turtles and, where appropriate, increase natural survivorship, including through developing management strategies with Aboriginal and Torres Strait Islander communities for the sustainable use of marine turtles		
Reduce mortality of marine turtles as by catch in fisheries	• Monitor the effectiveness of turtle exclusion devices (TEDs) for all vessels in the Northern Prawn Fishery. • Regulate for mandatory use of TEDs for all vessels in the Torres Strait Prawn Fishery in the fishing season 2002. • East Coast Otter Trawl managers to implement and monitor a marine turtle by catch reduction strategy that includes compulsory TED use; provides for the expansion of closed areas; ensures the continued monitoring of marine turtle by catch; and, incorporates these initiatives into the East Coast Otter Trawl management plan. • Fisheries managers to quantify marine turtle by catch and mortality in Barramundi, Fin Fish Trawl, Shark, Crab, Mesh/Gillnet, Offshore Mesh, Rock Lobster fisheries. • Fisheries managers to develop and implement Bycatch Action Plans for: Priority A (trawl) fisheries: Shark Bay Prawn; Shark Bay Scallop; Exmouth Gulf Prawn; Onslow Prawn; Nickol Bay Prawn ; Broome Trawl; Kimberley Prawn; and, Priority B fisheries: North Coast Shark; Kimberley Gillnet; Barramundi; West Coast Rock Lobster. • Fisheries managers to develop a by catch reduction strategy that: incorporates marine turtle conservation; takes into account actions in other trawl fisheries; uses by catch data to assess the effectiveness of marine turtle by catch mitigation measures adopted. • Prepare and implement by catch action plan that addresses marine turtle by catch.	Not applicable
Facilitate co-management of marine turtles with Indigenous communities	Management agreements to be established between lead agencies and Indigenous communities which: • recognise customary law and the cultural significance of marine turtles; • quantify existing harvest using the best available science and local Indigenous knowledge; • identify and implement negotiated mechanisms that will ensure that customary harvest does not threaten recovery of marine turtles; • control marine turtle use within the communities' area; • recognise that communities only carry out harvesting for traditional Aboriginal and Torres Strait Islander communities;	Consistent: • An access permit system would be developed in consultation with the Traditional Owners and would include control of access to the marine turtle nesting beach for recreational purposes by the construction and operational workforce. • RTA will work with the Traditional Owners on a program to reduce feral pigs.

Action	Sub-Action	Consistency of SoE Project with the National Recovery Plan
	• recognise endangered or critically endangered species and implement a zero take where possible; identify the research requirements of Indigenous communities regarding marine turtle conservation; and, • increase awareness of marine turtle conservation issues through information exchange.	
Mitigate incidental mortality resulting from marine debris	• Lead agencies to monitor mortality of marine turtles due to entanglement in marine debris. • Lead agencies to identify the source of marine debris. • NT agencies to determine the source of the nets entangling marine turtles and the magnitude of their mortality in the Cape Arnhem region. • Lead agencies to undertake remedial action to prevent/reduce marine turtle mortality in stranding events caused by marine debris. • Commonwealth, States and NT to implement legislation for the prevention of garbage discharge from vessels of all sizes.	Consistent: • Removal of ghost netting on beaches in the vicinity of the proposed Port.
Mitigate incidental mortality and monitor marine turtles in shark control activities	• Develop and trial shark control methods that reduce marine turtle take. • Determine the mortality and species composition of marine turtle by catch in shark control activities.	Not applicable
Mitigate incidental mortality and monitor the vessel strike of marine turtles	• EHP to identify areas of high vessel strike. • EHP to liaise with the Department of Transport and Main Roads (DTMR) to determine the feasibility of zoning boat speed restrictions where appropriate.	Consistent: • Marine fauna observers during dredging; • Ferries generally restricted to transit lanes; and, • Reporting of any vessel strike or animals found stranded, injured or killed.
Mitigate incidental mortality resulting from pearl farming and aquaculture	• Fisheries managers to encourage pearl farming and aquaculture licensees to use appropriate, non-disturbing, lighting technology. • Operators to monitor any incidental mortality of marine turtles in aquaculture operations. • Develop less appealing craypot buoys to minimise leatherback entanglement in Tasmanian waters.	Not applicable
Mitigate mortality and monitor marine turtles in relation to Defence activities.	• In consultation with lead agencies, the Department of Defence is to ensure that environmental impact assessments and environmental management plans for Defence activities minimise any possible effects on marine turtle populations and habitats. • In consultation with lead agencies, the Department of Defence is to cooperate with lead agencies to develop management strategies for affected marine turtle populations including monitoring sites on selected Defence estate.	Not applicable

Action	Sub-Action	Consistency of SoE Project with the National Recovery Plan
Objective: To develop programs and protocols to monitor marine turtle populations in Australia, assess the size and status of those populations, the causes of their mortality and address information gaps		
Actions to facilitate national monitoring of marine turtles	Lead agencies to develop an agreed minimum set of key protocols cooperatively for: • monitor key nesting beaches for marine turtle populations to develop population models in the longer term; • monitor marine turtle mortality to determine the levels, distribution and causes of that mortality; • conduct or support research on the prevalence and frequency of disease; and, • negotiate protocols for the management of national tagging, including satellite/radio tracking, and stranding data including the identification of an appropriate institution to house and manage the database. Recovery team toconduct a review of monitoring to coincide with the review of the recovery plan.	Consistent: • Annual nest surveys will be conducted as part of the feral pig control program. • Any stranded, injured or dead marine turtles will be reported.
Facilitate a national assessment of the status of marine turtles	• Assess the status of marine turtles in Australia. • Develop a population viability model for the southern GBR Green Turtle population that: — identifies the population behaviours that give the model its predictive power; — determines the risk in applying the model to other populations and species of marine turtle; and, — determines the limits to the interpretation on the outputs from such a model.	Not applicable
Complete genetic analysis of Australian marine turtles:	Complete the broad genetic analysis of Australian marine turtle populations to determine the: • geographic range of identifiable populations; • population composition of feeding populations; • population size for each population; and, • proportion of Australian populations harvested in the waters of PNG and Indonesia.	Not applicable
Objective: To manage factors that affect marine turtle nesting		
Manage the effects of light on marine turtles	• Develop and implement a code of practice to minimise the impact of lighting from petroleum facilities. • CALM to liaise with petroleum companies operating on the North West Shelf regarding ongoing monitoring research programs.	Consistent: • A comprehensive Port facilities lighting plan would be developed to minimise any impacts on nesting marine turtles. • Lighting on vessels would be limited to that required for safe operations.

Action	Sub-Action	Consistency of SoE Project with the National Recovery Plan
	• Lead agencies to: — encourage Local Government to employ light management practices that do not adversely affect marine turtles near nesting beaches; — address lighting problems on affected beaches with Local Government; — implement existing management practices such as zoning anchorage areas for boats; — support research into suitable lighting technology for boats; and, — support research into improved lighting technology and the impact of lights on marine turtles.	• Anchoring of Project vessels would be in existing, designated offshore anchorages.
Manage the effects of tourism and recreational activities on marine turtles	Lead agencies to: • identify tour operators that currently access marine turtle nesting beaches; • identify nesting beaches that have uncontrolled access; • develop management arrangements for access and beach activities with relevant Local Government authorities and landowners to ensure conservation of marine turtles; • develop a nationally agreed code of conduct for tour operators with the Australian Eco-Tourism Association; and, • implement these actions with particular reference to Loggerhead Turtles as a priority.	Consistent: • An access permit system would be developed in consultation with the Traditional Owners and would include control of access to the marine turtle nesting beach for recreational purposes by the construction and operational workforce.
Manage the effects of vehicles on marine turtles	For significant nesting beaches, lead agencies to: • manage vehicle access to areas within their jurisdictions; and, • negotiate the management of access with Local Government and other land managers.	Consistent: • Only the minimum required area would be used for beach access to temporary seaborne facilities, and this would be clearly defined to prevent vehicle access to other parts of the beach.
Manage the effects of predation on marine turtle eggs	• Lead agencies, in consultation with landowners, to identify sites where predation is a problem and initiate or continue appropriate management actions. • Minimise fox predation on loggerhead nests. • Minimise pig predation of Flatback Turtle nests on Cape York.	Consistent: • Feral pig control program would be implemented in the area between Ina Creek and Winda Winda Creek and associated riparian hinterland areas.
Objective: To identify and protect habitats that are critical for the survival of marine turtles		
Land and water quality management	• The Commonwealth to continue to assist communities with land management and use through appropriate funding programs. • Each jurisdiction to ensure that all activities that are likely to have an impact on marine turtles are subject to environmental impact assessment (such as EIS) and appropriate conditions.	Consistent: • Riparian buffers to protect water quality.

Action	Sub-Action	Consistency of SoE Project with the National Recovery Plan
	• States/NT to encourage local communities to become involved in land and catchment management in catchments adjacent to marine turtle habitat through Commonwealth programs. • EHP to manage the impact of coastal urbanisation and development on marine turtles through the development of best practice planning guidelines with Queensland Local Government Association and councils across the State.	• Waste management plans and measures to prevent land-sourced pollution entering marine areas.
Identification and management of marine turtle habitat	• Identify critical marine turtle benthic and sea grass habitats and nominate those places to the register of critical habitats under the EPBC Act. • Lead Agencies will protect critical marine turtle habitat using appropriate planning or zoning policies, regulations and laws as required. • Implementation of the Queensland East Coast Otter Trawl Management Plan to establish mechanisms to ensure that trawling is ecologically sustainable in the Great Barrier Reef World Heritage Area.	Consistent: • Seagrass and benthic habitat surveys conducted as part of Project planning. • Avoidance of areas where seagrass is present in planning and locating marine and estuarine facilities.
Management of oil spills and operational discharges	• Lead agencies to respond to oil spills in accordance with the National Plan to Combat Pollution of the Sea by Oil and Other Noxious and Hazardous Substances. • Proposals for oil and mineral exploration and exploitation are adequately assessed and, as appropriate, conditions imposed to ensure no adverse effects on marine turtles. • Lead agencies to provide Australian Marine Sciences Association (AMSA) with information relating to significant nesting sites for marine turtles.	Consistent: • All discharges from ships in strict accordance with MARPOL and national regulations. • No discharges in any port areas. • Bunkering in accordance with regulatory requirements with protective measures in place.
Determine the effect of noise on marine turtles	• Ongoing action to ensure that soft start procedures to be implemented in seismic surveys that occur within the distribution of marine turtles. • Recovery Team and DSEWPaC to monitor Australian and international literature on the effect of noise on marine turtles.	Consistent: • Marine fauna observers will be present during pile driving works. Any interactions with marine turtles, including behavioural changes, will be reported in the monitoring records.
Objective: To communicate the results of recovery actions and involve and educate stakeholders		
Communicate the results of recovery actions	Recovery Team to: • review the recovery plan annually; • host two biennial meetings on marine turtle; • conservation and management; and, • evaluate the effectiveness of the Recovery Plan after five years of operation.	Not applicable

Action	Sub-Action	Consistency of SoE Project with the National Recovery Plan
Raise awareness and involve the community	Lead agencies to encourage the participation of volunteers in monitoring programs: • Australian Fisheries Management Authority to coordinate the development of national guidelines on: minimising capture, and maximising the recovery of marine turtles taken in trawl, net and longline fisheries; eliminating the discard of fishing line and netting; and, reporting and/or retrieving discarded netting when encountered. • Australian Seafood Industry Council to liaise with other fishing industry councils to develop a national Threatened Species Awareness Course, (similar to the course currently conducted by Queensland Seafood Industry Association). • AMSA and lead agencies to promote compliance with laws restricting pollution from vessels. • Lead agencies to require licensed fishers to record all interactions with marine turtles. • Lead agencies to manage database on marine turtle mortality. • Lead agencies to develop education material on 'tell tale' signs of nesting beaches.	Not applicable
Raise awareness in northern Australian Indigenous communities.	DSEWPaC and lead agencies to support the establishment of an Indigenous coastal community network to support communities' management of marine turtles with lead agencies.	Consistent: • An access permit system would be developed in consultation with the Traditional Owners and would include control of access to the marine turtle nesting beach for recreational purposes by the construction and operational workforce. • RTA will work with the Traditional Owners on a program to reduce feral pigs. RTA consulted with Traditional Owners with respect to marine turtle surveys conducted.
Objective: To support and maintain existing agreements and develop new collaborative programs with neighbouring countries for the conservation of shared marine turtle populations.		
Prescribed action to improve regional conservation of marine turtles	• Commonwealth Government to maintain existing and develop new bilateral or multilateral agreements to ensure that international conservation and management of marine turtles is consistent with domestic policies and international treaty obligations.	Not applicable

Table 7-21 Consistency of SoE Project with the Threat Abatement Plan for Predation, Habitat Degradation, Competition and Disease Transmission with regard to the Flatback, Loggerhead and Hawksbill Turtles

Objective	Action	Consistency of the SoE Project with the Threat Abatement Plan
Prevent feral pigs from establishing in areas where they currently do not occur or are in low eradicable numbers, and where they are likely to pose a threat on biodiversity; especially where they would impact on nationally listed threatened species and ecological communities	• Identify those areas currently free from feral pigs or in low eradicable numbers and where these areas overlay priority areas for nationally listed threatened species and ecological communities, and which are feasible to maintain free of feral pigs. • Relevant agencies to verify as far as practicable, the presence or absence of feral pigs in priority areas. • Relevant agencies to develop and implement strategies including surveillance monitoring and contingency plans to remove and pigs found in these priority areas. Where practicable, monitoring should be integrated into other programs where they exist. • Awareness programs to be developed and implemented for key target groups (recreational hunters, bush walkers and land managers) to ensure that they understand the risk should feral pigs establish in these priority areas. • Review the adequacy and effectiveness of existing legislation and its implementation that aims to control the release, transport and keeping of feral pigs. Relevant jurisdictions to make appropriate amendments to develop best practice strategies to implement it where the review identifies inadequacies.	Not applicable: • Feral pigs are already established in the Project area, however the proposed feral pig control program aims to reduce feral pig numbers within the Project area including the beach where marine turtles are known to nest.
Integrate feral pig management plans and their implementation into natural resource planning and investment at a regional, state and territory and national level through consultation and liaison with key stakeholders	The Department and relevant state and territory agencies to: • Set out key concerns and issues to be included in Natural Resource Management planning/programs; and, • Establish protocols and use funding and other relevant mechanisms to improve the consistency and coordination of actions across tenures and jurisdictions.	Consistent: • A feral pig control program is proposed for the Project.

Objective	Action	Consistency of the SoE Project with the Threat Abatement Plan
Increase the awareness and understanding of land managers and the general community about the damage that feral pig cause and management options.	• Relevant government agencies to assess the adequacy of available information and needs of key groups concerned about feral pigs and their management. • Government agencies to arrange the preparation, packaging and dissemination of appropriate material to target groups to awareness and understanding of feral pig damage and how best to manage it. • Support the dissemination and adoption of the pest management component of the Conservation and Land Management Training Package being developed by the National Training Authority.	Consistent: • Through the feral pig control program that is proposed for the Project.
Quantify the impacts feral pigs have on biodiversity (especially nationally listed threatened species and communities) and determine the relationship between feral pig density and level of damage.	• Relevant government agencies to identify priority areas where nationally listed threatened species or ecological communities are known or perceived to be under threat from feral pigs. • Develop and implement appropriate studies that aim to determine the impact of feral pigs on national listed threatened species and the level of feral pig control required to reduce the impact to an acceptable level. This is best undertaken through and adaptive experimental approach to management.	Consistent: • Potential impacts from feral pigs on nesting marine turtle has been identified.
Improve the effectiveness, efficiency and humaneness of techniques and strategies used for managing the environmental damage due to feral pigs.	• In collaboration with private and government stakeholders, investigate and collate a list of current options for managing feral pigs, and assess the need for the development of effective and humane techniques and strategies with special emphasis on managing feral pigs in priority areas for the protection of nationally listed threatened species and ecological communities. • Relevant government agencies to assess techniques and strategies of feral pig control using these new approaches through an analysis of costs and benefits, safety, potential impact on no-target species and any other practical considerations, and formulate a regional best practice approach.	Consistent: • The proposed feral pig control program would use recognised methods for managing feral pigs within the Project area.

Table 7-22 Consistency of SoE Project with the Threat Abatement Plan for the Impacts of Marine Debris on Vertebrate Marine Life with regard to the Leatherback, Loggerhead and Olive Ridley Turtles

Objective	Action	Consistency of the SoE Project with the Threat Abatement Plan
Contribute to the long-term prevention of the incidence of harmful marine debris.	• Australian Government in consultation with the states and territories to facilitate the review of existing arrangements relevant to the control of marine debris on vessels smaller than 400 gross tonnes (including fishing vessels). • State, territory and Australian governments and appropriate local bodies to facilitate studies of port facilities and boating hubs for the disposal of fishing gear, including assessment of availability, use, capacity and cost. • State and territory governments to consider reviewing legislation to ensure that details of waste reception facilities for ships are included in port environment plans. • State and territory governments to investigate how Australia's obligations under MARPOL (i.e. to provide adequate waste reception facilities for ship waste) are encompassed in domestic legislation and policies. • Australian Government agencies to facilitate through international fora, taking into account policies and programs of IMO, studies of the ability of international ports in the Asia-Pacific region to handle vessel-sourced waste, particularly derelict fishing gear, including assessment of availability, capacity and cost. • Australian Government agencies to facilitate through domestic and international fora, taking into account policies and programs of IMO, studies of the barriers and incentives to the use of existing port waste reception infrastructure in Australia and the Asia-Pacific region. • Australian Government agencies in collaboration with state and territory governments to identify appropriate responses and responsibilities for recovery of hazardous debris at sea, notably large derelict fishing nets. • State, territory and Australian governments, in collaboration with industry, to identify and implement appropriate measures for incorporating waste reporting and management requirements (reporting and return of rubbish, damaged gear, etc. to port for disposal) into fishery management arrangements as appropriate. • State, territory and Australian governments, in collaboration with the fishing industry, to promote best practice waste management strategies on board fisheries vessels, including the uptake of existing codes of conduct, and identify any need for the development of new codes of conduct.	Consistent: • all vessels would operate in full compliance with international and Australian regulations with respect to the treatment and discharge of operational wastes; • no garbage or sewage would be discharged in the Port area and on-board garbage management plans and systems would reduce the risk of accidental loss of waste overboard; • no operational discharges from vessels would occur from Project-related shipping while in Australian waters other than the discharge of treated oily water from machinery spaces (oil content not exceeding 15ppm in accordance with MARPOL Annex I); • Project vessels would not discharge any garbage while at sea within the Port area, GBRMP or parts of the Torres Strait defined as "nearest land"; and, • Project vessels would have on-board garbage management plans and systems to minimise the risk of accidental loss overboard of garbage, particularly plastics; all Project vessels would have an on-board sewage treatment plant that is IMO approved, holding tanks and discharge connections to allow discharge at shore facilities or holding until the vessel is outside Australian Waters.

Objective	Action	Consistency of the SoE Project with the Threat Abatement Plan
	• Australian Government agencies to support an analysis of financial incentives to encourage return of waste generated at sea to land for appropriate disposal. • Australian Government agencies to support feasibility studies of market/consumer/peer-based incentives to encourage responsible handling and disposal of waste fishing gear. • State, territory and local governments and other relevant bodies to consider providing increased funding for the introduction of improved solid pollutant (particularly litter) control strategies in waterways. • State and territory governments to facilitate an analysis of the effectiveness of current litter public awareness and education campaigns to identify gaps and areas for improvement. • State, territory and Australian governments, in collaboration with appropriate non-government organisations, to develop options for establishing a more consistent and long-term national approach to litter abatement education, particularly for marine-based activities. • Australian Government agencies to examine introducing awareness-raising and outreach programs aimed at relevant groups contributing to marine debris in the Asia-Pacific region. • Australian Government agencies to identify opportunities for exchange visits between coastal (especially Indigenous) communities experiencing the impacts of marine debris and groups in other nations where large proportions of harmful marine debris originate. • Australian Government agencies to strengthen relations with regional neighbours on marine debris through relevant fora, and develop collaborative project proposals to address the sources and impacts of harmful marine debris. • Australian Government to encourage and assist relevant nations to sign, ratify and enforce Annex V of MARPOL.	
Remove existing harmful marine debris from the marine environment Monitor the quantities, origins and impacts of marine debris and assess the effectiveness of management arrangements over time for the strategic reduction in marine debris	• Australian Government agencies in collaboration with state and territory governments and other relevant stakeholders to support the development of nationally consistent, statistically rigorous data collection protocols and survey methods. DEWHA to support the development and management of national mapping of the spatial distribution and concentration of marine debris over time to assess the significance of marine debris and to reduce its occurrence.	Not applicable.

Objective	Action	Consistency of the SoE Project with the Threat Abatement Plan
	• State, territory and Australian governments to provide support for community-based coastal and waterway clean-up and monitoring activities. • Australian Government agencies in collaboration with state and territory government to facilitate the establishment of a national network of a limited number of permanent marine debris monitoring sites (including within Commonwealth Marine Protected Areas) to promote consistent monitoring and information gathering and exchange, to enable understanding of long-term trends, and to inform adaptive and effective management responses. • Australian Government agencies to support a study on the wind and sea circulation patterns in the Asia-Pacific region as a basis for better understanding the pathways and potential sources and sinks of harmful marine debris of foreign origins in Australian waters. • Australian Government to facilitate a feasibility study on introducing marking of fishing gear so that it may be identified as originating from a specific fishery. The feasibility study will also consider the practical implications of marking fishing gear and the implications of derelict gear being traced back to fisheries operations.	
Mitigate the impacts of harmful marine debris on marine species and ecological communities	• State, territory and Australian governments to support expanded and consistent, long-term monitoring, investigation, recording and management of data on vertebrate marine life harmed and killed by the physical and chemical impacts of marine debris. This information will assist the impacts of different types of marine debris on vertebrates to be quantified and characterised. • Australian Government to coordinate marine debris abatement strategies identified in existing marine wildlife recovery plans. • Australian Government to support research on the nature of degradation pathways of synthetic debris in the marine environment (including biodegradable and oxodegradable plastics), the extent that degradation products are contaminated by other potentially toxic compounds, and the potential toxicity of debris types on marine species. • Australian Government to identify measures to promote the uptake and application of biodegradable and oxodegradable plastic in marine-based industries and environments where it is found to be effective.	Not applicable.

7.4 Elasmobranchs

7.4.1 General Overview

Sawfishes are elongate rays having a shark-like body and a blade-like snout (rostrum) that has lateral, tooth-like denticles (rostral teeth) set into sockets. The preferred habitat of sawfishes is shallow inshore sedimentary marine areas (less than 10m depth), 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).

The Speartooth Shark is a medium sized whaler shark that has only been recorded in tidal rivers of the Northern Territory and Queensland. Large tropical river systems appear to be the primary habitat for this shark (Stevens *et al.* 2005). Due to a lack of collected specimens, there is limited information on the biology of this species (Fowler 1997, Pillans *et al.* 2005, Stevens *et al.* 2005).

Sawfishes and the Speartooth Shark are all large marine predators that occupy high trophic levels. Biologically, sawfish and the Speartooth Shark are characterised by their 'limited' life history characteristics (late age at maturity, slow growth rate, low fecundity, longevity, low rate of natural mortality), which result in slow population growth. Subsequently, they have a limited capacity to withstand human-induced increases in mortality and recover from population depletion. Sawfishes and the Speartooth Shark are viviparous, giving birth to well-developed live young, however most aspects of their reproductive biology are unknown. Phillips *et al*. (2011) identified that the Green Sawfish and Freshwater Sawfish (and probably Dwarf Sawfish) populations of the west coast of Australia and Gulf of Carpentaria constitute distinct maternal populations. This is attributed to the fidelity of females to nursery areas, however it is noted that this does not limit the large-scale movement of the species outside of the breeding and/or pupping periods. Though sawfish are highly mobile as adults, regional populations should be considered as independent populations, rather than a single panmictic population in Australian waters (Phillips *et al.* 2011).

Fishing and incidental capture in fishing nets pose significant threats to sawfish species, and have contributed to a rapid decline in sawfish populations (Last and Stevens 2009, Peverell *et al*. 2004, Stevens *et al*. 2008, Stobutzki *et al*. 2002). Other known threats identified are Indigenous harvest, habitat modification and recreational 'trophy' fishing (Peverell *et al.* 2004). Specimens are also occasionally taken from the wild for aquarium display purposes (Cook *et al*. 1995).

More recently, the high value of sawfish fins in the shark-fin trade has become a serious threat to the survival of all sawfish species (Rose and McLoughlin 2001).

Profiles of the Dwarf Sawfish, Green Sawfish, Freshwater Sawfish and Speartooth Shark are provided in the following sections, including available relevant information regarding the habitat and requirements of these species.

7.4.2 Species Profiles

7.4.2.1 Freshwater Sawfish

Regional distribution and population

The Freshwater Sawfish (*Pristis microdon*) is listed as vulnerable under the EPBC Act.

The Freshwater Sawfish is a large (growing to 7m) euryhaline sawfish (Allen 1989, Phillips *et al.* 2008). The Freshwater Sawfish spends its first 3-4 years in freshwater growing to about half its adult size. Juveniles and sub-adult Freshwater Sawfish predominantly occur in rivers and estuaries, while large mature animals tend to occur more often in coastal and offshore waters up to 25m depth (Giles *et al.* 2006, Stevens *et al.* 2005).

The Freshwater Sawfish has been recorded from South Africa to Southeast Asia and the Indo-Australian Archipelago (Compagno *et al.* 1989, Compagno and Cook 1995, Fowler 1941, Last and Stevens 1994, Misra 1969, Paxton *et al.* 1989, Wallace 1967). The Freshwater Sawfish is known to occur in Indonesia (Lake Sentani in West Papua) and Papua New Guinea (Digul, Middle Fly, the Ramu, and the Middle and Lower Sepik Rivers) (Allen 1991, Last and Stevens 1994). Last and Stevens (1994) suggested the Freshwater Sawfish possibly occurs westwards to India and has a worldwide distribution. The species is seen and very occasionally caught seasonally in rivers in Sabah, Malaysia (Compagno and Cook 2005).

The Freshwater Sawfish is found throughout northern Australia (Thorburn 2006) where it appears to be confined to freshwater drainages and the upper reaches of estuaries, occasionally being found as far as 400km inland from the sea (Thorburn *et al.* 2003, Whitty *et al.* 2008). The Freshwater Sawfish has been recorded in the Fitzroy, Durack and Ord Rivers in Western Australia, the Adelaide, Victoria and Daly rivers of the Northern Territory, and the Gilbert, Mitchell, Norman and Leichhardt Rivers of Queensland (Last and Stevens 1994). The species was also recorded in the McArthur River in the Northern Territory (Merrick and Schmida 1984). Reports of adult individuals at sea are scarce, with only a few records of individuals greater than 3m in total length from the Pilbara coast, and one individual from Cape Naturaliste in south-western Australia (DSEWPaC 2012q).

Peverell (2005) noted the species was identified from by-catch (during the 2000 to 2002 February to September fishing seasons) within the Gulf of Carpentaria inshore fishery but not the off-shore fishery. Distribution and relative abundance varied considerably within the regions and between commercial logbook grids. The species was predominantly caught late in the monsoonal wet season (95% of catch February to April) and from both freshwater and estuarine environments. The study identified that the species was previously known to be captured in the Wenlock, Flinders, Bynoe, Norman, Gilbert and Mitchell Rivers. Peverell (2005) reported 66 individuals were recorded as by-catch over the three fishing seasons in the 60,000km^2 fishery with fishing effort totalling 840km of net over 1428 days. Individuals were caught mainly at the mouths of the Mitchell, Gilbert, Archer, Nassau and Staaten Rivers. Individuals were predominantly juvenile, with mature Freshwater Sawfish taken in the months of March and April coinciding with large freshwater flows following the annual wet season. Freshwater sawfish was rarely found north of Kowanyama.

There are anecdotal reports from Traditional Owners of sawfish observations (species not identified) in the lower estuarine reaches of the Norman Creek and Ward River systems. The total global or regional populations of the Freshwater Sawfish are unknown. Records for the species from published sightings within the eastern Gulf of Carpentaria are shown in **Figure 7-24**. **Section 7.4.3** describes the methodology undertaken to survey this species as part of the EIS studies and details the survey results.

RioTintoAlcan

Project Boundary
Locality
River / Creek
Road / track

Freshwater Sawfish *(Pristis microdon)*

Recorded location
Indicative location *
(2) Number of records at location

SOURCES: Atlas of Living Australia (2012), Phillips *et al.* (2011), Thorburn *et al.* (2003)

* Indicative locations recorded within river indicated. Exact location of record in river system is not confirmed.

South of Embley Project

Fig. 7-24: Freshwater Sawfish Records (eastern Gulf of Carpentaria)

N

0 150km

Datum/Projection: GDA94/MGA Zone 54 Date: 17/10/2012

Life cycle

Pupping of Freshwater Sawfish occurs in freshwater during the wet season and in the vicinity of river mouths (Peverell 2005, Phillips *et al*. 2008). The young are born at about 50cm, and gestation lasts approximately five months, with litter sizes likely to range between one and 12 pups (Peverell *et al.* 2004, Wilson 1999). Breeding generally occurs at the beginning of the wet season in November or December (Allen 1991) with observations in the Gulf of Carpentaria suggesting that pupping occurs through the wet season and continues until the beginning of the dry season in early May (Peverell 2005). In the Fitzroy River, pupping was correlated with higher water levels in the late wet season (Whitty *et al.* 2008). There may be some synchronisation in timing of parturition or the newborns may migrate upstream in groups (Heupel and Simpendorfer 2005). Freshwater environments are important nursery habitats for this species (Peverell 2005, Pillans *et al.* 2010, Thorburn *et al.* 2007a).

Ecology and habitat

The Freshwater Sawfish prefers mud-bottom habitats located in river embayments and estuaries (Allen 1991, 1997) more than 1m deep; however, the species 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 2012q). Mature individuals may radiate out and follow the coastline within inshore marine waters, returning to rivers to breed and pup (Thorburn *et al.* 2004, Stevens *et al.* 2005).

Sawfish appear to primarily forage lower in the water column, using the rostrum to stun slow moving fish and for extracting molluscs and small crustaceans from the sediment (Allen 1982). In the Fitzroy River the Blue Catfish, detrital matter and freshwater prawn were noted as important prey (Whitty *et al.* 2008). The stomach contents of nine Freshwater Sawfish dissected by Thorburn *et al.* (2007a) contained 60% Lesser Salmon Catfish. Differences in diet are likely the results of variation in habitat utilisation by different age classes of Freshwater Sawfish and different prey available during the day and night (DSEWPaC 2012q).

Critical habitat is habitat that the Minister has listed in the Register of Critical Habitat (prepared under Section 207A of the EPBC Act) in relation to an EPBC-listed species or ecological community. The DSEWPaC's Register of Critical Habitat does not identify any critical habitat for the Freshwater Sawfish.

Threats

Significant threats to sawfishes include fishing and unintentional bycatch (Peverell *et al.* 2004, Stevens *et al.* 2008) and populations may be threatened in streams where poaching for barramundi is a common practice (Last and Stevens 1994).

When sawfish are taken in bycatch, they are often retained because of the high value of meat, fins and rostral saws. Rose and McLoughlin (2001) suggest that the high value of sawfish fins in the shark fin trade is a major threat to the survival of all sawfish species. They are also targeted opportunistically by fishermen. Very large specimens have been the target of trophy angling (Peverell *et al.* 2004). Specimens are occasionally taken from the wild for aquarium display purposes (Cook *et al.* 1995).

According to the Fisheries and Aquaculture Organisation online database, sawfish landings were recorded between 1962 and 2001, with a peak in 1978. Most of this catch was outside the main Indo-Pacific range and some annual figures appear to be extrapolations from previous years (DSEWPaC 2012q).

Most reports suggest that numbers taken by fisheries from many localities have fallen since the 1960s, if not earlier. It is not known if this is a result of decreasing population numbers or the species being targeted less.

The pressure analysis conducted in the Species Group Report Card – Sawfishes and River Sharks: Supporting the Marine Bioregional Plan for the North Marine Region (DSEWPaC 2012o) identifies changes in hydrological regimes (land-based activities) as an of concern pressure on sawfishes. DSEWPaC (2012o) also identifies chemical pollution/contaminants (onshore and offshore mining operations) as of potential concern on sawfish. However, given that bauxite is benign, (refer **Section 3.5.4**) it does not result in the release of contaminants. Therefore this pressure is not of concern in the Project area.

7.4.2.2 Dwarf Sawfish

Regional distribution and population

The Dwarf Sawfish (*Pristis clavata*) is listed as vulnerable under the EPBC Act.

There are no confirmed records of the Dwarf Sawfish outside of Australian waters. Although it is believed they may occur at least in New Guinea, Indonesia, and Malaysia, the Australian population of the species is believed to comprise the majority of the total global population (Cook *et al.* 2006, Thorburn *et al.* 2004, Stevens *et al.* 2005).

The extent of the Australian distribution for Dwarf Sawfish is considered to be from Cairns around Cape York Peninsula, and 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 (Last and Stevens 1994, McAuley *et al.* 2005, Stevens *et al.* 2008). Peverell (2005) reported 22 individuals were recorded as by-catch over the three fishing seasons in the 60,000km^2 of the Gulf of Carpentaria inshore and offshore fishery, mainly at the mouths of the Mitchell, Gilbert, Archer, Nassau and Staaten Rivers. Peverell (2005) notes that the distribution of the Dwarf Sawfish extends into all regions of the Gulf of Carpentaria within Queensland, and that its relative abundance is low everywhere and highly variable. Catches of Dwarf Sawfish were made during the post-wet season months, however only along the coastal foreshores and bays where the waters are brackish to salty at this time of the year. The species was recorded within Albatross Bay and the Dwarf Sawfish was identified as being previously captured from the Pine River (DSEWPaC 2012q). Records of the species from published sightings within the eastern Gulf of Carpentaria are shown in **Figure 7-25**. **Section 7.4.3** describes the methodology undertaken to survey this species as part of the EIS studies and details the survey results.

The DSEWPaC (2012q) SPRAT database identifies that there is insufficient data available to estimate the total numbers of mature individuals of Dwarf Sawfish in Australian waters.

Life cycle

The maximum age of the Dwarf Sawfish has been estimated at 50 years with an approximate age of maturity between eight and 10 years (DSEWPaC 2012q). Generation length is estimated at 20 years.

During the wet season the species enters estuarine or brackish waters to breed. 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).

Project Boundary
Locality
River / Creek
Road / track

Dwarf Sawfish *(Pristis clavata)*

- Recorded location
- Indicative location *
- (2) Number of records at location

SOURCES: Atlas of Living Australia (2012), Phillips *et al.* (2011), Thorburn *et al.* (2003), Whitty *et al.* (2008).

* Indicative locations recorded within river indicated. Exact location of record in river system is not confirmed.

South of Embley Project

Fig. 7-25: Dwarf Sawfish Records (eastern Gulf of Carpentaria)

N

0 150km

Datum/Projection: GDA94/MGA Zone 54 Date: 01/11/2012

Ecology and habitat

The Dwarf Sawfish typically inhabits shallow (2–3m) coastal waters and estuarine habitats. The species is not found in freshwater (Thorburn *et al.* 2007a). Adults were reported to migrate seasonally into inshore waters (Peverell 2007), although it remains unclear how far offshore the adults travel (DSEWPaC 2012q). Peverell (2005) found that Dwarf Sawfish moved into marine waters after the wet season, and during the wet season entered brackish waters to breed.

The species prefers highly turbid environments (DSEWPaC 2012q) and are only usually found in silt sections of an estuary, which are completely devoid of instream structure (Thorburn *et al.* 2003). However, DSEWPaC (2012q) notes that this species may rest either side of high tide in inundated mangrove forests. During the dry season months, this species maybe found ranging upstream of river mouths to a distance of 20 kilometres. There is a single record from a brackish riverine environment more than 100 kilometres from the estuary (Thorburn *et al.* 2003).

The Dwarf Sawfish uses its rostrum in a side-to-side slashing motion to feed, dislodging invertebrates from the substrate and stunning benthic schooling fishes (Larson *et al.* 2006). Not much is known about the feeding habits of Dwarf Sawfish, however, Popeye Mullet have been recorded as prey (Thorburn *et al.* 2007b). Small fishes and crustaceans, such as crabs and shrimps are also likely prey (DSEWPaC 2012q).

Critical habitat is habitat that the Minister has listed in the Register of Critical Habitat (prepared under Section 207A of the EPBC Act) in relation to an EPBC-listed species or ecological community. The DSEWPaC's Register of Critical Habitat does not identify any critical habitat for the Dwarf Sawfish.

Threats

The Dwarf Sawfish is highly susceptible to capture in fishing nets (Pogonoski *et al.* 2002) and it is believed there is significant accidental capture of Dwarf Sawfish in commercial gillnet and trawl fisheries, however there is currently no evidence of this species being targeted in any commercial fishery. Estuarine and near-shore gillnet fisheries, such as those targeting Barramundi and King Salmon are known to capture sawfish of all species as bycatch. Records of the Dwarf Sawfish in commercial fishery bycatch have been almost exclusively from inshore net fishing activities (DSEWPaC 2012q).

The Dwarf Sawfish is known to be collected live for aquarium display purposes (Peverell 2007). Recreational fishers are also known to have collected sawfish rostra as souvenirs, but the extent of this activity is currently unquantified (Thorburn *et al.* 2004). DSEWPaC (2012q) also identified Indigenous harvest as a threat to this species.

Habitat disturbance and degradation of coastal areas adjacent to coastal development have been identified as a potential threat to other sawfish species. However, this is currently considered a lesser threat to the Dwarf Sawfish as its remote habitat is subject to lower levels of disturbance and development (Peverell 2005).

The pressure analysis conducted in the Species Group Report Card – Sawfishes and River Sharks: Supporting the Marine Bioregional Plan for the North Marine Region (DSEWPaC 2012o) identifies changes in hydrological regimes (land-based activities) as an of concern pressure on sawfishes. DSEWPaC 2012o also identifies chemical pollution/contaminants (onshore and offshore mining operations) as of potential concern on sawfish. However, given that bauxite is benign, (refer **Section 3.5.4**) it does not result in the release of contaminants. Therefore this pressure is not of concern in the Project area.

7.4.2.3 Green Sawfish

Regional distribution and population

The Green Sawfish (*Pristis zijsron*) is listed as vulnerable under the EPBC Act.

The Green Sawfish appears to grow longer than any other living sawfish species and may attain a maximum length of at least 7.3m.

While age and growth data have not been reported for this species, males are thought to reach maturity at around 4.3m. A post-partum female Green Sawfish recorded from the Gulf of Carpentaria measured 3.8m (Last and Stevens 1994, TSSC 2008a, 2008b).

No quantitative data is available on the global population size of the Green Sawfish. The Green Sawfish was 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. (Manjaji 2002, Stevens *et al.* 2005). It is unknown whether there is migration into Australian waters of Green Sawfish adults or juveniles from populations outside Australia, and it has been suggested that northern Australia may be the only region where significant populations of Green Sawfish remain (Stevens *et al.* 2005).

In Australia, Green Sawfish were historically recorded in the coastal waters off Broome in Western Australia, around northern Australia and down the east coast as far as Jervis Bay in New South Wales (Stevens *et al.* 2005). The species was historically described as the most commonly encountered sawfish in the Australian region, regularly becoming entangled in and damaging nets (Pogonoski *et al.* 2002). However, 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.

Since the 1960s there have been no reports of the Green Sawfish south of Cairns. Stevens *et al.* (2005) noted that data available from the Queensland Shark Control Program indicated a total disappearance of all sawfish species in southern regions of Australia. The last recorded specimen from New South Wales was captured in 1972, and the last specimen from the Sydney region was captured in 1926, representing a contraction of range of around 30% in Australian waters (Stevens *et al.* 2005). Little is known about their historical distribution in Western Australia and the Northern Territory. The Green Sawfish is most commonly known from the Gulf of Carpentaria (Stevens *et al.* 2005). Green Sawfish have been encountered in the Mission River and at Albatross Bay (Thorburn *et al.* 2004). Peverell (2005) reported 17 individuals were recorded as by-catch over the three fishing seasons in the 60,000km^2 Gulf of Carpentaria inshore and offshore fishery, mainly at the mouths of the Mitchell, Gilbert, Archer, Nassau and Staaten Rivers. Peverell (2005) notes that the distribution of the Green Sawfish extends into all regions of the Gulf of Carpentaria within Queensland, and that its relative abundance is low everywhere and highly variable. **Section 7.4.3** describes the methodology undertaken to survey this species as part of the EIS studies and details the survey results.

Records for the species from published sightings within the eastern Gulf of Carpentaria are shown in **Figure 7-26**.

RioTintoAlcan

Project Boundary
Locality
River / Creek
Road / track

Green Sawfish *(Pristis zijsron)*

Recorded location
Indicative location *
(2) Number of records at location

SOURCES: Atlas of Living Australia (2012), Phillips *et al.* (2011), Thorburn *et al.* (2003)

* Indicative locations recorded within river indicated. Exact location of record in river system is not confirmed.

South of Embley Project

Fig. 7-26: Green Sawfish Records (eastern Gulf of Carpentaria)

N

0 150km

Datum/Projection: GDA94/MGA Zone 54 Date: 17/10/2012

Life cycle

Limited data are available on the life history of Green Sawfish. It is likely that they are long-lived, produce few pups and mature late in life (Stevens *et al.* 2005, Walker 1998), in common with other sawfish species. Generation length for Green Sawfish has been suggested to be about 16 years (Stevens *et al*. 2005). The sex ratio of males to females is 1:1 (Peverell 2005).

As in other sawfish species, reproduction is aplacental viviparity. The gestation period of the Green Sawfish is not known. The limited information available on the species' reproductive activity suggests pupping may occur during the wet season (Peverell 2005). The litter size of the Green Sawfish comprises approximately 12 pups (Last and Stevens 2009).

Ecology and habitat

The Green Sawfish lives in muddy bottom habitats close to shore in estuaries, river mouths, embankments and along sandy and muddy beaches throughout its range (Allen 1997, Peverell *et al.* 2004, Stead 1963, Stevens *et al.* 2005, Thorburn *et al.* 2004). In Queensland and the Gulf of Carpentaria, the Green Sawfish has been found in the same areas as Freshwater Sawfish and Speartooth Shark within Port Musgrave and this species has also been recorded in the Van Diemen Gulf area (Stevens *et al.* 2005). Green Sawfish have been recorded in very shallow water (less than 1m) to offshore trawl grounds in over 70m of water (Stevens *et al.* 2005).

The smaller specimens of the species (less than 2.5 m in length) are more common in coastal waters, estuaries and river mouths at slightly reduced salinities, but do not venture into freshwater, whereas the larger individuals (greater than 2.5m in length) are found in both inshore and offshore waters (Giles *et al.* 2006, Stevens *et al.* 2005, Thorburn *et al.* 2004). 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 (DSEWPaC 2012q, Peverell 2005).

Molluscs and small crustaceans are swept out of the sand and mud by the saw (Allen 1982, Cliff and Wilson 1994, Peverell and Pillans 2004). Green Sawfish are known to actively pursue schools of baitfish and prawns (Poganoski *et al.* 2002).

Critical habitat is habitat that the Minister has listed in the Register of Critical Habitat (prepared under Section 207A of the EPBC Act) in relation to an EPBC-listed species or ecological community. The DSEWPaC's Register of Critical Habitat does not identify any critical habitat for the Green Sawfish.

Threats

The Green Sawfish has experienced significant population decline in many parts of its range and the late maturity and low reproductive rates of the Green Sawfish limit its ability to recover from impacts. Gillnet and trawl fisheries pose the greatest threat to the species in Australia (Stevens *et al.* 2005). Bycatch of Green Sawfish also occurs in both the Pilbara Trawl Fishery and the Northern Prawn Fishery (Stobutzki *et al.* 2002). Pogonoski *et al.* (2002) reported a substantial decline in numbers of sawfish following the increase in commercial and recreational fishing, and sawfish bycatch in the Queensland Shark Control Program declined steadily from 1970 to 1990, particularly in southern Queensland (Stevens *et al.* 2005). Information on catch rates and post release mortality by recreational fishers is unreported (TSSC 2008a).

Other identified threats to the Green Sawfish include shark finning and habitat degradation as a result of coastal developments (DSEWPaC 2012q, Peverell 2005). DSEWPaC (2012j) also identifies that this species is vulnerable to impacts from Indigenous harvesting in Australia. It is believed that there are

fewer pressures on the species in Western Australia as a result of limited coastal development (Stevens *et al.* 2005).

The pressure analysis conducted in the Species Group Report Card – Sawfishes and River Sharks: Supporting the Marine Bioregional Plan for the North Marine Region (DSEWPaC 2012o) identifies changes in hydrological regimes (land-based activities) as an of concern pressure on sawfishes. DSEWPaC 2012o also identifies chemical pollution/contaminants (onshore and offshore mining operations) as of potential concern on sawfish. However, given that bauxite is benign, (refer **Section 3.5.4**) it does not result in the release of contaminants. Therefore this pressure is not of concern in the Project area.

7.4.2.4 Speartooth Shark

Regional distribution and population

The Speartooth Shark (*Glyphis glyphis*) is listed as 'critically endangered' under the EPBC Act.

The Speartooth Shark is a rare species of medium-sized whaler shark. This species appears to be a large inshore marine and freshwater, euryhaline species like the Bull Shark. The small eyes and slender teeth of the Speartooth Shark suggest that they are primarily fish eaters adapted to living in turbid waters with poor visibility (Compagno 1984, Fowler 1997).

The largest known male and female Speartooth Sharks are 1.57m and 1.75m long respectively, and the adult maximum length is estimated to be 2 to 3m (DSEWPaC 2012q).

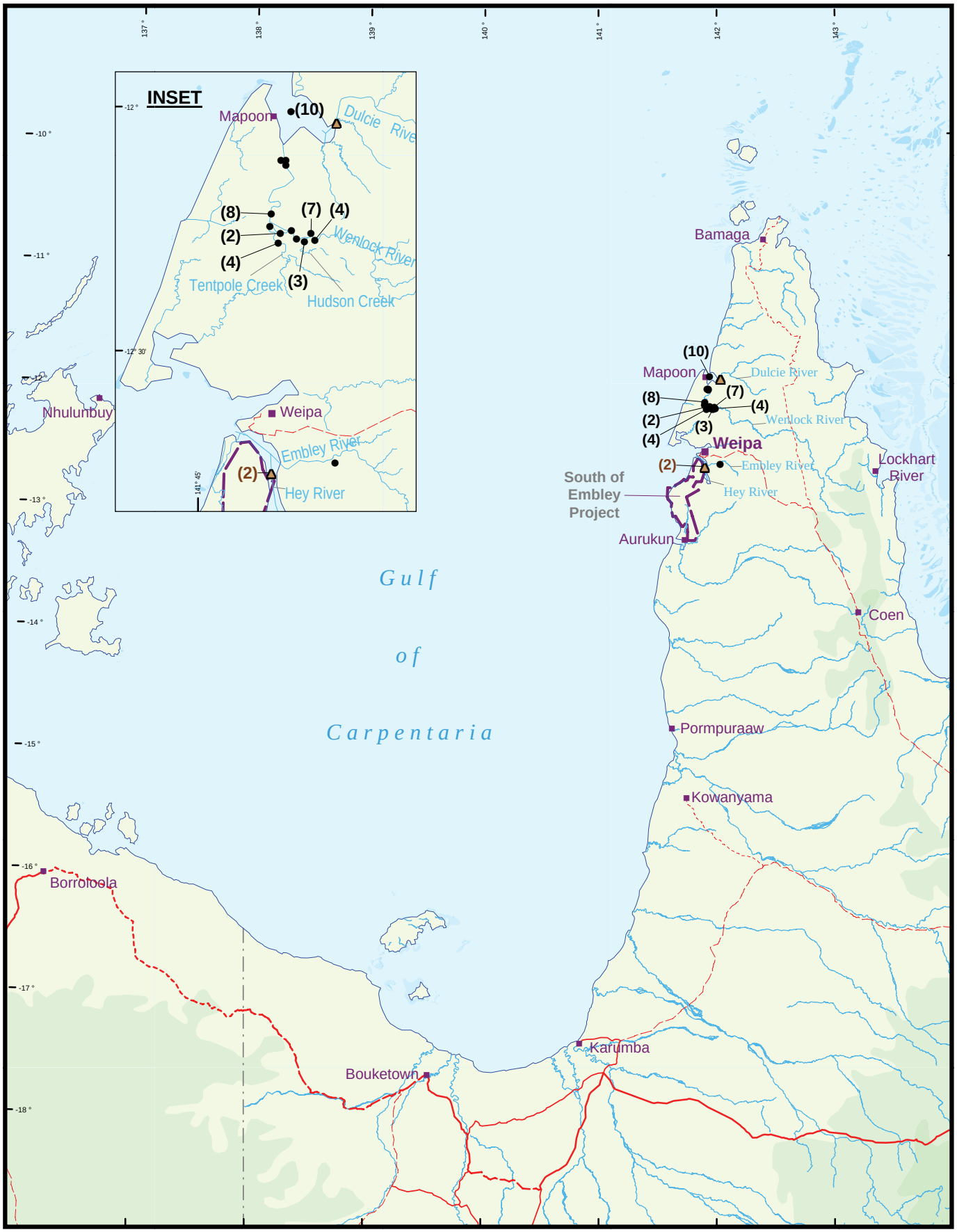
The population size of the Speartooth Shark remains unknown, but is thought to be small based on current knowledge and the apparent rarity of the species. There are insufficient data regarding the Speartooth Shark to suggest a decline in population size. No sexually mature specimens of the Speartooth Shark have been recorded and the distribution and habitat preferences of adults are a critical gap in the knowledge of this species (Pillans *et al.* 2010).

The Speartooth Shark is known from only Australia and Papua New Guinea. The DSEWPaC (2012q) 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 2012q). In Queensland the Speartooth Shark has been found in the Wenlock and Dulcie Rivers, Port Musgrave (the mouth of these two rivers) and the Bizant River (Stevens *et al.* 2005, Peverell *et al*. 2006, Pillans *et al.* 2008). The Speartooth Shark has also been recorded close to Port Romilly and the Fly River in New Guinea (Compagno *et al*. 2008).

Records of *Glyphis* spp. were confirmed from the Hey and Embley Rivers from 1981 and 1985 respectively (Peverell *et al.* 2006). These were not included within the distribution of *G. glyphis* by Pillans *et al.* (2010) due to lack of taxonomic resolution and the fact that the species have not been recorded in these rivers since 1985, despite extensive survey over the past 20 years (Stevens *et al.* 2005).

Data on the short term movement patterns of neonate and juvenile *Glyphis* spp. in the Wenlock River show that animals have a tidally influenced movement pattern, moving up and downstream with the flood and ebb tides, respectively (Pillans *et al.* 2008). **Section 7.4.3** describes the methodology undertaken to survey this species as part of the EIS studies and details the survey results.

Records for the species from published sightings within the eastern Gulf of Carpentaria are shown in **Figure 7-27**.



RioTintoAlcan

Project Boundary
Locality
River / Creek
Road / track

Speartooth Shark *(Glyphis glyphis)*

Recorded location
Indicative location *
(2) Number of records at location

SOURCES: Peverell *et al.* (2006), Pillans *et al.* (2008), Stevens *et al.* (2005).

* Indicative locations recorded within river indicated. Exact location of record in river system is not confirmed.

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Fig. 7-27: Speartooth Shark Records (eastern Gulf of Carpentaria)

N

0 150km

Datum/Projection: GDA94/MGA Zone 54 Date: 01/11/2012

Life cycle

Little is known of the life history of this species due to the lack of specimens (Fowler 1997). The majority of the specimens to date have been new recruits and juveniles, although a small number of sub-adults have also been captured (Pillans *et al.* 2005, Stevens *et al.* 2005). The Speartooth Shark is viviparous. Birthing is likely to occur from October to December, with newborns measuring around 50 to 59cm (Pillans *et al.* 2009). Freshwater environments are important nursery habitats for the Speartooth Shark (Peverell 2005, Pillans *et al.* 2010, Thorburn *et al.* 2007a).

Ecology and habitat

The habitat utilised by the Speartooth Shark includes predominantly large tropical river systems, relatively shallow, turbid, upper freshwater, and brackish, reaches and associated floodplains. The species seems to be particularly adapted to high turbidity and low oxygen environments. Turbidity appears to be an important factor in habitat utilisation for the Speartooth Shark and its distribution within rivers is limited by both upstream and downstream environments (Pillans *et al.* 2010).

To date, the Speartooth Shark has only been captured in tidal rivers and estuaries, indicating that large tropical river systems appear to be a primary habitat (Stevens *et al.* 2005). The species has been caught in varying levels of salinity from very low up to salinity levels nearing seawater (DSEWPaC 2012q).

The morphology of the Speartooth Shark suggests it feeds primarily on benthic and demersal fish, and is adapted to hunting in soft substrates in turbid river waters (Fowler 1997). Peverell *et al.* (2006) found stomach contents included Long-armed Prawns, Burrowing Gobies, Gudgeons, and Bony Bream.

Critical habitat is habitat that the Minister has listed in the Register of Critical Habitat (prepared under Section 207A of the EPBC Act) in relation to an EPBC-listed species or ecological community. The DSEWPaC's Register of Critical Habitat does not identify any critical habitat for the Speartooth Shark.

Threats

The main threats to the Speartooth Shark have been identified by DSEWPaC (2012j) as being recreational line fishing, gillnetting, and habitat degradation. Given its small population, restricted range, and restrictive habitat requirements, this species is likely to be highly susceptible to these pressures.

The Speartooth Shark may also be at risk from habitat modification, such as the potential development of Port Musgrave by mining companies, with proposed dredging activities in the Dulcie and Wenlock River systems and Port Musgrave. This development could potentially affect the populations of Speartooth Shark in this area (DSEWPaC 2012q). Nursery areas are vulnerable to habitat modification associated with industrial, domestic and agricultural development. In addition, aquaculture, ecotourism, spread of exotic organisms and pollution in the marine environment can also impact adversely on aquatic habitats and shark nursery areas and may also warrant monitoring and management to ensure shark populations are protected (DSEWPaC 2012q).

The pressure analysis conducted in the Species Group Report Card – Sawfishes and River Sharks: Supporting the Marine Bioregional Plan for the North Marine Region (DSEWPaC 2012o) identifies changes in hydrological regimes (land-based activities) as an of concern pressure on the Speartooth Shark. DSEWPaC 2012o also identifies chemical pollution/contaminants (onshore and offshore mining operations) as of potential concern on the Speartooth Shark. However, given that bauxite is benign, (refer **Section 3.5.4**) it does not result in the release of contaminants. Therefore this pressure is not of concern in the Project area.

7.4.3 Elasmobranch Survey Methodology and Results

A comprehensive review of the available information was undertaken, including commercial catch records, to confirm potential habitats for sawfish and the Speartooth Shark in the Project area and the likelihood of occurrence. Field surveys were undertaken in freshwater, estuarine and marine sites in the Project area as described below.

In addition to the review of available secondary source information in **Section 7.4.2**, sampling of Project area freshwater and estuarine stream reaches was undertaken during two post wet season sampling periods 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. Further targeted sampling for sawfish and Speartooth Shark was conducted in August 2012 at Boyd Point, Norman Creek estuary and Hey/Embley River estuary. **Figure 7-28** shows the sampling sites for 2007 – 2012. A total of 63 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.

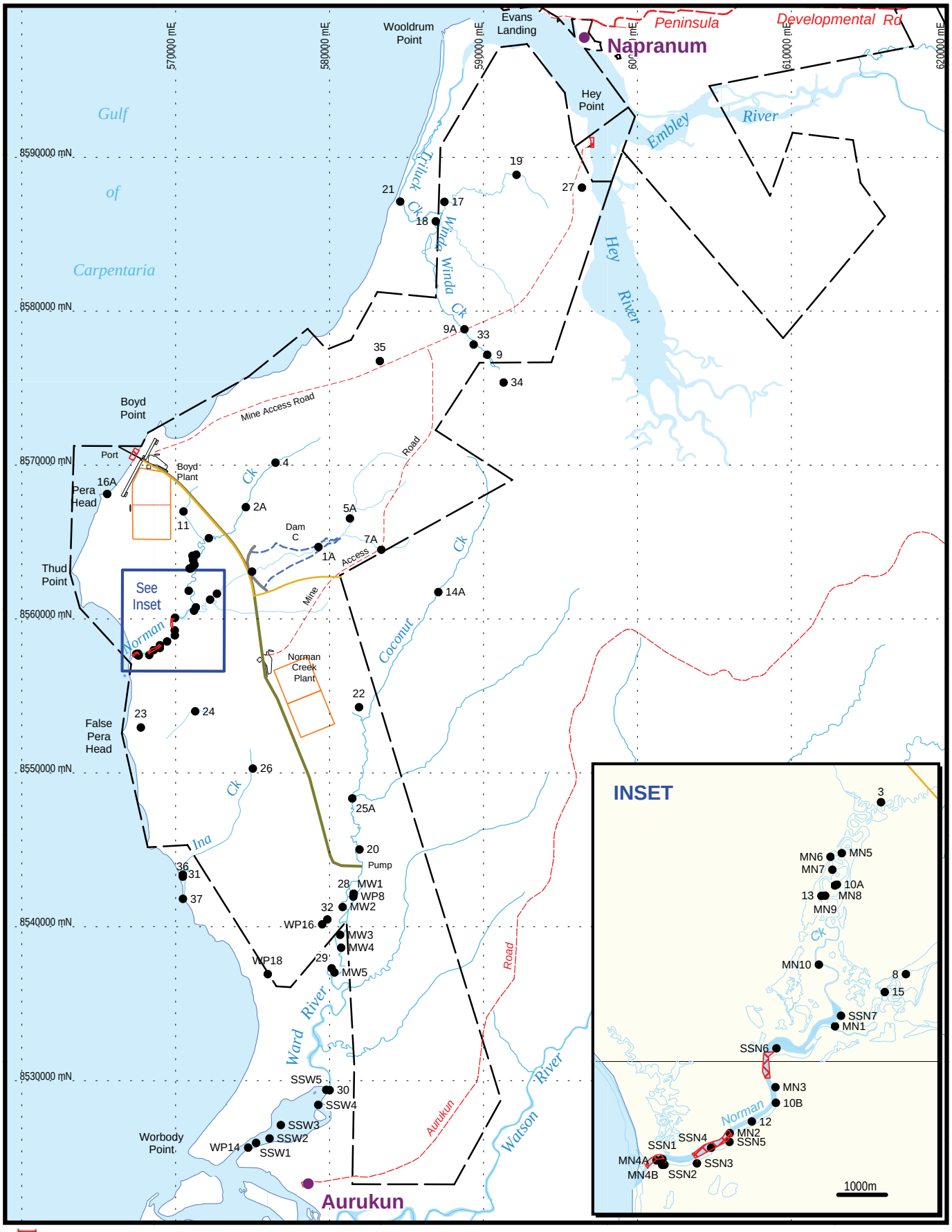
At each site biophysical habitat including riparian and aquatic vegetation were described and digital photographs taken. Aquatic ecosystem assessments were made at the same sites.

The survey methods employed for sampling the freshwater and estuarine stream reaches in May 2008 and May 2009 were gill nets, backpack electrofishing, bait trapping, fyke netting, targeted angling and visual observation (highly effective in the very clear freshwater habitats of the Project area). Field observations were also made opportunistically at other times, but the limited biological sampling undertaken could not 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 was considered to be suitably characterised.

The May 2008 and May 2009 surveys were subject to a number of constraints associated with sampling efficiency, access and safety. During the wet season watercourses could not be sampled due to the inaccessibility of sites due to inundation of the landscape and the presence of debris laden high flows that prevented the safe and effective deployment of sampling equipment. Large populations of Estuarine Crocodile also limited night work due to the risk of crocodile attack and risk associated with removal of enmeshed crocodiles from gill nets at night. For this reason gill nets were set for standard four hour 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 tributaries flowing to the Norman Creek estuary, overnight net sets were employed at a range of sites upstream of the proposed Dam C 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. As identified previously, these stream reaches could not be sampled during the wet season due to the inaccessibility of sites. During the dry season, freshwater habitats upstream of the proposed Dam C were reduced to small residual pools that were too small to deploy gill nets and lacked flow for effective use of fyke nets.

Net sampling targeting the threatened sawfish species and Speartooth Shark was conducted in August 2012. Sampling was conducted at both Boyd Point and Norman Creek estuary over three days, and Embley/Hey River estuary over four days (**Figure 7-28**). Net locations were selected to cover the likely habitats of the species, and specifically included the margins of shallow sand/mud bars and deeper main channel sites.



RTA Mining Lease boundary
Locality
Drainage
Road/track
Tailings storage facility
Infrastructure corridor

Aquatic ecosystem sampling
Targetted threatened elasmobranch netting site

Rio Tinto Alcan

South of Embley Project

Fig. 7-28: Aquatic, Estuarine and Marine Sampling Sites

N

5 0 5 10km

Datum/Projection: GDA94/MGA Zone 54 Date: 01/11/2012

The survey methods were developed in conjunction with D. Thorburn (Indo-Pacific Environmental) with the aim of determining size, abundance and biomass of threatened elasmobranch species. At each location three monofilament gill nets (80m length, 3m drop, and 6 inch mesh) were set. Nets were set from the mid-ebb tide to mid-flood tide, and the varying tidal cycle meant net set durations varied from approximately six to 12 hours (**Table 7-23**). The varying tidal cycle also allowed for survey at dawn and dusk which were identified as key movement times for the species.

Initially, three triple-strand monofilament gill nets (80m length, 3m drop, and 150mm mesh) were set at each location. After sampling for four days (three days at Boyd Point and one day in Norman Creek (middle estuary site)) nets with a greater drop were trialled. The alternate nets were known to effectively collect sharks in the local area, as it was thought that their greater drop better facilitated entanglement of larger sharks in the local high-current conditions. Two monofilament gill nets, 60m long with a 5m drop and mesh size of 162.5mm were used for the remainder of the survey effort in conjunction with one of the original 80m nets. The change from a standard shark net to a local variant of known efficacy was considered a worthy trial of alternative gear, and of no detriment to the Project objectives of determining presence or absence of the target species.

Table 7-23 Net Sampling Schedule, including Tide and Net Set Information, August 2012

Date	Site	Tide times			Net information	Set Duration
		High	Low	High		
15/8/12	Boyd Point	01:48 AM	10:26 AM	02:47 AM	Nets in 06:40 out 18:50	12:10
16/8/12	Boyd Point	02:47 AM	11:13 AM	03:36 AM	Nets in 07:15out 20:00	12:45
17/8/12	Norman Creek	03:36 AM	11:53 AM	06:18 PM	Nets in 08:40 out 15:30	6:50
18/8/12	Boyd Point	04:20 AM	12:30 PM	06:26 PM	Nets in 08:25 out 15:28	7:03
19/8/12	Embley/Hey River	06:35 AM	02:06 PM	07:32 PM	Nets in at 09:30 out at 16:15	6:45
21/8/12	Norman Creek	07:25 AM	02:33 PM	08:06 PM	Nets in at 10:20 out at 17:50	7:30
22/8/12	Norman Creek	05:03 AM	01:04 PM	06:39 PM	Nets in 10:30 out 17:00	6:30
23/8/12	Embley/Hey River	08:20 AM	02:52 PM	08:41 PM	Nets in at 11:45 out at 17:45	6:00
24/8/12	Embley/Hey River	09:26 AM	02:44 PM	09:17 PM	Nets in at 12:20 out at 17:50	5:30
25/8/12	Embley/Hey River	11:07 AM	02:31 PM	09:56 PM	Nets in at 12:15 out at 18:20	6:05

Captured elasmobranch individuals were identified to species level. Shark and sawfish specimens were measured (fork length) and photographs were taken. Fin clippings were taken of specimens of uncertain taxonomy and any specimens of particular taxonomic interest for subsequent DNA analysis. The DNA samples were sent to the Queensland Museum for on-forwarding for analysis. Records were also kept of any net bycatch, including rays, and photographs were taken of any bycatch species which could not be readily identified *in situ,* for later confirmation.

The long duration of the netting period and incorporation of night time and dusk and dawn activities increased difficulties associated with the netting program, including increased probability of entanglement of Estuarine Crocodiles and non-threatened shark species. Once the nets were set, the sampling team remained within sight of the nets to ensure any animal captured was released as soon as possible, ideally within 15 minutes, to limit harm to specimens caught.

Sampling for extended night time periods was not possible due to constraints associated with safety and access associated with the large population of resident Estuarine Crocodiles.

None of the four listed elasmobranch species were confirmed as present within any of the sites surveyed in the Project area in 2007, 2008, 2009 or 2012. The 2012 surveys captured at least ten

elasmobranch species which are not listed threatened species under the EPBC Act including one sawfish; Narrow Sawfish (*Anoxypristis cuspidate*), six ray species; Spotted eagle ray (*Aetobatus narinari*) Shovel nose ray (*Glaucostegus typus*); Coach-whip stingray (*Himantura uarnk*); Blue spotted stingray (*Neotrygon kuhlii*); Cow tail ray (*Pastinachus sephen*); White spotted guitar fish (*Rhynchobatus australiae*) and at least three shark species; Lemon Shark (*Negaprion brevirostris),* Nervous Shark (*Carcharhinus cautus*), and multiple Blacktip Shark individuals (*Carcharhinus tilstoni and/or Carcharhinus limbatus*) which are indistinguishable through field observation. This demonstrates the effectiveness of the survey methodology for the targeted sawfish species and Speartooth Shark species.

Freshwater Sawfish

The Freshwater Sawfish has not been recorded in surveys of the Project area. Freshwater sections of rivers and creeks are generally considered to be important habitats for juvenile Freshwater Sawfish. However, upstream reaches of rivers in the Project area 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. 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. In addition to the osmoregulation constraint, surveys of aquatic fauna carried out for the EIS found that the lack of prey species and the general absence of deeper holes (which would provide refuges) mean that it is unlikely that freshwater sections of rivers in the Project area would provide suitable habitat for the Freshwater Sawfish. The habitat suitability assessment was reviewed by D. Thorburn (Indo-Pacific Environmental Pty Ltd) who concurred with the assessment. The Freshwater Sawfish may occur in the lower reaches of rivers and coastal areas of the Project area. Suitable habitat is present in the brackish reaches of Norman Creek and the Ward River. The freshwater reaches of Norman Creek, including the middle tributary both upstream and downstream of where Dam C is proposed to be located, are not considered suitable habitat for sawfish species because these reaches are small, highly seasonal, lack large permanent pools and lack suitable schooling prey species.

While near-mature and mature animals may traverse the proposed new spoil ground and the Albatross Bay spoil ground, Freshwater Sawfish generally prefer inshore waters.

The review of available secondary source information (refer **Section 7.4.2.1**) indicates the Freshwater Sawfish has low abundance in the Gulf of Carpentaria and is rare north of Kowanyama. Data from Peverell (2005) indicates a by catch rate of 22 individuals per annum in the Gulf of Carpentaria inshore and offshore fishery. The Project area coastal and estuarine waters cover approximately 1% of the fishery area. This, together with the lack of capture or observation of this species during targeted surveys, supports the conclusion that the Freshwater Sawfish is rare in the vicinity of the Project area. Peverell (2005) noted that, given the rarity of Pristids, it is hard to obtain the data necessary to model sawfish populations.

Dwarf Sawfish

The Dwarf Sawfish has not been recorded in surveys of the Project area but are considered likely to occur in shallow coastal areas and the estuarine and lower brackish reaches of the Project area's main drainage systems as suitable habitat is present at these sites. The species was previously recorded along the coastal shoreline within Albatross Bay (Phillips *et al.* 2011). The review of available secondary source information (refer **Section 7.4.2.2**) indicates that abundance of Dwarf Sawfish in the Gulf of Carpentaria is low and highly variable. Data from Peverell (2005) indicates a by catch rate of about 7 individuals per annum in the Gulf of Carpentaria inshore and offshore fishery. The Project area coastal and estuarine waters cover approximately 1% of the fishery area. This, together with the lack of capture or observation of this species during targeted surveys, supports the conclusion that Dwarf Sawfish is rare in the vicinity of the Project area. Peverell (2005) noted that, given the rarity of Pristids, it is hard to obtain the data necessary to model sawfish populations.

Green Sawfish

The Green Sawfish has not been recorded in surveys of the Project area but it has been recorded from Albatross Bay (Thorburn *et al.* 2004). The Project area, including the proposed Port 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 non-fragmented and to occur throughout northern Australia. The review of available secondary source information (refer **Section 7.4.2.3**) indicates that the Green Sawfish is low in abundance and highly variable in the Gulf of Carpentaria. Data from Peverell (2005) indicates a by catch rate of about 7 individuals per annum in the Gulf of Carpentaria inshore and offshore fishery. The Project area coastal and estuarine waters cover approximately 1% of the fishery area.

This, together with the lack of capture or observation of this species during targeted surveys, supports the conclusion that the Green Sawfish is rare in the vicinity of the Project area, Peverell (2005) noted that, given the rarity of Pristids, it is hard to obtain the data necessary to model sawfish populations. It is presumed that since it is a large species, and therefore 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.

Speartooth Shark

The Speartooth Shark has not been recorded in surveys of the Project area. It is considered that the Speartooth Shark may inhabit inshore marine coastal areas, such as adjacent to the entrance to the Hey River, although so far no specimens have been caught in a marine environment despite intensive sampling. *G. glyphis* has not been recorded in the Embley and Hey estuaries since 1985, despite extensive survey over 20 years (Stevens *et al*. 2005) (refer **Section 7.4.2.4**). Given the locations and habitat in which *G. glyphis* has been previously documented as reported in the available secondary source information (refer **Section 7.4.2.4**), it is considered unlikely that the species would occur within the vicinity of the proposed Port facilities, located approximately 35km southwest of the entrance to the Embley River. The DSEWPaC (2012q) SPRAT database indicates that the species may be naturally rare. This, together with the lack of capture or observation of this species during targeted surveys, supports the conclusion that Speartooth Shark is rare in the vicinity of the Project area.

7.4.4 Likelihood of Occurrence within the Project Area

The likelihood of occurrence of sawfish and the Speartooth Shark in the Project area and along Project-related shipping routes is presented in **Table 7-24**.

The potential habitat of sawfish and the Speartooth Shark is presented in **Figure 7-29** to **Figure 7-32** respectively.

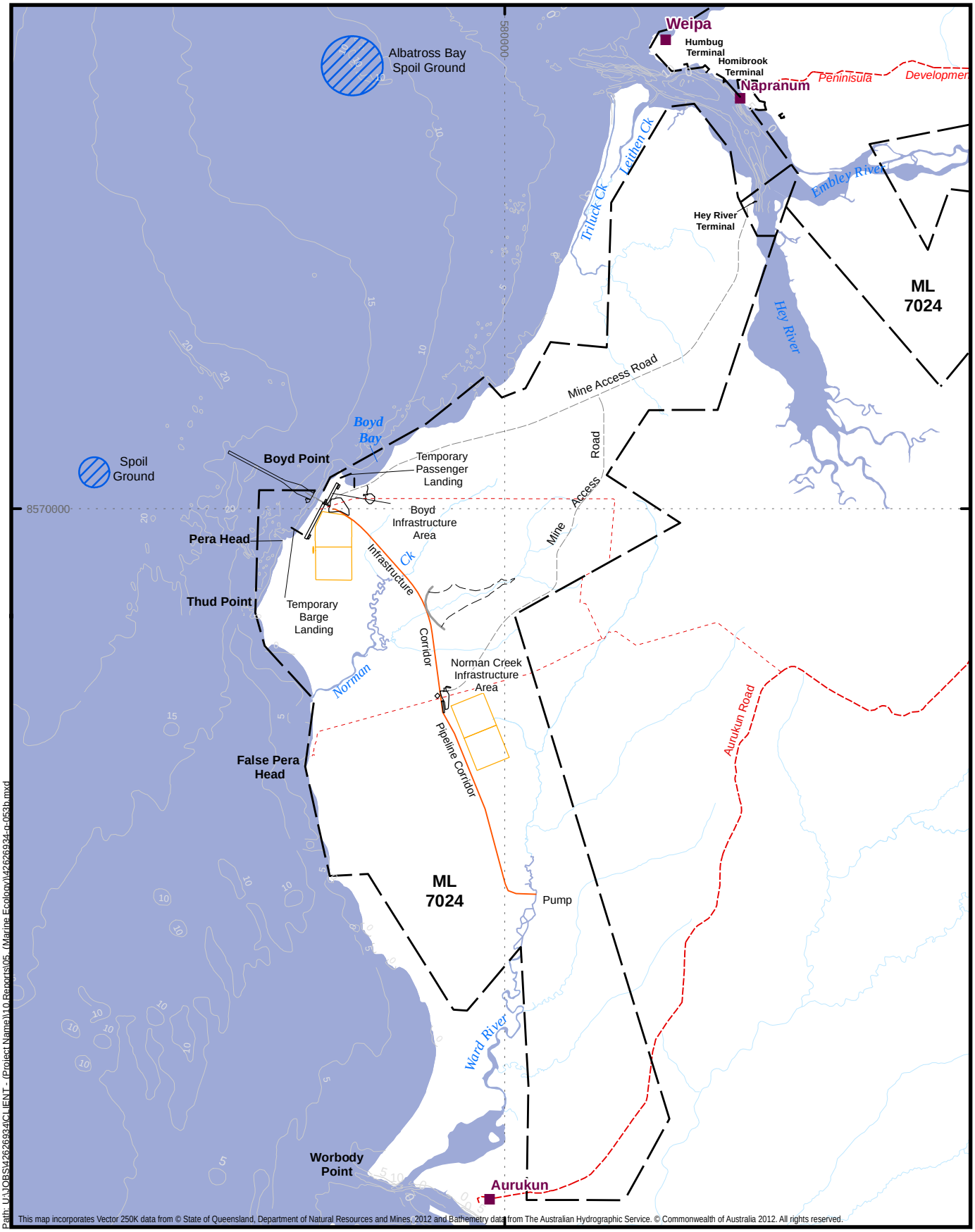
Table 7-24 Profile Summaries – Elasmobranchs

Species	Habitat Preferences		Likelihood of Occurrence
	Foraging	**Breeding**	
Freshwater Sawfish (*Pristis microdon*) (Vulnerable)	Generally confined to the main channels of large rivers over soft mud bottoms. Forage primarily low in the water column. Adults may radiate out and follow the coastline within inshore marine waters.	Pupping in freshwater near river mouths during the wet season. Freshwater environments appear important nursery areas.	**Proposed Port Site** **Possible**: Subadults are commonly associated with estuarine waters and migrate to sea as they near maturity so may occur in the area. Not found during surveys. **Proposed New Spoil Ground** **Possible**: Subadults are commonly associated with estuarine waters and migrate to sea as they near maturity so may enter the area although are generally associated with inshore waters. **Albatross Bay Spoil Ground** **Possible**: Subadults are commonly associated with estuarine waters and migrate to sea as they near maturity so may traverse the area although are generally associated with inshore waters. **Proposed Dam C – Norman Creek** **Unlikely**: Not found during targeted surveys. Anecdotal records only of sawfish species have been recorded in the lower estuarine reaches of Norman Creek, which is downstream of Dam C. The freshwater reaches of the Norman Creek tributary above and below the proposed Dam C location are generally narrow and depths rarely exceed 0.5 m during periods of reduced flow. No suitable habitat for *P. microdon* appears to exist and no suitable prey species were identified as occurring in freshwater above or below the proposed Dam C location, which suggests the tributary is unlikely to be extensively utilised by the species or represent significant habitat of the species. In addition, 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. **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 2.5ha of riverbed. The dredging in these areas would only be to a depth of -7.2m LAT. **Balance of Project Area not disturbed** **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 in these systems.

Species	Habitat Preferences		Likelihood of Occurrence
	Foraging	Breeding	
			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. **Shipping Routes** **Possible**: Subadults are commonly associated with estuarine waters and migrate to sea as they near maturity so may enter the area although are generally associated with inshore waters.
Dwarf Sawfish (*Pristis clavata*) (Vulnerable)	Usually inhabits shallow (2–3 m) coastal waters and estuarine habitats. Prefers highly turbid waters and silt sections of an estuary without instream structure.	Pups in estuarine waters, which are also nursery areas up to 3 years of age.	**Proposed Port Site** **Likely**: The species has been recorded from Albatross Bay and the proposed Port footprint contains suitable habitat for the species. Not found during surveys. **Proposed New Spoil Ground** **Unlikely**: This species prefers shallower waters. The proposed new 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 new spoil ground, it is unlikely that this species would occur at the Albatross Bay spoil ground. **Proposed Dam C – Norman Creek** **Unlikely**: Not found during surveys. This species is not found and does not enter 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:** Not found during targeted surveys. 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 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. **Balance of Project Area not disturbed** **Likely:** The species is likely to occur within Albatross Bay and the Project area contains suitable habitat for the species. **Shipping Routes** **Unlikely**: This species prefers shallower waters. The shipping route is in waters deeper than this species would usually inhabit.

Species	Habitat Preferences		Likelihood of Occurrence
	Foraging	**Breeding**	
Green Sawfish (*Pristis zijsron*) (Vulnerable)	Inshore marine waters along sandy and muddy beaches, estuaries, river mouths and embankments.	Breeding in estuarine or low saline marine environments. Nursery areas generally shallow inshore waters.	**Proposed Port Site** **Likely:** Not found during surveys. The species has been recorded from Albatross Bay and the proposed Port footprint contains suitable habitat for the species. **Proposed New Spoil Ground** **Possible:** While smaller specimens are more common in coastal waters, estuaries and river mouths, larger animals have been found in deeper offshore waters. **Albatross Bay Spoil Ground** **Possible:** While smaller specimens are more common in coastal waters, estuaries and river mouths, larger animals have been found in deeper offshore waters. **Proposed Dam C – Norman Creek** **Unlikely**: Not found during surveys. This species is not found and does not enter 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**: Not found during surveys. 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 2.5ha of riverbed. The dredging in these areas would only be to a depth of -7.2m LAT. **Balance of Project Area not disturbed** **Likely:** The species has been recorded from Albatross Bay and the Project area contains suitable habitat for the species. **Shipping Routes** **Possible**: While smaller specimens are more common in coastal waters, estuaries and river mouths, larger animals have been found in deeper offshore waters.
Speartooth Shark (*Glyphis glyphis*) (Critically Endangered)	Predominantly large tropical river systems. Relatively shallow, turbid, upper freshwater, and brackish, reaches and associated floodplains.	Breeding habitat unknown. Nursery areas in freshwater.	**Proposed Port Site** **Unlikely:** Not found during survey. The species has only been captured in tidal rivers and estuaries. Although the species can tolerate higher salinities, it is considered that the proposed Port site is too far away (~35km) from the river entrances that provide potential suitable habitat.

Species	Habitat Preferences		Likelihood of Occurrence
	Foraging	Breeding	
			Proposed New Spoil Ground **Unlikely:** This species prefers shallower waters and has only been captured in tidal rivers and estuaries. Although the species can tolerate higher salinities, the proposed new spoil ground is remote from usual suitable habitat. **Albatross Bay Spoil Ground** **Unlikely:** This species prefers shallower waters and has only been captured in tidal rivers and estuaries. Although the species can tolerate higher salinities, the Albatross Bay spoil ground is remote from usual suitable habitat. **Proposed Dam C – Norman Creek** **Unlikely**: Not found during surveys. 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 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. In addition, 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, including the middle tributary both upstream and downstream of the proposed Dam C, do not. **Ferry/Barge Terminals – Hey and Embley Rivers** **Possible**: This species was identified as occurring in the Embley and Hey Rivers during surveys conducted between 1978 and 1986 (Peverell *et al.* 2006, Last and Stevens 2009), however was not recorded in surveys by CSIRO conducted between 1986 and 2004, nor during the August 2012 targeted survey. While *G. glyphis* has not been confirmed as present in the Embley or Hey systems, it has been assumed the species may persist in those systems. 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. **Balance of Project Area not disturbed** **Possible**: 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 *et al.* 2006). **Shipping Routes** **Unlikely**: This species prefers shallower waters and has only been captured in tidal rivers and estuaries. Although the species can tolerate higher salinities, the majority of the shipping route is remote from usual suitable habitat.



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Rio Tinto Alcan

- RTA mining lease boundary
- Locality
- Roads/ track
- River
- Freshwater dam
- Tailings storage facility

Habitat

- Potential foraging habitat (0 - 70m deep)

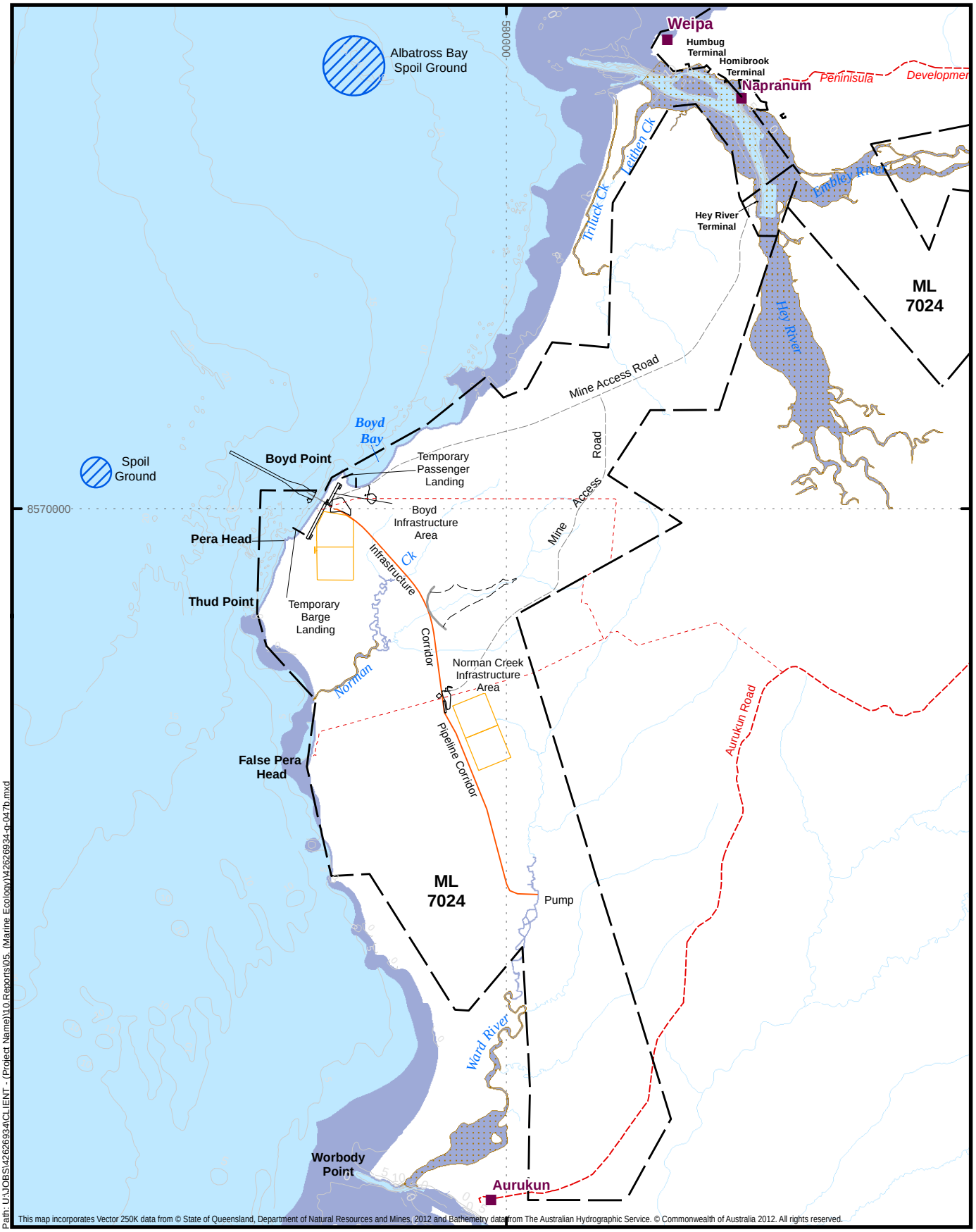
South of Embley Project

Fig. 7-29: Potential Habitat of Freshwater Sawfish (Project Area)

N

0 2.25 4.5 9 km

Datum/Projection: GDA94/MGA Zone 54 Date: 06/11/2012



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Rio Tinto Alcan

- RTA mining lease boundary
- Locality
- Roads/track
- River
- Freshwater dam
- Tailings storage facility

Habitat
- Potential foraging habitat (0 - 3m deep)
- Potential nursery habitat

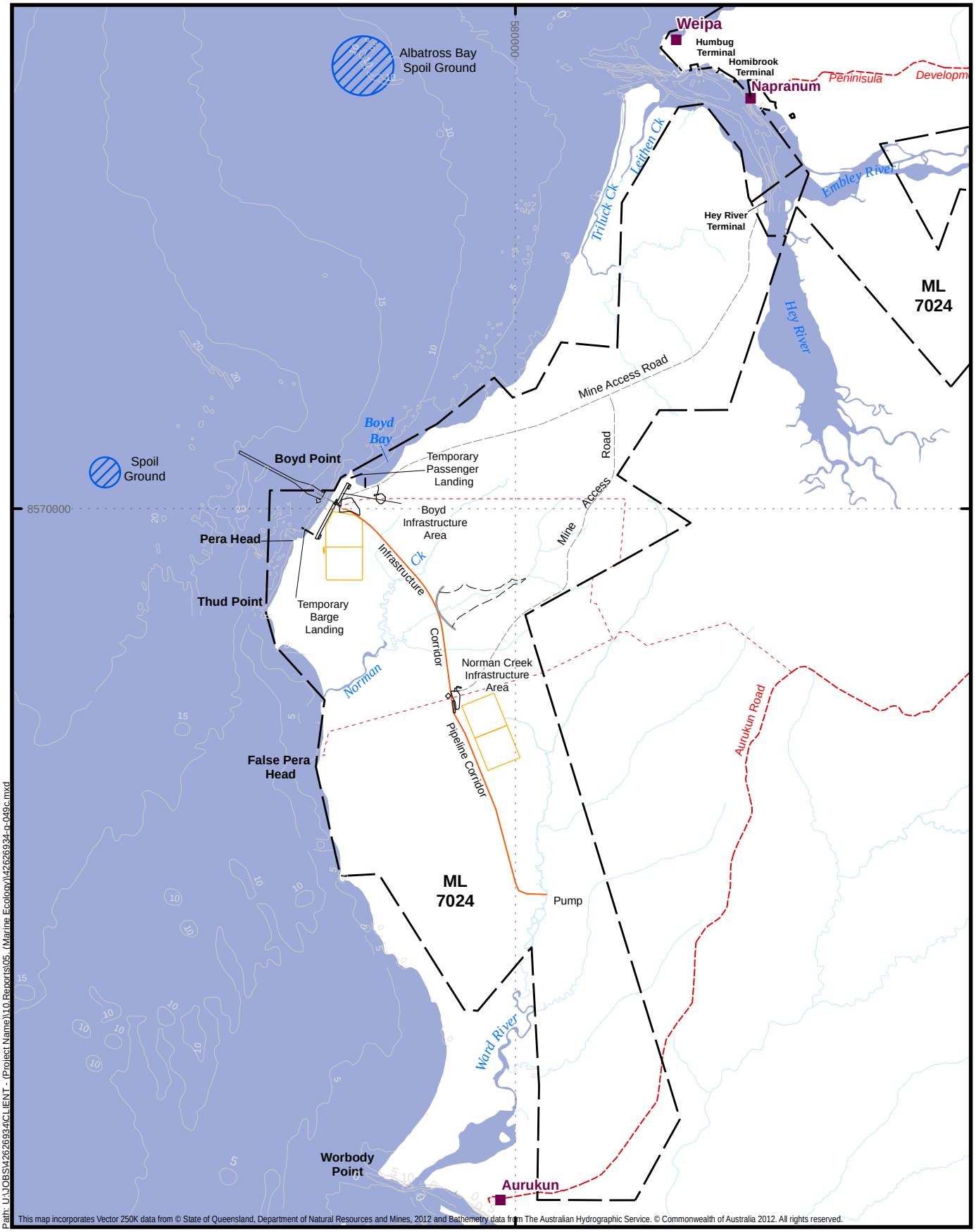
South of Embley Project

Fig. 7-30: Potential Habitat of Dwarf Sawfish (Project Area)

N

0 2.25 4.5 9 km

Datum/Projection: GDA94/MGA Zone 54 Date: 06/11/2012



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Rio Tinto Alcan

- RTA mining lease boundary
- Locality
- Roads/track
- River
- Freshwater dam
- Tailings storage facility

Habitat

- Potential foraging and nursery habitat (0 - 70m deep)

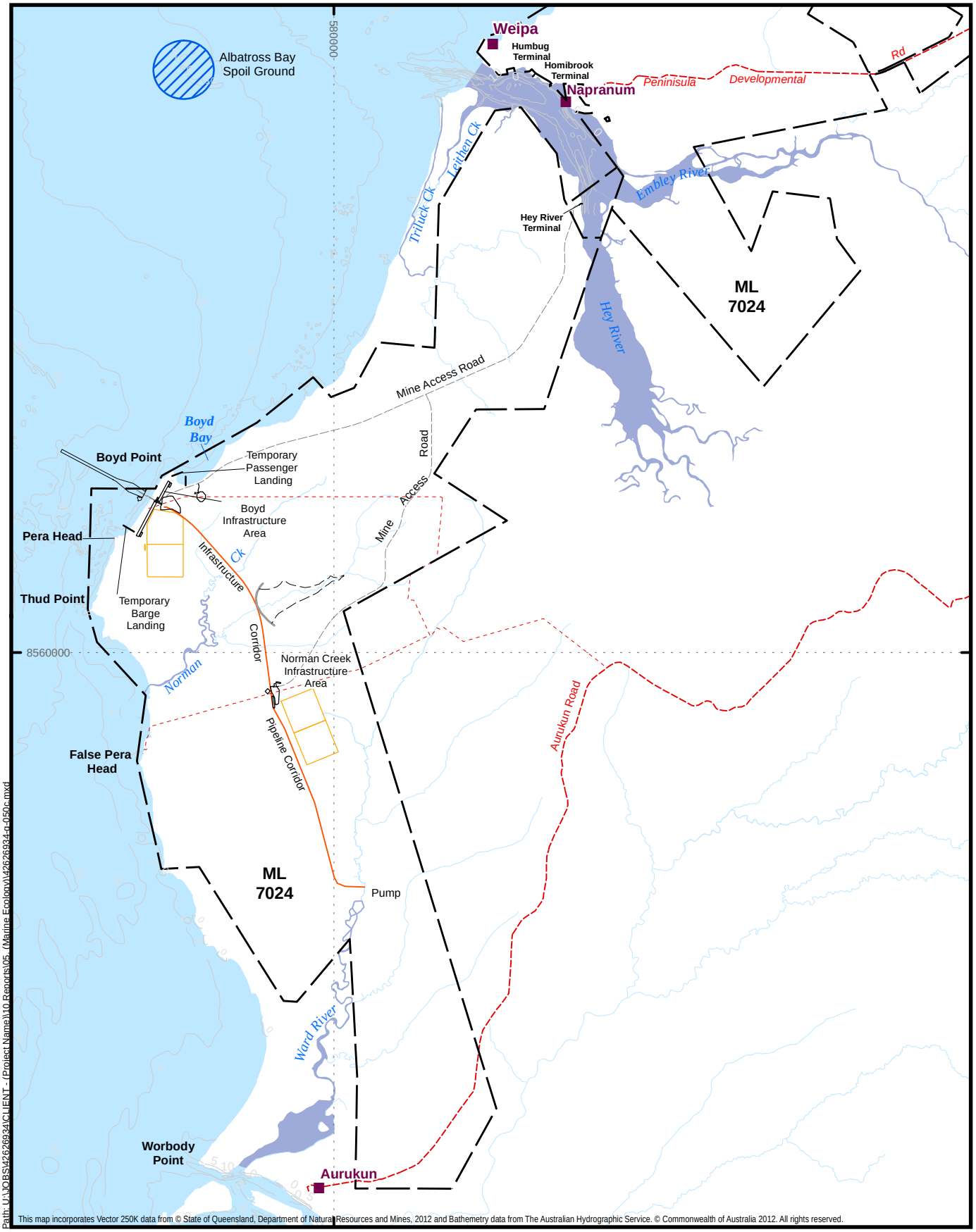
South of Embley Project

Fig. 7-31: Potential Habitat of Green Sawfish (Project Area)

N

0 2.25 4.5 9 km

Datum/Projection: GDA94/MGA Zone 54 Date: 06/11/2012



RTA mining lease boundary
Locality
Roads/ track
River
Freshwater dam
Tailings storage facility

Habitat
Potential foraging habitat

South of Embley Project

Fig. 7-32: Potential Habitat of Speartooth Shark (Project Area)

N

0 2.25 4.5 9 km

Datum/Projection: GDA94/MGA Zone 54 Date: 06/11/2012

7.4.5 Relevant Impacts on Sawfish and the Speartooth Shark

The Green Sawfish, Dwarf Sawfish, Freshwater Sawfish and Speartooth Shark have not been recorded in surveys of the Project area but the occurrence of these species within certain parts of the Project area is considered to be likely or possible. However, it is considered that the extent of potential habitats that would be disturbed by the Project would be limited.

If they were present, the potential impacts on threatened elasmobranch species during the construction and operational stages of the Project may result from dredging and offshore spoil disposal, construction and operation of the marine and river facilities, and the operation of Dam C.

The potential unmitigated relevant direct and indirect impacts on threatened sawfish species and the Speartooth Shark from the construction and operational stages of the Project are discussed in **Sections 7.4.5.1** to **7.4.5.3** and **Table 7-25** provide cross references to the sections in this document where each relevant impact is described. The specific avoidance and mitigation measures that would be implemented to reduce the potential impacts on elasmobranchs are presented in **Section 7.4.6**.

Table 7-25 Cross References to Impacts on Sawfish and Speartooth Shark from Construction and Operations

	CONSTRUCTION ACTIVITIES		OPERATIONAL ACTIVITIES		
POTENTIAL IMPACT PRIOR TO MITIGATIONS	**Dredging and offshore spoil disposal**	**Marine and river facilities**	**Dredging and offshore spoil disposal**	**Marine and river facilities**	**Dam C**
DIRECT IMPACTS					
Physical disturbance of benthic or intertidal habitats	**7.4.5.1**	**7.4.5.2**	**7.4.5.1**	**7.4.5.2**	
Creation of turbidity plume	**7.4.5.1**		**7.4.5.1**		
Deposition of dredged sediments on benthic habitat	**7.4.5.1**		**7.4.5.1**		
INDIRECT IMPACTS					
Restricted movement and flow in riverine habitat					**7.4.5.3**

7.4.5.1 Dredging and Offshore Spoil Disposal

A description of dredging and offshore spoil disposal activities is provided in **Section 7.3.5.1**. The potential direct and indirect impacts on sawfish and the Speartooth Shark from capital and maintenance dredging include:

- physical disturbance to benthic habitats from dredging;
- creation of a turbidity plume; and,
- deposition of dredged sediments on benthic habitat.

These potential direct and indirect impacts are discussed in detail below.

Physical disturbance to benthic habitats from dredging

It is considered unlikely that the Speartooth Shark would occur within the vicinity of the proposed Port facilities or offshore spoil disposal grounds, which are remote from the entrance to the Hey and Embley Rivers. The dredge footprint for the Port is also not located directly within any important habitats identified for the Dwarf Sawfish and the proposed dredge footprint for the Port is also small compared to the overall area of coastline and subtidal habitat available for these species. On the basis of published observations, it is likely that adult Freshwater or Green Sawfish may be present within the vicinity of the proposed Port dredging footprint although it is unlikely that juvenile Freshwater or Green Sawfish would occur. The Freshwater and Green Sawfish is widely distributed throughout northern Australia, and the Port location is well removed from estuaries that are the key habitat for this species.

The proposed dredging activities within the Hey and Embley Rivers would result in negligible impacts to the viability of the adjacent mangrove system, or to fisheries values or habitat essential to sawfish and the Speartooth Shark. The overall area of disturbance from dredging in the rivers is only approximately three hectares, and the nature of the disturbance would not exclude use of these areas by sawfish or the Speartooth Shark. The potential unmitigated impacts of physical disturbance to benthic habitats on sawfish and the Speartooth Shark from dredging activities at the proposed Port and river facilities would be negligible, but would continue throughout the duration of the Project as a result of annual maintenance dredging so would be long term.

Creation of turbidity plume

Dredging and offshore spoil disposal may impact on water quality through minor increases in turbidity (refer **Section 7.3.5.1**). The Project area is currently exposed to periodic but significant physical disturbance and elevated turbidity during extreme weather events. Sawfish and the Speartooth Shark typically inhabit turbid waters, are highly mobile, and can move away from any local areas that are affected by disturbance. Therefore, the potential unmitigated impacts from turbidity plumes on sawfish and the Speartooth Shark from dredging activities would be negligible and would eventuate only during dredging campaigns so would be short term.

Deposition of dredged sediments on benthic habitat

Physical disturbance on benthic habitats as a result of spoil disposal at the existing Albatross Bay spoil ground and the proposed new spoil ground could potentially reduce the amount of prey species available where dredge spoil buries faunal communities. However, these areas are not identified as preferred habitat for sawfish and the Speartooth Shark. The proposed new spoil ground would have a deposition area of approximately 1km radius from the centre of disposal. Both spoil grounds consist of soft sediment habitat, of which there is extensive similar habitat within and surrounding the Project area. Spoil disposal would be localised and would occur over a short time-frame over a small area in the proposed new spoil ground. These species are highly mobile and have the ability to move to similar habitats within or adjacent to the Project area. The potential unmitigated impacts on sawfish and the Speartooth Shark from the deposition of dredged sediments associated with capital dredging would be negligible and short term.

Impacts from the deposition of dredged sediments associated with maintenance dredging would also be negligible but would continue throughout the duration of the Project so would be long term.

7.4.5.2 Marine and River Facilities Construction and Operation

A description of dredging activities and offshore spoil disposal activities associated with the construction and operation of marine and river facilities is provided in **Section 7.3.5.2**.

The only potential direct and indirect impacts on sawfish and the Speartooth Shark from the construction and operation of marine and river facilities is considered to be physical disturbance to benthic or intertidal habitats from reclamation or piling. This potential unmitigated impact is discussed in detail below, including the relevance of the impact on each species.

Physical disturbance to benthic or intertidal habitats

Construction of the Port would involve the installation of a total of 274 piles in the seabed. The physical footprint of disturbance is insignificant compared to the overall area of the coastline and subtidal habitat in the Project area. The proposed Port is not directly located within any critical habitats for sawfish or the Speartooth Shark. Only 0.4ha of sub-tidal habitat would be reclaimed at the Hey River terminal. It is considered that impacts on the habitat of sawfish and the Speartooth Shark due to piling and reclamation activities would be negligible and long term.

The Dwarf Sawfish and Green Sawfish are known to occupy flooded mangrove areas in the Pilbara (Stevens *et al*. 2008) however; the lack of dense mangrove communities at the Hey River terminal means that it would be unlikely that this area would sustain large quantities of suitable prey species. Although isolated mangroves are present at some locations, the footprints of the other river facilities do not contain mangrove communities. It is considered that physical disturbance as a result of construction of the Hey River terminal would result in negligible impacts on habitat of Dwarf Sawfish and Green Sawfish, but any impacts would be long term.

7.4.5.3 Dam C

Restricted movement and flow in riverine habitat

A water supply dam (Dam C) would be constructed in a tributary of Norman Creek. It would have storage capacity of up to 29GL and would have a footprint area of up to 700ha. The location and hydrological impact of Dam C is described in **Section 16.2.3**. The key findings of modelling of the impact of Dam C on downstream flow found:

- 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;
- 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 for the 15Mdptpa, 30Mdptpa and 50Mdptpa production rates; and,
- mean monthly flows to the receiving estuary are maintained above 91.4% of pre-impact flows for the core March-April wet season period (impacts on wet season primary productivity and fisheries recruitment in the estuary, if they occur, are predicted to be small).

Sufficient water would be reserved in Dam C to enable continued releases in the driest months (August to October) of a volume equivalent to 25% of dam inflows. The late dry season flows are naturally very small (several litres per second).

The purpose of the release is to maintain some connection between in-stream waterholes, rather than provide large flows for movement of larger fish.

The pressure analysis conducted in the Species Group Report Card – Sawfishes and River Sharks: Supporting the Marine Bioregional Plan for the North Marine Region (DSEWPaC 2012o) identifies changes in hydrological regimes (land-based activities) as an of concern pressure on sawfish and the Speartooth Shark. The assessment in DSEWPaC (2012o) relates to the suggestion that wet season freshwater flows are a cue for triggering sawfish pupping and that the alteration of flow could change the timing of reproduction and the level of recruitment. Specifically DSEWPaC 2012o states:

> *"Wet season freshwater flows have been suggested as the cue for triggering sawfish pupping (Peverell 2005; Whitty et al. 2008) demonstrated that the number of new recruits of freshwater sawfish captured in the dry season of each year is significantly correlated to higher water levels during the late wet season. The alteration of flow could change the timing of reproduction and the level of recruitment. Australian tropical rivers have highly energetic, episodic flows related to the monsoonal wet season that transport sediments downstream with little trapping of materials in waterways (Brodie and Mitchell 2005)."*

Once constructed, Dam C may present a barrier to sawfish and the Speartooth Shark, were they to be present. Freshwater reaches of Norman Creek, including reaches upstream and downstream of Dam C, have been assessed and are not considered to be suitable habitat for the Freshwater Sawfish (**Figure 7-29**) and Speartooth Shark (**Figure 7-30**) as they are small and highly seasonal habitats that lack large permanent pools, and lack suitable prey species (Thorburn *et al.* 2003 and 2004, Thorburn and Morgan 2005). Furthermore, the extremely low conductivity in these upstream reaches is considered likely to present an osmoregulation constraint on the Freshwater Sawfish (refer **Section 7.4.3**). Freshwater reaches are not suitable habitat for Green or Dwarf Sawfish, which are considered to be restricted to marine and estuarine habitats and do not enter freshwater (refer **Sections 7.4.2.2**, **7.4.2.3** and **7.4.3**).

The potential unmitigated impacts on sawfish and the Speartooth Shark from potential restricted movement in riverine habitat associated with Dam C and changed downstream flow regime are considered negligible and long term.

7.4.5.4 Summary of Relevant Impacts on Elasmobranchs Prior to Mitigation

The Project is predicted to have negligible potential unmitigated impacts on sawfish and the Speartooth Shark.

7.4.6 Avoidance and Mitigation Measures and Residual Impacts

As no significant potential unmitigated impacts are anticipated, specific mitigation measures are not required for sawfish and the Speartooth Shark. However a range of mitigation measures that would be implemented to protect marine and estuarine fauna and habitats would also reduce the risk of impacts on sawfish and the Speartooth Shark, as described in the following sections.

An environmental management plan outline for sawfish and the Speartooth Shark that summarises these avoidance, mitigation and enhancement measures is provided in **Appendix 7-E**.

7.4.6.1 Dredging and Offshore Spoil Disposal

The mitigation and monitoring requirements included in the draft Port and river facilities DMPs (refer **Appendix 7-C** and **Appendix 7-D**) are designed to avoid or minimise impacts from capital dredging and offshore spoil disposal associated with the Project. Details of these measures are also provided in **Section 7.3.6.1**. DMPs submitted for subsequent capital and maintenance dredging activities would include similar mitigation measures, where appropriate.

Physical disturbance to benthic habitats

The mitigation measures to further reduce the impacts of physical disturbance of benthic habitats on sawfish and the Speartooth Shark associated with dredging and offshore spoil disposal activities are the same as those detailed in **Section 7.3.6.1** for marine turtles.

Creation of turbidity plumes

The mitigation measures to further reduce the impacts of turbidity plumes and subsequent deposition and re-suspension of sediments associated with dredging and offshore spoil disposal activities are the same as those detailed in **Section 7.3.6.1** for marine turtles.

Deposition of dredged sediments on benthic habitat

The mitigation measures to further reduce the impacts of dredged sediment deposition on sawfish and the Speartooth Shark associated with offshore spoil disposal activities are the same as those detailed in **Section 7.3.6.1** for marine turtles.

7.4.6.2 Marine and River Facilities Construction and Operations

Physical disturbance to benthic or intertidal habitats

The mitigation measures to further reduce the impacts on sawfish and the Speartooth Shark from physical disturbance of benthic or intertidal habitats during reclamation or pile-driving activities are the same as those detailed in **Section 7.3.6.2** for marine turtles.

7.4.6.3 Summary of Residual Impacts on Elasmobranchs Following Mitigation

Table 7-26 to **Table 7-29** summarise the potential impacts on sawfish and the Speartooth Shark resulting from the Project after proposed mitigation measures have been considered, in relation to the significant impact criteria for matters of NES (DEWHA 2009c).

7.4.6.4 National Recovery Plan and Threat Abatement Plans

It is recognised that DSEWPaC is currently developing a recovery plan for the following species:

- *Pristis clavata* (Dwarf Sawfish);
- *Pristis microdon* (Freshwater Sawfish);
- *Pristis zijsron* (Green Sawfish); and,
- *Glyphis glyphis* (Speartooth Shark).

The Project is expected to be consistent with the recovery plans once developed as the impact assessment process concludes there would be only negligible impacts on sawfish and the Speartooth Shark.

There are no relevant threat abatement plans for sawfish or the Speartooth Shark.

Table 7-26 Impact Assessment Summary – Dwarf Sawfish

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. The species is not found in freshwater (Thorburn *et al.* 2007a). The only shallow water (2-3m) development relates to the barge and ferry terminals where minor dredging would be required over a limited area and would not affect critical habitat. The proposed Port area works in shallow depths relate only to piling. The Project is unlikely to result in a long term decrease in the size of a local Dwarf Sawfish population if it is present. Predicted Project-related shipping activities would not impact on important populations of this species.
.... 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 occupancy of a local population.
....fragment an existing important population into two or more populations?	The Project development and operation, including predicted shipping activities, would not create any barriers to movement for the Dwarf Sawfish. As a benthic species, the Dwarf Sawfish would be able to swim under any wharf structures or facilities such as barges.
....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. Predicted Project-related shipping activities would not impact on important populations of this species.
....disrupt the breeding cycle of an important population?	The development and operation of the Port and barge/ferry terminal areas are 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 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. Predicted Project-related shipping activities are not anticipated to adversely impact any critical habitat areas for this 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 Dwarf Sawfish would be introduced due to the development or operation of Project marine infrastructure or predicted Project-related shipping.
.....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 or predicted Project-related shipping.
....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 these threats. The Project, including predicted shipping activities, would not result in any substantial interference with the recovery of this species.

Table 7-27 Impact Assessment Summary – Green Sawfish

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. 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 alternate suitable habitat. Predicted Project-related shipping activities would not impact on important populations of this species.
.... reduce the area of occupancy of an important population?	Given the extent of suitable habitat in northern Australia, the Project development and operation, including predicted shipping activities, 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, including predicted shipping activities, 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. Predicted Project-related shipping activities are not anticipated to adversely impact any critical habitat areas for this species.
....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. Predicted Project-related shipping activities are not anticipated to adversely impact any critical habitat areas for this 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 the Green Sawfish would be introduced due to the development or operation of Project marine infrastructure or predicted Project-related shipping.
.....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 or predicted Project-related shipping.
....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 the Green Sawfish limits the ability of the species to recover from these threats. The Project, including predicted shipping activities, would not result in any substantial interference with the recovery of this species.

Table 7-28 Impact Assessment Summary – Freshwater Sawfish

Will the proposed works...	**Freshwater Sawfish (*Pristis microdon*): Vulnerable**
....lead to a long-term decrease in the size of an important population?	A long term decrease in any population of this species if present is unlikely to occur. Predicted Project-related shipping activities would not impact on important populations of this species.
....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 populations?	Any population present would not be fragmented. Evidence suggests that the species would not travel upstream of the proposed Dam C footprint on a freshwater tributary of Norman Creek.
....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. The species is unlikely to travel upstream of the proposed Dam C footprint and these freshwater environments are not considered critical breeding habitat for the species. Predicted Project-related shipping activities are not anticipated to adversely impact any critical habitat areas for this species.
....disrupt the breeding cycle of an important population?	The breeding cycle of this species (if present within proposed disturbance areas) would not be disrupted. the species is unlikely to travel upstream of the proposed Dam C footprint and these freshwater environments are not considered critical breeding habitat for this 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 travel upstream of the proposed Dam C footprint and these freshwater environments are not considered critical breeding habitat for this species. 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 it is present. There is no evidence to suggest that large vessels pose a threat to sawfish species or would cause a decline in these species. Predicted Project-related shipping activities are not anticipated to adversely impact any critical habitat areas for this species
....result in invasive species that are harmful to endangered vulnerable species becoming established in the vulnerable species' habitat?	The Project, including predicted shipping activities, is unlikely to lead to the introduction of any invasive fauna that could affect this species.
.....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, including predicted shipping activities, would represent a threat with respect to the introduction of disease.
....interfere substantially with the recovery of the species?	The Project, including predicted shipping activities, is not expected to interfere with the recovery of this species.

Table 7-29 Impact Assessment Summary – Speartooth Shark

Will the proposed works...	Speartooth Shark (*Glyphis glyphis*): Critically Endangered
....lead to a long-term decrease in the size of a population?	A long term decrease in any population of this species, if present, is unlikely to occur. Project-related shipping activities would not impact on a population of this species.
....reduce the area of occupancy of the species?	Sufficient habitat would remain to support this species, if present within the proposed disturbance areas, and the area of occupancy of any population of this species, if present, would not be reduced.
....fragment an existing population into two or more populations?	Any population present would not be fragmented. Evidence suggests that the species would not travel upstream of the proposed Dam C footprint on a freshwater tributary of Norman Creek.
....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. The species is unlikely to travel upstream of the proposed Dam C footprint and these freshwater environments are not considered critical breeding habitat for this species. Predicted Project-related shipping activities are not anticipated to adversely impact any critical habitat areas for this species.
....disrupt the breeding cycle of a population?	The breeding cycle of this species (if present within proposed disturbance areas) would not be disrupted. The species is unlikely to travel upstream of the proposed Dam C footprint and these freshwater environments are not considered critical breeding habitat for this 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 travel upstream of the proposed Dam C footprint and these freshwater environments are not considered critical breeding habitat for this species. 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 this species if it is present. There is no evidence to suggest that large vessels pose a threat to the Speartooth Shark or would cause a decline in this species. Predicted Project-related shipping activities are not anticipated to adversely impact any critical habitat areas for this species
....result in invasive species that are harmful to a critically endangered species becoming established in the critically endangered species' habitat?	The Project, including predicted shipping activities, is unlikely to lead to the introduction of any invasive fauna that could affect this species.
.....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, including predicted shipping activities, would represent a threat with respect to the introduction of disease.
....interfere with the recovery of the species?	The Project, including predicted shipping activities, is not expected to interfere with the recovery of this species.

7.4.7 Offsets

Under the *EPBC Act Environmental Offsets Policy* (DSEWPaC 2012b), offsets are not required where the residual impact is not likely to be significant (when assessed against the *Matters of National Environmental Significance: Significant Impact Guidelines 1.1* (DEWHA 2009c)).

Section 7.4.5 and **Section 7.4.6** of this report document the results of the impact assessment process and concludes that with the implementation of the proposed mitigation measures, the residual impacts associated with the construction and operation of the Project on sawfish and the Speartooth Shark would be negligible and therefore not significant as outlined in **Section 7.1.2.** As such, offsets relating to sawfish and the Speartooth Shark are not required under the Commonwealth offsets policy.