APPENDIX D: FLORA AND VEGETATION

D.1: West Angelas Beyond 2020 Infrastructure Corridors Reconnaissance and Targeted Survey

a. Western Hill and Deposit F Infrastructure Areas

b. Deposit H Infrastructure Area

Biologic Environmental Survey Pty Ltd
PO Box 179
Floreat, WA, 6014

12 January 2023

Attn: Elizabeth Mason and Stephanie Stack

Rio Tinto Iron Ore

Dear Elizabeth and Stephanie,

Please find below a memo summarising the reconnaissance and targeted flora and vegetation survey completed by Biologic Environmental Survey Pty Ltd (Biologic) within unsurveyed areas for the Western Hill, and Deposit F Infrastructure areas for the West Angelas Project Envelope.

If you have any queries, please do not hesitate to contact me.

Yours sincerely,

Clinton van den Bergh
Principal Botanist | Manager of Botany
Clinton@biologicenv.com.au
(08) 6365 5066 | 0439 910 881

1. INTRODUCTION AND OBJECTIVES

Biologic were commissioned to undertake a reconnaissance and targeted flora and vegetation survey of unsurveyed proposed infrastructure areas for Western Hill, Deposit H and Deposit F within the West Angelas Project Envelope (herein collectively referred to as the Study Area) (Figure 1.1). The Study Area is located within the West Angelas Revised Proposed Development Envelope and comprises three survey areas covering a total of 1,036.86 hectares (ha) (Figure 1.1), comprising:

- Western Hill Infrastructure (WHI) area – 118.89 ha (includes two areas);
- Deposit H Infrastructure (DHI) area – 858.25 ha; and
- Deposit F Infrastructure (DFI) area – 59.72 ha.

The overarching objective of this assessment was to undertake a single season reconnaissance and targeted flora and vegetation survey to identify the occurrence of flora and vegetation within the Study Area, with a particular focus on significant species (as per EPA (2020)), to inform future development and environmental approvals within the West Angelas Development Envelope. Significant species that were the focus of this survey are based on species identified in a previous desktop assessment completed for the broader West Angelas Revised Proposal Development Envelope, which encompasses the Study Area (Biota, 2020).

The DHI area was not surveyed at the time of WHI and DFI due to time constraints, as such, this memo only addresses WHI and DFI. The plant identifications for DHI are still being completed and a separate memo will be submitted in due course.

Conformance and Licensing

This assessment was carried out in a manner consistent with the following guidelines and recommendations from the Environmental Protection Authority (EPA), relevant survey-specific license conditions and, where relevant, Rio Tinto guidelines and standards:

- DoE (2013) Matters of National Environmental Significance: Significant impact guidelines 1.1;
- EPA (2018) Statement of Environmental Principles, Factors and Objectives;
- EPA (2016a) Environmental Factor Guideline: Flora and Vegetation;
- EPA (2016b) Technical Guidance – Flora and Vegetation Surveys for Environmental Impact Assessment; and
- Rio Tinto (2021a) for targeted flora surveys and data collection.

Flora specimen collections were conducted under a DBCA Regulation 62 “Flora Taking (Biological Assessment) Licences issued to Clinton van den Bergh (FB62000105), Emma Marsh (FB62000233-4) and Sam Coultas (FB62000017-2). In accordance with Section 40 of the *Biodiversity Conservation Act 2016* (BC Act), threatened species sampling was completed under a DBCA “Authorisation to Take or Disturb Threatened Species” issued to Clinton van den Bergh (authorisation number TFL 59-1819) and Sam Coultas (authorisation number TFL 60-1819).

670000
676000
682000
688000
7440000
7434000

Western Hill Infrastructure 2

Western Hill Infrastructure 1

Deposit H Infrastructure

West Angelas

Deposit F Infrastructure

Legend

- Study Area
- Operating Mine
- Pilbara Region

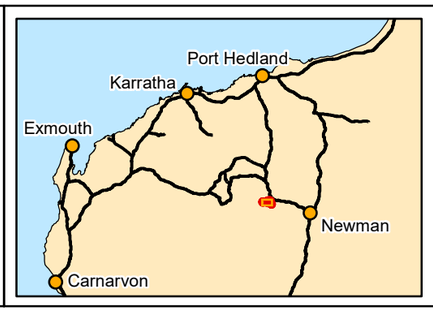
N

biologic Environmental Survey

Scale: 1:62,000

0 1 2 3 Km

Coordinate System: GDA2020 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA2020 Created 02/11/2022



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West Angelas Infrastructure Areas Reconnaissance and Targeted Flora and Vegetation Survey

Figure 1.1: Study Area and regional context

Background to Protection of Flora and Ecological Communities

Within Western Australia, native flora and ecological communities are protected under the BC Act and at a national level under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Any action that has the potential to impact on native flora or ecological communities needs to be approved by relevant state and/or federal departments as dictated by the state *Environmental Protection Act 1986* (EP Act) and the EPBC Act.

While all native flora and ecological communities are protected under these Acts, some species of flora and ecological communities that are determined to be at risk of extinction or decline are afforded extra protection under these Acts. These include species that are considered Threatened (Critically Endangered, Endangered and Vulnerable) under the EPBC Act and/or BC Act.

The EPBC Act identifies Threatened Ecological Communities (TECs) as ecological communities at risk of extinction. The BC Act provides for the statutory listing of TECs by the WA Minister for Environment (the Minister). The Minister has endorsed 69 ecological communities as Threatened under Critically Endangered (20), Endangered (17), Vulnerable (28) and Presumed Totally Destroyed (four).

Furthermore, any species or ecological communities that may be threatened but for which there is insufficient information available to allocate a threatened status under the BC Act, can also be listed as Priority species (Priority 1–4) or ecological communities (Priority 1-5) by the Western Australian Department of Biodiversity, Conservation and Attractions (DBCA).

For the purposes of this memo, these species are deemed to be significant species. A summary of applicable legislation and status codes is provided in Table 1.1.

Table 1.1: Significance assessment guidelines

Agreement, Act or List	Status Code
Federal	
Environment Protection and Biodiversity Conservation Act 1999 DAWE lists threatened flora, which are determined by the Threatened Species Scientific Committee (TSSC) according to criteria set out in the Act. The Act lists flora that are considered to be of conservation significance under one of eight categories (listed under 'Status Codes'). TECs are those that are at risk of extinction.	• Extinct (EX) • Extinct in the Wild (EW) • Critically Endangered (CE) • Endangered (EN) • Vulnerable (VU) • Conservation Dependent (CD) • Critically Endangered (CE) • Endangered (EN) • Vulnerable (VU)
State	
Biodiversity Conservation Act 2016 The BC Act provides for the listing of threatened native flora and ecological communities that need protection as critically endangered, endangered or vulnerable species or ecological communities because they are under identifiable threat of extinction (species) or collapsed (ecological communities).	• Schedule 1 (Critically Endangered) (S1 or CR) • Schedule 2 (Endangered) (S2 or EN) • Schedule 3 (Vulnerable) (S3 or VU) • Schedule 4 (Extinct) (S4 or EX)

Agreement, Act or List	Status Code
DBCA Priority list DBCA produces a list of Priority species and ecological communities (e.g., PECs) that have not been assigned statutory protection under the BC Act. This system gives a ranking from Priority 1 to Priority 4 for flora and Priority 1 to Priority 5 for ecological communities	• Priority 1 (P1) • Priority 2 (P2) • Priority 3 (P3) • Priority 4 (P4) • Priority 5 (PECs) (P5)

2. METHODS

2.1. Taxonomy and Nomenclature

Flora nomenclature used in this *memo* is consistent with the WAH's plant census, provided on Florabase© (WAH, 1998-). All species are current at the time of report preparation.

Plant taxa that could not be identified during the field survey were collected, assigned a unique number for tracking purposes, and pressed for subsequent identification. Identifications were carried out by Biologic's taxonomists, Mr Samuel Coultas and Dr Rachel Meissner, utilising Western Australian Herbarium's reference collection, taxonomic keys, and reference material. All taxa were checked against FloraBase© (WAH, 1998-) to ensure their currency and validity.

A representative specimen of all significant flora observed in the Survey Area was collected and submitted to the Rio Tinto sponsored botanist, Steve Dillon, for confirmation, in accordance with Rio Tinto's chain of custody requirements. The submitted specimens list and their confirmed identification is included in Appendix A.

2.2. Desktop Assessment

A desktop assessment was undertaken utilising information collated from the desktop assessment and field survey conducted by Biota (2020) for the broader West Angelas Beyond 2020 Development Envelope, which encompasses the Study Area. This assessment also reviewed aerial photography (Scale 1:30,000) of the Study Area and Google Earth Pro© imagery, along with data provided by Rio Tinto from their internal database (Rio Tinto, 2021b).

The desktop assessment was used to further refine sampling methods to ensure appropriate sampling was undertaken for all target species and to allow an accurate assessment of their occurrence or likelihood of occurrence within the Study Area.

2.3. Field Survey

Survey Timing and Personnel

The field survey was undertaken over three days on the 23rd to the 25th of February 2022 by Principal Botanist Clinton van den Bergh and Botanist Emma Marsh, whom collectively have over 18 years of experience undertaking flora surveys within the Pilbara region, including targeted surveys for the significant species that were the focus of this assessment (Table 2.1).

Table 2.1: Project Team and experience

Personnel	Position and Role	Qualification	Experience
Clinton van den Bergh	Principal Botanist • project management • field survey • reporting	BSc (Hons) Environmental Biology Post Graduate Diploma (Environmental Assessments Management)	• 16 years, experience field survey • 15 years' experience EIA (consulting) • 16 years' experience botanical • 15 years' Pilbara botanica/ field experience
Emma Marsh	Botanist • field survey • Identifications	BSc Biological Science & Conservation & Wildlife Biology (minor in Australian Indigenous Studies)	• 3 years' experience field survey • 2 years' experience EIA (consulting) • 3 years' experience botanical • 3 years' Pilbara botanical/ field experience

Climate and Weather

Observed weather conditions prior to and during the survey are shown in Figure 2.1, alongside long-term climatic data for Newman Airport (station #007176). In the 12 months prior to the survey (March 2021–February 2022), mean minimum and maximum temperatures recorded at Newman Airport were similar to the long-term averages for most months (Figure 2.1). Rainfall in the 12 months preceding the survey was variable, with below long-term averages recorded through most months, except for April 2021, which recorded well above the annual long-term average (56 mm v 21 mm), and November 2021 (14 mm v 12 mm) and February 2022 (73 mm v 72 mm), which had rainfall consistent with long-term averages Figure 2.1. In total, the rainfall received in the 12 months prior to the survey (March 2021 to February 2022; 191.60 mm) was well below the annual long-term average (324.4 mm) (BoM, 2021).

Observed minimum temperatures during the survey were similar to the long-term average, while maximum temperatures were slightly higher (Table 2.2) (BoM, 2021). No rainfall was recorded during the survey (Table 2.2); however, a total of 73.0 mm was recorded in the two weeks prior (BoM, 2021).

Table 2.2: Climatic conditions recorded for Newman Airport during the field survey

Date	Min. temp (°C)	Max. temp (°C)	Rainfall (mm)
23/02/2022	22.8	42.1	0
24/02/2022	24.2	42.2	0
25/02/2022	25.9	41.1	0
Average/ total	**24.3**	**41.8**	**0**

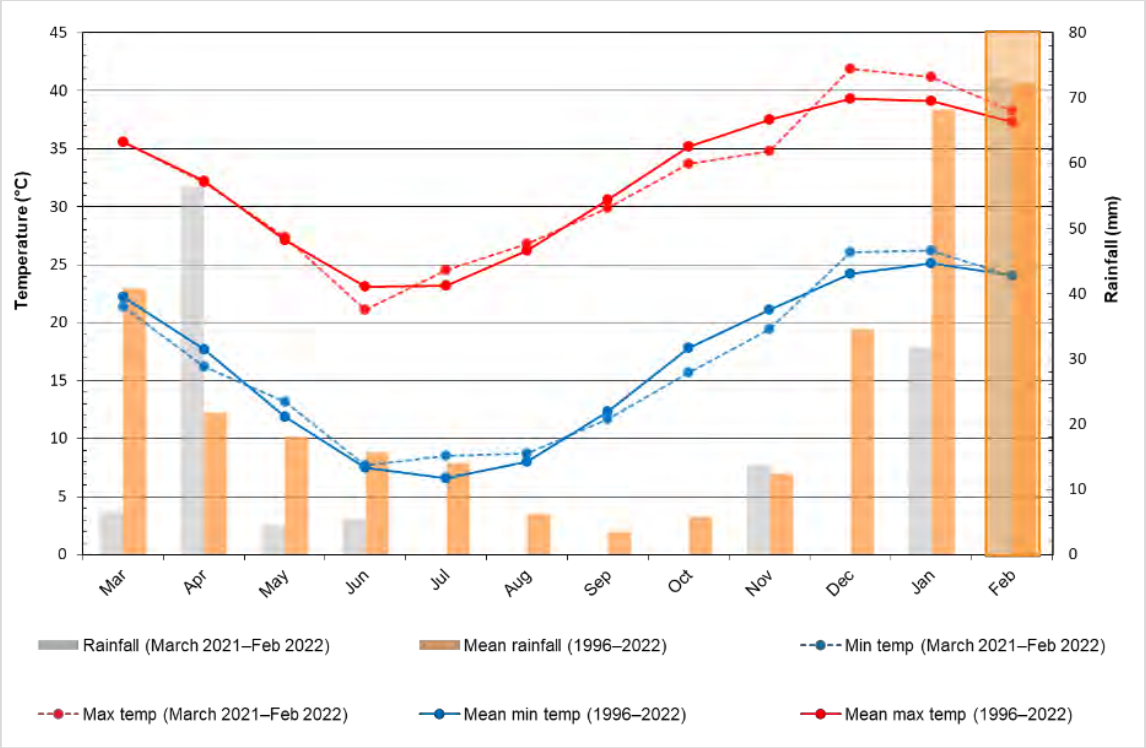

Figure 2.1: Monthly rainfall and long-term average rainfall for Newman Aero (Station ID 007176) (BoM, 2021) with approximate survey timing shown in shaded box

2.4. Sampling and Survey Methods

Reconnaissance Survey

Aerial photography (Scale 1:15,000) of the Survey Area and Google Earth Pro©, were used with previous vegetation mapping (Beard, 1975; Shepherd *et al.*, 2002)Biologic, 2021) to determine the mapped vegetation type boundaries prior to the field survey. Reconnaissance surveys are traditionally sampled at a low intensity via relevés (unmarked area within which data is collected; EPA, 2016a) and vegetation mapping points (unmarked area within which the vegetation unit and condition is broadly described).

Where practical, at least one sampling site (relevé) was established in each of the existing consolidated vegetation type (Figure 2.2), to ensure that each type occurring within the Study Area was captured by the survey and described appropriately in accordance with EPA (2016b)EPA (2016b) guidelines. Furthermore, the sample sites were compared against the existing consolidated mapping to determine if it was similar, or if a different vegetation type was warranted.

The entire Survey Area was accessible via vehicle and on foot, with all the major landforms and vegetation units traversed and sampled. A total of 55 relevé sites were sampled across the Study Area, while an additional 26 vegetation mapping points were also sampled (Figure 2.2). Dominant vascular flora taxa within each relevé were recorded. Taxa not yet recorded from the relevés or during site traverses, were also recorded to document a comprehensive species list for the Survey Area. A brief

summary of the condition and vegetation assemblage at each site was also recorded to aid in producing vegetation unit descriptions (NVIS Technical Working Group, 2017). In addition, the following information was recorded at each relevé:

- relevé number;
- date of survey;
- personnel;
- a central GPS coordinate (GDA 94);
- site photograph of the representative vegetation unit, generally facing south-east;
- soil characteristics (texture and colour);
- geology (type, size and nature of any rocks, stones, gravel, or outcropping);
- topography (landform type and aspect);
- vegetation condition;
- vegetation structure, including the dominant flora species in the three traditional strata, upper, mid, and lower;
- disturbance (if present);
- approximate time since last fire; and
- GPS coordinates for significant or introduced flora.

Flora taxa observed opportunistically in the vicinity of sample sites, or while traversing the Study Area, were also recorded. For any populations of taxa known to be of significance or introduced, a GPS location and a count of the individuals present, or percentage foliage cover for a given area, were recorded.

Targeted Searches

Prior to the survey, a list of significant flora known, highly likely, likely, or possible, to occur within the Study Area was compiled as part of the desktop assessment. Field personnel familiarised themselves with photographs, reference samples and descriptions of these taxa before conducting the survey. Once on the ground, personnel actively searched while traversing the Study Area focussing on habitat and features considered likely to support significant flora (i.e., hill summits, gorges, and drainage lines) (Figure 2.2).

Where significant flora taxa were located in the field, a GPS coordinate of the individual was taken, or if the species existed within a small population, a central coordinate with an approximate 20 m radius was used. For larger populations the extent was mapped using a GPS to record the spatial extent of the population. Generalised information was collected for each occurrence, including an estimate of the number of individuals, reproductive status, condition and broad vegetation community and condition.

Threatened and Priority Flora Report Forms will be provided to the Parks and Wildlife Division (Parks and Wildlife) of DBCA, as required under the flora collecting permits. Significant flora specimens will be vouchered with the Western Australian Herbarium (WAH), where required and appropriate.

652000 664000 676000 688000 700000

7452000 7440000 7428000

South Flank

Great Northern Hwy

West Angelas

Legend

- Study Area
- Operating Mine
- State Road
- Heritage site

Sampling Type

- Relevé
- Vegetation mapping note
- Traverse

N

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Scale: 1:150,000

0 4 8 Km

Coordinate System: GDA2020 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA2020 Created 02/11/2022

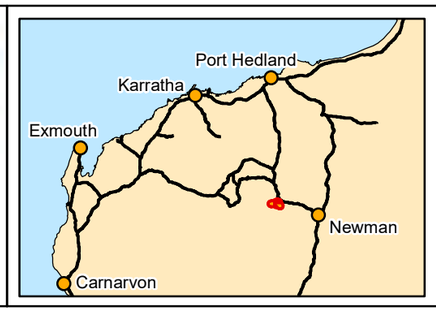

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Figure 2.2: Sample sites and traverses

The targeted searches also focused on significant environmental weeds (Weeds of National Significance and Declared Pests listed under Section 22 of the BAM Act). Any such weeds located in the Study Area had their locations noted and searches were conducted within a minimum radius of 20 m from the given specimen, to document the number of individual plants and map the spatial extent of the infestation.

2.5. Likelihood of Significant Flora Occurrence

The significant flora taxa identified from the database searches and literature review were assessed and ranked on the likelihood of occurring within the Study Area (Appendix B). The rankings were assigned using the following definitions presented in Table 2.3 and are intended to be an indicative guide only.

Table 2.3: Flora likelihood of occurrence decision matrix

Occurrence categories	Habitat categories (within the Study Area)			
	Core/ critical habitat present	Suitable habitat present/ within known distribution	Marginal habitat present/ adjacent to known distribution	No suitable habitat present/ outside of known distribution
Recorded in the Study Area	Confirmed	Confirmed	Confirmed	Confirmed
Recorded within <5 km	Highly Likely	Likely	Possible	Possible
Recorded within 5-15 km	Likely	Possible	Possible	Unlikely
Recorded within 15 - 50 km	Possible	Possible	Unlikely	Unlikely
Recorded >50 km	Possible	Unlikely	Unlikely	Highly Unlikely
Species considered locally/ regionally extinct	Unlikely	Unlikely	Highly Unlikely	Highly Unlikely

2.6. Limitations

No potential limitations which are expected to have significantly impacted the results of the survey and/or the determined likelihood of occurrence assessments for significant species within the Study Area, as outlined by EPA (2016b), were encountered during the survey.

Due to time constraints during the February 2022 field survey, DHI area was not surveyed. The DHI area was surveyed later in April/ May. The plant identifications for this component are nearing completion, so DHI has not been included in this memo.

In addition to the time constraints associated with DHI, time related constraints with the helicopter during the 24th and 25th of February meant that field survey days were a little shorter than usual, which resulted in less on-ground coverage. However, for the purposes of the reconnaissance survey, this reduced on-ground coverage is not considered to be a limitation to the survey.

3. RESULTS AND DISCUSSION

3.1 Desktop Assessment

A total of 48 significant vascular flora species were identified following a review of the desktop assessment completed for the West Angelas Beyond 2020 Detailed Flora and Vegetation Survey (Biota, 2020). Five significant flora taxa have previously been recorded within the Study Area according to data provided by Rio Tinto (Rio Tinto, 2021b) and DBCA (DBCA, 2021) (Figure 3.1):

- *Aristida lazaridis* (P2) – Western Hill;
- *Isotropis parviflora* (P2) – Western Hill;
- *Indigofera gilesii* (P3) – Deposit F;
- *Triodia* sp. Mt Ella (M.E. Trudgen 12739) (P3) – Deposit F; and
- *Acacia bromilowiana* (P4) – Deposit F.

The spatial data on significant flora held by Rio Tinto indicates that there is only one record each of *Aristida lazaridis* and *Isotropis parviflora* at WHI. There are two records of *Indigofera gilesii* at DFI, and only one record each for *Triodia* sp. Mt Ella (M.E. Trudgen 12739), and *Acacia bromilowiana* at DFI. The DBCA spatial data did not have any known records within the Study Area.

The flora taxa of significance identified by the desktop assessment were assessed and ranked on the likelihood of occurring within the Study Area. The full list is presented in Appendix B. The five taxa mentioned above have been previously recorded within the Study Area and are therefore considered confirmed. Of the remaining taxa, five are considered Highly Likely to occur, and seven Possible (Table 3.1). The remaining 31 taxa were considered Unlikely (three) or Highly Unlikely (28) to occur within the Study Area (Appendix B).

Table 3.1: Significant flora likelihood of assessment results (confirmed to possible)

Taxon	Description (WAH, 1998-)	Location
Confirmed		
Indigofera gilesii (P3)	Skeletal red-brown loam on rocky slopes, gorges, and creeklines.	Within Study Area
Triodia sp. Mt Ella (M.E. Trudgen 12739) (P3)	Light orange-brown to red-brown pebbly loam on hill slopes and in gullies.	Within Study Area
Aristida lazaridis (P2)	Major drainage areas through clayey flats.	Within Study Area
Isotropis parviflora (P2)	Undulating ironstone plains.	Within Study Area
Acacia bromilowiana (P4)	Skeletal loam soils on rocky hills, breakaways, scree slopes, gorges and rocky creek beds.	Within Study Area
Highly Likely		
Eremophila pusilliflora (P2)	Alluvial plains.	300 m north of WHI
Rhagodia sp. Hamersley (M. Trudgen 17794) (P3)	Mulga (Acacia aneura) and Snakewood (A. xiphophylla) vegetation on clay plains.	450 m east of WHI
Aristida jerichoensis var. *subspinulifera* (P3)	Hardpan clay plains.	250 m east of DFI

Taxon	Description (WAH, 1998-)	Location
Dolichocarpa sp. Hamersley Station (A.A. Mitchell PRP 1479) (P3)	Stony undulating clay plains.	4.8 km east of WHI
Themeda sp. Hamersley Station (M.E. Trudgen 11431) (P3)	Clay plains.	1 km east of WHI
Possible		
Euphorbia clementii (P3)	Gravelly hillsides, stony ground.	7 km west of DFI
Vittadinia sp. Coondewanna Flats (S. van Leeuwen 3835) (P3)	Mainly on red clay on plains, low in the landscape.	2.8 km east of DFI
Euphorbia stevenii (P3)	Clay soils.	3.5 km south-east of WHI
Rostellularia adscendens var. *latifolia* (P3)	Various; creeks, plains, low hills.	9 km south-east of WHI
Xerochrysum boreale (P3)	Loamy, sandy or gravelly soils on plains.	11 km north of WHI
Acacia effusa (P3)	Stony red loam; scree	7 km south-west of DFI
Swainsona thompsoniana (P3)	Creekline, claypan.	3.3 km south-east of WHI

610000
640000
670000
700000
730000
7470000
7440000
7410000
Juna Downs Rd
Packsaddle Rd
Junction Southeast
MAC-C
MAC-E
Hope Downs 1
South Flank
West Angelas Rd
Great Northern Hwy
Eagle Pool Rd

Legend

- Study Area
- Operating Mine
- Local Road
- State Road

N

biologic Environmental Survey

Scale: 1:400,000

0 10 20 Km

Coordinate System: GDA2020 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA2020 Created 02/11/2022

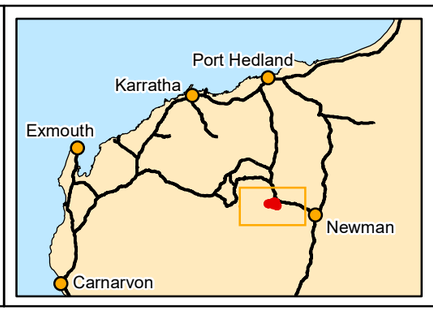

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Figure 3.1 Significant flora recorded in the desktop assessment

DBCA

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- *Thryptomene wittweri*

P1

- *Rhodanthe ascendens*
- *Triodia* sp. Karijini (S. van Leeuwen 4111)

P2

- *Aristida lazaridis*
- *Eragrostis* sp. Mt Robinson (S. van Leeuwen 4109)
- *Eremophila pusilliflora*
- *Eremophila* sp. West Angelas (S. van Leeuwen 4068)
- *Euphorbia inappendiculata* var. *queenslandica*
- *Hibiscus* sp. Gurinbiddy Range (M.E. Trudgen MET 15708)
- *Isotropis parviflora*
- *Oxalis* sp. Pilbara (M.E. Trudgen 12725)
- *Tetratheca fordiana*
- *Teucrium pilbaranum*

P3

- *Acacia daweana*
- *Acacia effusa*
- *Acacia subtiliformis*
- *Aristida jerichoensis* var. *subspinulifera*
- *Dampiera metallorum*
- *Eremophila magnifica* subsp. *velutina*
- *Eremophila rigida*
- *Euphorbia clementii*
- *Euphorbia stevenii*
- *Goodenia lyrata*
- *Goodenia* sp. East Pilbara (A.A. Mitchell PRP 727)
- *Grevillea saxicola*
- *Indigofera gilesii*
- *Olearia mucronata*
- *Pilbara trudgenii*
- *Rhagodia* sp. Hamersley (M. Trudgen 17794)
- *Rostellularia adscendens* var. *latifolia*
- *Sida* sp. Hamersley Range (K. Newbey 10692)
- *Solanum kentrocaule*
- *Stackhousia clementii*
- *Swainsona thompsoniana*
- *Themeda* sp. Hamersley Station (M.E. Trudgen 11431)
- *Triodia basitricha*
- *Triodia* sp. Mt Ella (M.E. Trudgen 12739)
- *Xerochrysum boreale*
- *Vittadinia* sp. Coondewanna Flats (S. van Leeuwen 4684)

P4

- *Acacia bromilowiana*
- *Eremophila magnifica* subsp. *magnifica*
- *Lepidium catapycnon*
- *Ptilotus mollis*
- *Sida* sp. Barlee Range (S. van Leeuwen 1642)

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P1

- *Hibiscus* sp. Mt Brockman (E. Thoma ET 1354)

P2

- *Aristida lazaridis*
- *Eremophila pusilliflora*
- *Hibiscus* sp. Gurinbiddy Range (M.E. Trudgen MET 15708)
- *Isotropis parviflora*
- *Oxalis* sp. Pilbara (M.E. Trudgen 12725)
- *Tetratheca fordiana*

P3

- *Acacia daweana*
- *Acacia effusa*
- *Acacia subtiliformis*
- *Aristida jerichoensis* var. *subspinulifera*
- *Dampiera metallorum*
- *Euphorbia clementii*
- *Geijera salicifolia*
- *Goodenia* sp. East Pilbara (A.A. Mitchell PRP 727)
- *Grevillea saxicola*
- *Indigofera gilesii*
- *Olearia mucronata*
- *Pilbara trudgenii*
- *Rhagodia* sp. Hamersley (M. Trudgen 17794)
- *Rostellularia adscendens* var. *latifolia*
- *Sida* sp. Hamersley Range (K. Newbey 10692)
- *Solanum kentrocaule*
- *Themeda* sp. Hamersley Station (M.E. Trudgen 11431)
- *Triodia* sp. Mt Ella (M.E. Trudgen 12739)
- *Vittadinia* sp. Coondewanna Flats (S. van Leeuwen 4684)

P4

- *Acacia bromilowiana*
- *Eremophila magnifica* subsp. *magnifica*
- *Lepidium catapycnon*
- *Ptilotus mollis*
- *Sida* sp. Barlee Range (S. van Leeuwen 1642)

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3.2. Field Survey

Flora Records

A total of 147 confirmed vascular flora taxa were recorded from the Study Area, including four introduced taxa, while the remaining 143 taxa are native (Appendix C). The 147 confirmed vascular flora taxa are from 33 families and 78 genera. The diversity of the Study Area is consistent with a survey of this size, intensity, adequacy and timing. Previous flora and vegetation surveys of the West Angelas Revised Proposed Development Envelope has recorded the majority of the expected flora species likely to occur in the Study Area.

Significant Flora

The targeted flora survey component of the field survey recorded a total of three significant flora taxa, all listed as Priority flora (Figure 3.2; Appendix A):

- *Eremophila pusilliflora* (P2);
- *Indigofera gilesii* (P3); and
- *Triodia* sp. Mt Ella (M.E. Trudgen 12739) (P3).

Eremophila pusilliflora (P2) (Plate 1) was recorded from one location within WHI (Figure 3.2), with only one individual observed. The immediate area was traversed to identify any additional individuals, however, none were observed. *Eremophila pusilliflora* has previously been recorded from the West Angelas Revised Proposal Development Envelope, with the nearest record known to the north, 375 m, of WHI (Figure 3.1).

Indigofera gilesii (P3) (Plate 2) and *Triodia* sp. Mt Ella (M.E. Trudgen 12739) (P3) (Plate 3) were both observed from DFI (Figure 3.2). *Indigofera gilesii* was recorded from one gully in the DFI area (Figure 3.2), with approximately 15 individuals from four-point locations up slope, and approximately 10 individuals from one point location towards the bottom of the gully. *Indigofera gilesii* has been recorded extensively across the West Angelas Revised Proposal Development Envelope (Figure 3.1).

The individuals of *Triodia* sp. Mt Ella (M.E. Trudgen 12739) recorded from the DFI area (Figure 3.2) increase the known extent of this species (Figure 3.1). Individuals generally occurred in minor gullies and flowlines in rocky substrate, with two locations occurring on top of the hill, above a rocky slope. Approximately 340 individuals of *Triodia* sp. Mt Ella (M.E. Trudgen 12739) were observed from 24-point locations within the DFI. An additional 45 individuals from two point locations were recorded immediately adjacent (<25 m) to the DFI boundary (Figure 3.1). *Triodia* sp. Mt Ella (M.E. Trudgen 12739) is known to occur extensively within the West Angelas Revised Proposal Development Envelope (Figure 3.1).

652000 664000 676000 688000 700000

7452000 7440000 7428000

South Flank

Great Northern Hwy

West Angelas

Legend

- Study Area
- Operating Mine
- State Road

Significant Species

- *Eremophila pusilliflora* - P2
- *Indigofera gilesii* - P3
- *Triodia* sp. Mt Ella (M.E. Trudgen 12739) - P3

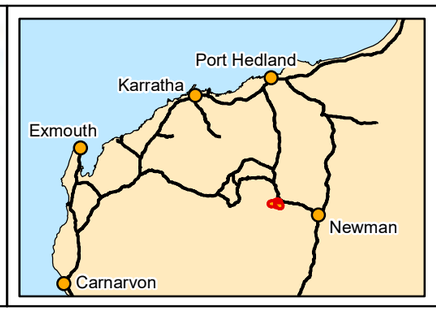
N

biologic Environmental Survey

Scale: 1:150,000

0 4 8 Km

Coordinate System: GDA2020 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA2020 Created 02/11/2022



RIO TINTO IRON ORE

West Angelas Infrastructure Areas Reconnaissance and Targeted Flora and Vegetation Survey

Figure 3.2: Significant flora recorded in the Study Area

Plate 1: *Eremophila pusilliflora* (P2) individual observed from the WHI (Biologic photos)

Plate 2: *Indigofera gilesii* (P3) recorded from DFI (left) and individuals observed from Deposit H and the West Angelas MAR (Biologic photos)

Plate 3: *Triodia* sp. Mt Ella (M.E. Trudgen 12739) (P3) recorded from DFI (left) and Mt Ella East (Biologic photos).

Post-survey Likelihood of Occurrence for previously Confirmed Taxa

Following the February 2022 field survey of WHI and DFI, the likelihood of occurrence for the previously confirmed taxa was revisited. Five Priority listed taxa were confirmed to occur within the Study Area prior to the field survey (Figure 3.1). Following the survey, three of the five taxa were not observed, *Aristida lazaridis* (P2), *Isotropis parviflora* (P2) and *Acacia bromilowiana* (P4).

The *Aristida lazaridis* and *Isotropis parviflora* records within WHI were visited to determine if they persist, and to assist in field identifications. Neither of the two Priority listed taxa were observed in

February 2022. Both species were recorded in 2018 by Biota (Biota, 2019), with *Aristida lazaridis* perennial and *Isotropis parviflora* a short-lived perennial, so there is the possibility that both species may have been identifiable at the time of the survey, if present. *I. parviflora* is a small sub-shrub and occurs more prolifically following fire, before being overtaken by other shrubs and hummock grasses. *I. parviflora* can be difficult to see due to its small stature and preference to occur in amongst grass clumps.

Aristida lazaridis is a perennial tussock grass with a distinct open panicle inflorescence and can be easily identified when flowering. No individuals were observed from WHI, suggesting it does not occur, or the GPS coordinates have a large error. The habitat where the known record is located was considered to be marginal habitat.

The previous *Acacia bromilowiana* record was visited during the survey. No individuals were observed from the location with the taxon being a large, perennial shrub so should have been identifiable if present. The *Acacia bromilowiana* location was recorded by Rio Tinto in 2014 during surveys for Deposit F (Rio Tinto, 2022). The habitat at the *A. bromilowiana* location was not considered to be the normal, suitable habitat (i.e., rocky hills, breakaways, scree slope, gorges; WAH (1998-)).

Introduced Flora

A total of four introduced flora taxa were recorded from the Study Area, with all four taxa recorded from WHI. The four taxa, **Bidens bipinnata, *Cenchrus ciliaris, *Malvastrum americanum,* and **Setaria verticillata* occurred in association with the drainage lines and floodplains of WHI. The four introduced taxa have previously been recorded from the West Angelas Revised Proposal Development Envelope.

Vegetation Types

The Study Area occurs within the consolidated vegetation mapping context area (Biologic, 2021), however, actual on-ground survey work is dated. As such, the vegetation of the Study Area was assessed via the sampling of relevés and vegetation mapping points to determine if the vegetation is consistent with the consolidated mapping, or if amendments are required. Prior to the field survey, the Study Area supported the following vegetation types based on the consolidated mapping (Biologic, 2021):

Western Hill Infrastructure:

- D2: EvAcTErTHtTp - *Eucalyptus victrix* low open woodland *Acacia citrinoviridis* tall open shrubland over *Tephrosia rosea* var. Fortescue Creeks (M.I.H. Brooker 2186) scattered low shrubs *Themeda triandra* very open tussock grassland over *Triodia pungens* scattered hummock grasses to very open hummock grassland.
- D6: ChCdAanPlTp - *Corymbia hamersleyana* and/or *Corymbia deserticola* subsp. *deserticola* low open woodland *Acacia 'aneura'*, *Petalostylis labicheoides* tall open shrubland *Triodia pungens* open hummock grassland.

- H8: ElCdApTvTp - *Eucalyptus leucophloia* subsp. *leucophloia* and/or *Corymbia deserticola* subsp. *deserticola* low open woodland *Acacia pruinocarpa* scattered tall shrubs *Triodia vanleeuwenii* and/or *T. pungens* open hummock grassland.
- M1: AanApTp/AanAcaApERfoTp - *Acacia 'aneura'*, *Acacia pruinocarpa* low open woodland/*Acacia 'aneura'*, *A. catenulata* subsp. *occidentalis* and/or *Acacia pruinocarpa* low woodland to low open forest - / *Eremophila forrestii* subsp. *forrestii* open shrubland *Triodia pungens* open hummock grassland/*Triodia pungens* very open hummock grassland.

Deposit F Infrastructure:

- D7: ChAmoTHtTp - *Corymbia hamersleyana* low open woodland *Acacia monticola* tall shrubland *Themeda triandra* very open tussock grassland over *Triodia pungens* very open hummock grassland.
- H7: ElAmTvTp - *Eucalyptus leucophloia* subsp. *leucophloia* scattered low trees *Acacia maitlandii* scattered shrubs *Triodia vanleeuwenii*, *T. pungens* open hummock grassland.
- H9: ElCdEgTv - *Eucalyptus leucophloia* subsp. *leucophloia* and/or *Corymbia deserticola* subsp. *deserticola* low open woodland over *E. gamophylla* low open mallee woodland *Triodia vanleeuwenii* open hummock grassland.

Following the review of the on-ground floristic assemblage and vegetation type determination, the vegetation type mapping for the Study Area was altered. Following further consolidated vegetation mapping work for the Turee Creek, the vegetation types of WHI were further altered (Table 3.2 and Figure 3.3). The vegetation types within the WHI area expanded to include five vegetation types, with the splitting of vegetation type D2, resulting in the creation of a new vegetation type, D14 (Table 3.2).

The consolidated vegetation mapping for DFI was consistent with the on-ground observations, with some minor amendments to boundaries between vegetation types (Table 3.2). The amended vegetation type mapping does not take into consideration all the new and historic disturbance layers. For example, some new disturbance has been mapped within the WHI area, while other areas have not been digitised.

Table 3.2: Vegetation types recorded from the Study Area

Location	Code	Description	Photo (from the Study Area)
Western Hill Infrastructure	D2 EvAcTErTHtTp	*Eucalyptus victrix* low open woodland *Acacia citrinoviridis* tall open shrubland over *Tephrosia rosea* var. Fortescue Creeks (M.I.H. Brooker 2186) scattered low shrubs *Themeda triandra* very open tussock grassland over *Triodia pungens* scattered hummock grasses to very open hummock grassland	
	D6 ChCdAanPlTp	*Corymbia hamersleyana* and/or *Corymbia deserticola* subsp. *deserticola* low open woodland over *Acacia 'aneura', Petalostylis labicheoides* tall open shrubland over *Triodia pungens* open hummock grassland	
	D14 AcAapApyPlTpTHtEENlCYa	*Acacia citrinoviridis, A. aptaneura* isolated trees/low open woodland/woodland over *A. pyrifolia* var. *pyrifolia, Petalostylis labicheoides* tall sparse to tall open shrubland over *Indigofera georgei, Ptilotus obovatus, Solanum lasiophyllum* low isolated to low open shrubland over *Triodia pungens* sparse to open hummock grassland over *Themeda triandra, Enneapogon lindleyanus*, *Cymbopogon ambiguus* sparse to open tussock grassland	

Location	Code	Description	Photo (from the Study Area)
	H8 ElCdApTvTp	*Eucalyptus leucophloia* subsp. *leucophloia* and/or *Corymbia deserticola* subsp. *deserticola* low open woodland *Acacia pruinocarpa* scattered tall shrubs *Triodia vanleeuwenii* and/or *T. pungens* open hummock grassland	
	M1 AanApTp/ AanAcaApERfoTp	*Acacia 'aneura'*, *Acacia pruinocarpa* low open woodland/*Acacia 'aneura'*, *A. catenulata* subsp. *occidentalis* and/or *Acacia pruinocarpa* low woodland to low open forest - / *Eremophila forrestii* subsp. *forrestii* open shrubland *Triodia pungens* open hummock grassland/*Triodia pungens* very open hummock grassland	
Deposit F Infrastructure	D7 ChAmoTHtTp	*Corymbia hamersleyana* low open woodland *Acacia monticola* tall shrubland *Themeda triandra* very open tussock grassland over *Triodia pungens* very open hummock grassland.	

Location	Code	Description	Photo (from the Study Area)
	H7 ElAmTvTp	*Eucalyptus leucophloia* subsp. *leucophloia* scattered low trees *Acacia maitlandii* scattered shrubs *Triodia vanleeuwenii*, *T. pungens* open hummock grassland	
	H9 ElCdEgTv	*Eucalyptus leucophloia* subsp. *leucophloia* and/or *Corymbia deserticola* subsp. *deserticola* low open woodland over *E. gamophylla* low open mallee woodland *Triodia vanleeuwenii* open hummock grassland	

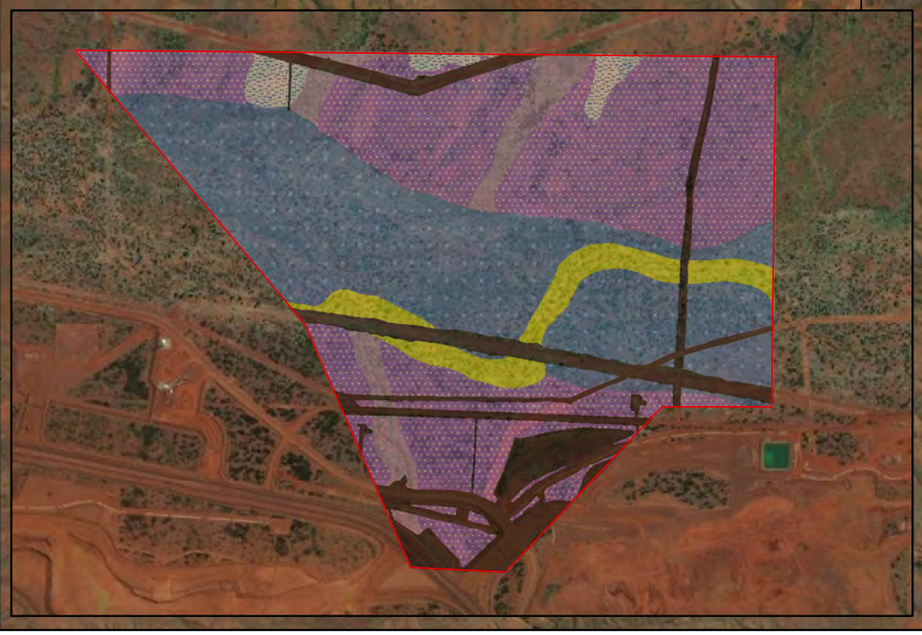
652000 664000 676000 688000 700000

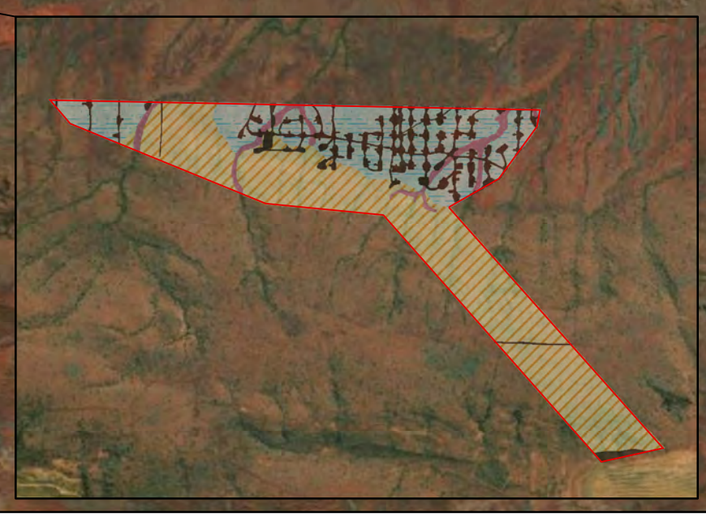
7452000 7440000 7428000

South Flank

Great Northern Hwy

West Angelas





Legend

- Study
- Operating Mine
- State Road

Vegetation Type

- D2
- D6
- D7
- D14
- H7
- H8
- H9
- M1
- Disturbed

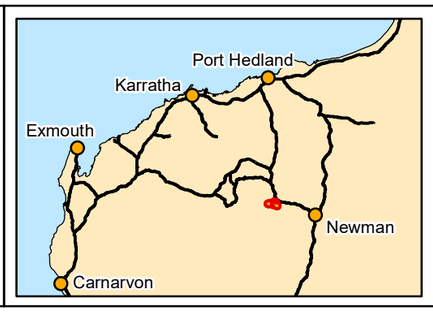
N

biologic Environmental Survey

Scale: 1:150,000

0 4 8 Km

Coordinate System: GDA2020 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA2020 Created 02/11/2022



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West Angelas Infrastructure Areas Reconnaissance and Targeted Flora and Vegetation Survey

Figure 3.3: Vegetation Types in the Study Area

Significant Vegetation

The vegetation mapped within the Study Area did not represent any known TECs or PECs from within and adjacent to the West Angelas Revised Proposal Development Envelope. The D2 vegetation type supported *Eucalyptus victrix* which may access groundwater at times during the year. As such, the D2 vegetation type may be considered a groundwater dependent vegetation (GDV) community, although, on the lower end of the spectrum as individuals of *Eucalyptus victrix* were scattered in the Study Area.

Vegetation types D14, D7 and H7 have a low level of significance for supporting populations of Priority listed taxa. *Eremophila pusilliflora* (P2) was recorded from vegetation type D14, while *Indigofera gilesii* (P3) and *Triodia* sp. Mt Ella (M.E. Trudgen 12739) (P3) were recorded from vegetation types D7 and H7 at DFI. The Priority listed taxa are not solely reliant on these vegetation types, hence the low level of significance. Furthermore, according to the consolidated vegetation mapping, these vegetation types are fairly extensive within the West Angelas Revised Proposal Development Envelope (Biologic, 2021)

Vegetation Condition

The condition of the vegetation within the Study Area is Poor to Excellent based on the condition rating scale developed by Trudgen (1988) and presented in EPA (2016b). The majority of the Study Area was Very Good to Excellent with drainage and floodplain areas returning a lower vegetation condition rating, Poor to Good.

The WHI area ranged from Poor to Excellent, with the drainage line and floodplains in a Poor to Very Good condition, while the stony plains and northern sections of the Study Area were in a Very Good to Excellent condition. The expansion of the adjacent mine has resulted in the clearing of some native vegetation, with this area considered to be Completely Degraded, along with some heavily dust impacted vegetation along the clearing boundary. The DFI area was generally Very Good or Excellent throughout.

Disturbances within the Study Area included mine site expansion, exploration drilling, weed presence and density and fires that had passed through the area within the last five or so years. In general, these disturbances did not alter the vegetation substantially, warranting lower condition ratings, except along drainage lines and near new cleared areas. Weeds and negative dust impacts were more prevalent in these locations.

4. SUMMARY

Three Priority listed flora taxa were recorded from the Study Area, including *Eremophila pusilliflora* (P2), *Indigofera gilesii* (P3), and *Triodia* sp. Mt Ella (M.E. Trudgen 12739) (P3). The three Priority listed taxa are known from the West Angelas Revised Proposal Development Envelope. The vegetation type mapping of the Study Area was amended from the original consolidated mapping to reflect the on-ground results. The vegetation within the Study Area is not considered to be significant with respect to the BC Act or the EPBC Act. Four vegetation types, D2, D14, D7 and H7, have a low level of significance for supporting Priority listed taxa, and potential GDV. The remaining four vegetation types have a negligible significance rating.

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Appendix A: Rio Tinto Sponsored Botanist Chain of Custody

RioTinto

Chain of Custody: Significant Specimens to Herbarium

Company	Biologic Environmental Survey	**Date Collections Submitted to RTIO Sponsored Botanist**	05/04/2022
Consultant Contact Name	Carmel Winton	**Consultant Contact Number**	08 6365 5066
Rio Tinto Contact Name	Hayden Ajduk, Anthea Jones	**Rio Tinto Contact Number**	_____
Study Area	West Angelas - Mt Ella, Dep J & Dep G	**RTIO AR Number**	_____
Senders Internal Job Name / Number	21082 RTIO Mt Ella, Dep J & Dep G Flora & Fauna	**Number of Collections Submitted**	7
Collections From (Named location and distance & direction to nearest town)	In deposits within the West Angelas mining lease		
Datum & Zone of Study Area	_____		
Central GPS Co-ords of study area	-23.179868°, 118.773998°	**Dates of Field Survey**	21-25 Feb 2022
RTIO Required Date (RTIO to inform)	____ / _____ / _____		

RioTinto

Chain of Custody: Significant Specimens to Herbarium

Collection Number	Consultant ID	Cons Status	Easting / Latitude	Northing / Longitude	Plant Habit	Habitat	Consultant Comment	Photos (if applic)	Steve Dillon ID	Steve Dillon Comment
WAE-17	*Seringia exastia*	T	-23.14086702	118.6415554	Shrub	Rocky hills				
EM-opp06	*Triodia* sp. Mt Ella (M.E. Trudgen 12739)	P3	-23.18687066	118.8572386	Hummock Grass	Steep sides of gully			*Triodia* sp. Mt Ella (M.E. Trudgen 12739)	P3.
CV-opp08	*Triodia* sp. Mt Ella (M.E. Trudgen 12739)	P3	-23.184307	118.8543552	Hummock Grass	Rocky hill			*Triodia* sp. Mt Ella (M.E. Trudgen 12739)	P3.
CVopp06	*Eremophila pusilliflora*	P2	-23.1417421	118.6605483	Shrub	Stony plain			*Eremophila pusilliflora*	P2.
CVopp.01	*Themeda* ? sp. Hamersley Station (M.E. Trudgen 11431)	?P3	-23.1413681	118.7162632	Tussock grass	Drainage area/floodplain	Tall, robust and blue suggesting *T.* sp. Hamersley Station. However, characters well within the described range of *T. triandra*		*Themeda triandra*	
WAE10-02	Malvaceae sp.		-23.1421678	118.6671979	Shrub	Drainage area/floodplain	Immature leaves and old fruits throwing me off		*Abutilon amplum* (fruit only); GOK (rest of plant)	The fruit is definitely *Abutilon amplum*, the rest of the plant definitely isn't. The lack of glandular hairs suggests it's not an *Abutilon* – I'm leaning towards *Sida.* Material is sterile so haven't been able to take it any further (I tried, probably spent way more time than I should have).
Cvopp10	*Indigofera fractiflexa* subsp. *fractiflexa*		-23.1815203	118.8517694	Shrub	Rocky gully of hill	Nuytsia key a bit difficult when it gets to the hairiness step. Matches fractiflexa subsp. fractiflexa specimen best		*Indigofera gilesii*	P3. Has stipules that are relatively large with a broad, persistent base; stems not "zig-zag"; indumentum, especially on the leaflets, denser than typical *I. fractiflexa*. The stipules are probably the most reliable of those three characters.

RioTinto

Chain of Custody: Significant Specimens to Herbarium (Indicate Study Area Location)

Appendix B: Western Hill and Deposit F Infrastructure Areas Flora Likelihood of Occurrence

Species	Conservation Status			Habitat	Likelihood of Occurrence		Comments
	EPBC Act	BC Act	DBCA		Pre-Survey	Post-Survey	
Eremophila pusilliflora			P2	Alluvial plains.	Highly Likely	Confirmed	One individual recorded from WHI during the field survey
Indigofera gilesii			P3	Skeletal red-brown loam on rocky slopes, gorges, and creeklines.	Confirmed	Confirmed	Confirmed within DFI
Triodia sp. Mt Ella (M.E. Trudgen 12739)			P3	Light orange-brown to red-brown pebbly loam on hill slopes and in gullies.	Confirmed	Confirmed	Confirmed within DFI
Aristida lazaridis			P2	Major drainage areas through clayey flats.	Confirmed	Possible	A confirmed record within WHI, but was not found during the field survey. Suitable habitat present, while individuals may have been missed
Isotropis parviflora			P2	Undulating ironstone plains.	Confirmed	Possible	A confirmed record within WHI, while numerous records to the north. The known record was searched with no individuals found. There is the possibility individuals were missed.
Euphorbia clementii			P3	Gravelly hillsides, stony ground.	Possible	Possible	Suitable habitat present in DFI, however, no individuals were observed, but the possibility that individuals were missed.
Rhagodia sp. Hamersley (M. Trudgen 17794)			P3	Mulga (*Acacia aneura*) and Snakewood (*A. xiphophylla*) vegetation on clay plains.	Highly Likely	Possible	Known individuals within 1 km of WHI. No individuals recorded, but there is the possibility that individuals do occur and they were just missed
Vittadinia sp. Coondewanna Flats (S. van Leeuwen 3835)			P3	Mainly on red clay on plains, low in the landscape.	Possible	Unlikely	Suitable habitat is not present within the Study Area
Aristida jerichoensis var. *subspinulifera*			P3	Hardpan clay plains.	Highly Likely	Unlikely	Marginal habitat present within WHI, although unlikely to occur following the field survey

Species	Conservation Status			Habitat	Likelihood of Occurrence		Comments
	EPBC Act	BC Act	DBCA		Pre-Survey	Post-Survey	
Dolichocarpa sp. Hamersley Station (A.A. Mitchell PRP 1479)			P3	Stony undulating clay plains.	Highly Likely	Unlikely	Although suitable habitat may be present, it is unlikely that any individuals occur following the field survey
Euphorbia stevenii			P3	Clay soils.	Possible	Unlikely	Suitable habitat is not present within the Study Area
Rostellularia adscendens var. *latifolia*			P3	Various; creeks, plains, low hills.	Possible	Unlikely	Marginal habitat present within D2 vegetation type, however no individuals were recorded.
Themeda sp. Hamersley Station (M.E. Trudgen 11431)			P3	Clay plains.	Highly Likely	Unlikely	Suitable habitat is not present within the Study Area
Xerochrysum boreale			P3	Loamy, sandy or gravelly soils on plains.	Possible	Unlikely	Marginal habitat is present, however, the nearest known record is greater than 10 km to the north. The field survey did not identify any individuals
Acacia bromilowiana			P4	Skeletal loam soils on rocky hills, breakaways, scree slopes, gorges and rocky creek beds.	Confirmed	Unlikely	A known record from DFI was visited, with no individuals observed. Unlikely that any individuals occur based on knowledge of the taxon and the habitats present in the Study Area
Eragrostis sp. Mt Robinson (S. van Leeuwen 4109)			P2	Red-brown skeletal soils, ironstone; steep slopes, summits of tall hills.	Highly unlikely	Highly unlikely	Poorly understood and currently only known from Mt Robinson
Eremophila sp. West Angelas (S. van Leeuwen 4068)			P2	Skeletal red-brown soil on hill summits high in the landscape.	Highly unlikely	Highly unlikely	Restricted to steep gorges and gullies, summits and high in the landscape. Suitable habitat not present in the Study Area
Euphorbia inappendiculata var. *queenslandica*			P2	Heavy clay soils on open plains and gentle slopes.	Highly unlikely	Highly unlikely	No suitable habitat present within the Study Area

Species	Conservation Status			Habitat	Likelihood of Occurrence		Comments
	EPBC Act	BC Act	DBCA		Pre-Survey	Post-Survey	
Hibiscus sp. Mt Brockman (E. Thoma ET 1354)			P1	Gorges, rocky areas.	Highly unlikely	Highly unlikely	Restricted to steep gorges and gullies, summits and high in the landscape. Suitable habitat not present in the Study Area
Rhodanthe ascendens			P1	Cracking clay.	Highly unlikely	Highly unlikely	No suitable habitat present within the Study Area
Triodia sp. Karijini (S. van Leeuwen 4111)			P1	Skeletal dark orange-brown to red-brown soil on upper slopes and summits of mountains.	Highly unlikely	Highly unlikely	Restricted to steep gorges and gullies, summits and high in the landscape. Suitable habitat not present in the Study Area
Hibiscus sp. Gurinbiddy Range (M.E. Trudgen MET 15708)			P2	Hilltops, upper hillslopes.	Highly unlikely	Highly unlikely	Restricted to steep gorges and gullies, summits and high in the landscape. Suitable habitat not present in the Study Area
Oxalis sp. Pilbara (M.E. Trudgen 12725)			P2	Red-brown loam on rocky hillslopes and in gorges.	Highly unlikely	Highly unlikely	Restricted to breakaways, gullies, gorges and shaded areas. No suitable habitat present in the Study Area
Tetratheca fordiana			P2	Shale pockets amongst ironstone on free rock faces.	Highly unlikely	Highly unlikely	Restricted to steep gorges and gullies, summits and high in the landscape. Suitable habitat not present in the Study Area
Teucrium pilbaranum			P2	Crab hole floodplains; margins of calcrete tables.	Highly unlikely	Highly unlikely	No suitable habitat is present in the Study Area
Acacia daweana			P3	Stony red loamy soils on low rocky rises and along drainage lines.	Unlikely	Highly unlikely	Suitable habitat present, however, it would have been easily identifiable during the survey, and was not observed. Furthermore, nearest known record is further to the south
Acacia effusa			P3	Stony red loam; scree	Possible	Highly unlikely	Suitable habitat present, however, it would have been easily identifiable during the survey, and was not observed

Species	Conservation Status			Habitat	Likelihood of Occurrence		Comments
	EPBC Act	BC Act	DBCA		Pre-Survey	Post-Survey	
Acacia subtiliformis			P3	Calcrete platforms.	Unlikely	Highly unlikely	No suitable habitat (calcrete) is present within the Study Area
Dampiera metallorum			P3	Skeletal red-brown gravelly soil over banded ironstone; steep slopes and hill summits at high elevation.	Highly unlikely	Highly unlikely	Restricted to steep slopes, summits and high in the landscape. Suitable habitat not present in the Study Area
Eremophila magnifica subsp. velutina			P3	Skeletal soils over ironstone on summits and breakaways.	Highly unlikely	Highly unlikely	Restricted to upper hillslopes, breakaways, gullies and rock outcropping. Marginal habitat present in DFI, with no individuals recorded
Eremophila naaykensii			P3	Skeletal red-brown silty loam on hill crests, cliff tops, gorges.	Highly unlikely	Highly unlikely	Restricted to upper hillslopes, breakaways, gullies and rock outcropping. Marginal habitat present in DFI, with no individuals recorded
Eremophila rigida			P3	Red sand alluvium. Hardpan plains and stony clay depressions.	Highly unlikely	Highly unlikely	Mostly occurs within the Gascoyne bioregion
Geijera salicifolia			P3	Skeletal and stony soils in massive rock scree, rockpiles and gorges.	Highly unlikely	Highly unlikely	Mostly restricted massive rock screes, rockpiles and gorges. No suitable habitat is present within the Study Area
Goodenia lyrata			P3	Near claypans.	Unlikely	Highly unlikely	No suitable habitat present within the Study Area
Goodenia sp. East Pilbara (A.A. Mitchell PRP 727)			P3	Red-brown clay soil, typically on calcrete platforms.	Highly unlikely	Highly unlikely	No suitable habitat (calcrete) is present within the Study Area
Grevillea saxicola			P3	Upper scree slopes on banded ironstone, usually with Mulga.	Highly unlikely	Highly unlikely	Restricted to upper hillslopes, breakaways, gullies and rock outcropping. Marginal habitat present in DFI, with no individuals recorded

Species	Conservation Status			Habitat	Likelihood of Occurrence		Comments
	EPBC Act	BC Act	DBCA		Pre-Survey	Post-Survey	
Olearia mucronata			P3	Hills and rocky drainage channels.	Highly unlikely	Highly unlikely	Restricted to upper hillslopes, breakaways, gullies and rock outcropping. Marginal habitat present in DFI, with no individuals recorded
Pilbara trudgenii			P3	Skeletal red stony soil over ironstone; hill summits, steep slopes, screes, cliff faces.	Highly unlikely	Highly unlikely	Restricted to upper hillslopes, breakaways, gullies and rock outcropping. Marginal habitat present in DFI, with no individuals recorded
Sida sp. Barlee Range (S. van Leeuwen 1642)			P4	Steep slopes, rocky gullies and breakaways.	Highly unlikely	Highly unlikely	Restricted to upper hillslopes, breakaways, gullies and rock outcropping. Marginal habitat present in DFI, with no individuals recorded
Sida sp. Hamersley Range (K. Newbey 10692)			P3	Base of rocky cliff habitats in red skeletal stony soils or ironstone.	Highly unlikely	Highly unlikely	Restricted to upper hillslopes, breakaways, gullies and rock outcropping. Marginal habitat present in DFI, with no individuals recorded
Solanum kentrocaule			P3	Hillsides and mountain crests, creek beds; skeletal red-brown soil over ironstone on basalt or scree.	Highly unlikely	Highly unlikely	Restricted to upper hillslopes, breakaways, gullies and rock outcropping. Marginal habitat present in DFI, with no individuals recorded
Stackhousia clementii			P3	Skeletal soils, sandstone hills.	Highly unlikely	Highly unlikely	Marginal habitat present within DFI, however no known records in close proximity
Swainsona thompsoniana			P3	Creekline, claypan.	Possible	Highly unlikely	Marginal habitat presnet, with no individuals recorded. Highly unlikely to occur with WHI or DFI

Species	Conservation Status			Habitat	Likelihood of Occurrence		Comments
	EPBC Act	BC Act	DBCA		Pre-Survey	Post-Survey	
Triodia basitricha			P3	Slopes or crests of rocky hills.	Highly unlikely	Highly unlikely	Restricted to upper hillslopes, breakaways, gullies and rock outcropping. Marginal habitat present in DFI, with no individuals recorded
Eremophila magnifica subsp. *magnifica*			P4	Rocky hillslopes, breakaways.	Highly unlikely	Highly unlikely	Restricted to upper hillslopes, breakaways, gullies and rock outcropping. Marginal habitat present in DFI, with no individuals recorded
Lepidium catapycnon			P4	Skeletal soils on hill slopes.	Highly unlikely	Highly unlikely	Marginal habitat present in DFI, however no individuals were recorded
Ptilotus mollis			P4	Stony hills and screes.	Highly unlikely	Highly unlikely	Restricted to upper hillslopes, breakaways, gullies and rock outcropping. Marginal habitat present in DFI, with no individuals recorded
Thryptomene wittweri	VU	VU		Breakaways and stony creek beds on high mountains (>1,000 m in elevation).	Highly unlikely	Highly unlikely	Restricted to Mt Meharry in the Pilbara

Appendix C: Flora Recorded from the Study Area

Acanthaceae

Dipteracanthus australasicus subsp. *australasicus*

Amaranthaceae

Alternanthera nana

Ptilotus calostachyus

Ptilotus exaltatus

Ptilotus obovatus

Ptilotus rotundifolius

Apocynaceae

Leichhardtia australis

Vincetoxicum lineare

Asteraceae

**Bidens bipinnata*

Chrysocephalum gilesii

Pterocaulon sphacelatum

Boraginaceae

Halgania gustafsenii

Halgania gustafsenii var. *gustafsenii*

Heliotropium chrysocarpum

Heliotropium crispatum

Heliotropium ovalifolium

Trichodesma zeylanicum var. *zeylanicum*

Capparaceae

Capparis lasiantha

Caryophyllaceae

Polycarpaea longiflora

Chenopodiaceae

Maireana villosa

Maireana sp. indet

Rhagodia eremaea

Salsola australis

Cleomaceae

Arivela viscosa

Convolvulaceae

Duperreya commixta

Evolvulus alsinoides var. *decumbens*

Cucurbitaceae

Cucumis variabilis

Cyperaceae

Fimbristylis simulans

Fabaceae

Acacia adoxa var. *adoxa*
Acacia aneura
Acacia aptaneura
Acacia bivenosa
Acacia catenulata subsp. *occidentalis*
Acacia citrinoviridis
Acacia colei
Acacia dictyophleba
Acacia hamersleyensis
Acacia inaequilatera
Acacia maitlandii
Acacia marramamba
Acacia monticola
Acacia pachyacra
Acacia pruinocarpa
Acacia pteraneura
Acacia pyrifolia var. *pyrifolia*
Acacia rhodophloia
Acacia sibirica
Acacia steedmanii subsp. *borealis*
Acacia tetragonophylla
Gastrolobium grandiflorum
Glycine canescens
Gompholobium oreophilum
Indigofera fractiflexa subsp. *fractiflexa*
Indigofera georgei
Indigofera gilesii (Priority 3)
Indigofera monophylla
Isotropis iophyta
Petalostylis labicheoides
Rhynchosia minima
Senna artemisioides subsp. *filifolia*
Senna artemisioides subsp. *helmsii*
Senna artemisioides subsp. *oligophylla*
Senna glutinosa subsp. ×*luerssenii*
Senna glutinosa subsp. *glutinosa*

Fabaceae (cont'd)

Senna glutinosa subsp. *pruinosa*

Senna symonii

Senna venusta

Tephrosia rosea var. Fortescue creeks (M.I.H. Brooker 2186)

Goodeniaceae

Goodenia lamprosperma

Goodenia stobbsiana

Scaevola amblyanthera

Gyrostemonaceae

Codonocarpus cotinifolius

Lauraceae

Cassytha capillaris

Malvaceae

Abutilon amplum

Abutilon lepidum

Abutilon sp. Dioicum (A.A. Mitchell PRP 1618)

Androcalva luteiflora

Corchorus lasiocarpus

Corchorus tridens

Gossypium robinsonii

Hibiscus burtonii

Hibiscus coatesii

Hibiscus sturtii

Hibiscus sturtii var. *campylochlamys*

**Malvastrum americanum*

Seringia exastia

Sida fibulifera

Sida sp. Golden calyces glabrous (H.N. Foote 32)

Sida sp. Pilbara (A.A. Mitchell PRP 1543)

Marsileaceae

Marsilea hirsuta

Moraceae

Ficus platypoda

Myrtaceae

Corymbia candida

Corymbia deserticola subsp. *deserticola*

Corymbia ferriticola

Corymbia hamersleyana

Myrtaceae (cont'd)

Eucalyptus gamophylla

Eucalyptus leucophloia subsp. *leucophloia*

Eucalyptus victrix

Nyctaginaceae

Boerhavia coccinea

Oleaceae

Jasminum didymum subsp. *lineare*

Phyllanthaceae

Notoleptopus decaisnei

Nellica maderaspatensis

Poaceae

Aristida contorta

Aristida holathera var. *holathera*

Aristida inaequiglumis

Bothriochloa ewartiana

**Cenchrus ciliaris*

Chrysopogon fallax

Cymbopogon ambiguus

Enneapogon caerulescens

Enneapogon lindleyanus

Enneapogon polyphyllus

Eragrostis tenellula

Eriachne lanata

Eriachne mucronata

Eriachne pulchella

Eulalia aurea

Panicum laevinode

Paraneurachne muelleri

Paspalidium rarum

**Setaria verticillata*

Themeda sp. Mt Barricade (M.E. Trudgen 2471)

Themeda triandra

Triodia longiceps

Triodia pungens

Triodia sp. Mt Ella (M.E. Trudgen 12739) (Priority 3)

Triodia vanleeuwenii

Triodia wiseana

Proteaceae

Grevillea wickhamii subsp. *hispidula*

Hakea lorea subsp. *lorea*

Pteridaceae

Cheilanthes sieberi subsp. *sieberi*

Rubiaceae

Psydrax suaveolens

Santalaceae

Exocarpos sparteus

Santalum lanceolatum

Sapindaceae

Atalaya hemiglauca

Dodonaea coriacea

Dodonaea lanceolata

Scrophulariaceae

Eremophila forrestii subsp. *forrestii*

Eremophila jucunda subsp. *pulcherrima*

Eremophila lachnocalyx

Eremophila latrobei subsp. *latrobei*

Eremophila longifolia

Eremophila pusilliflora (Priority 2)

Solanaceae

Solanum gabrielae

Solanum lasiophyllum

Solanum piceum

Violaceae

Afrohybanthus aurantiacus

Zygophyllaceae

Tribulus suberosus

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D.1: West Angelas Beyond 2020 Infrastructure Corridors Reconnaissance and Targeted Survey

b. Deposit H Infrastructure Areas

Biologic Environmental Survey Pty Ltd
PO Box 179
Floreat, WA, 6014

7 December 2022

Attn: Elizabeth Mason and Stephanie Stack

Rio Tinto Iron Ore

Dear Elizabeth and Stephanie,

Please find below a memo summarising the reconnaissance and targeted flora and vegetation survey completed by Biologic Environmental Survey Pty Ltd (Biologic) within unsurveyed areas for the Deposit H Infrastructure area for the West Angelas Project Envelope.

If you have any queries, please do not hesitate to contact me.

Yours sincerely,

Clinton van den Bergh
Principal Botanist | Manager of Botany
Clinton@biologicenv.com.au
(08) 6365 5066 | 0439 910 881

1. INTRODUCTION AND OBJECTIVES

Biologic were commissioned to undertake a reconnaissance and targeted flora and vegetation survey of unsurveyed proposed infrastructure areas for Western Hill, Deposit H and Deposit F within the West Angelas Project Envelope (herein collectively referred to as the Study Area) (Figure 1.1). The Study Area is located within the West Angelas Revised Proposed Development Envelope and comprises three survey areas covering a total of 1,036.86 hectares (ha) (Figure 1.1), comprising:

- Western Hill Infrastructure (WHI) area – 118.89 ha (includes two areas);
- Deposit H Infrastructure (DHI) area – 858.25 ha; and
- Deposit F Infrastructure (DFI) area – 59.72 ha.

The overarching objective of this assessment was to undertake a single season reconnaissance and targeted flora and vegetation survey to identify the occurrence of flora and vegetation within the Study Area, with a particular focus on significant species (as per EPA (2020)), to inform future development and environmental approvals within the West Angelas Development Envelope. Significant species that were the focus of this survey are based on species identified in a previous desktop assessment completed for the broader West Angelas Revised Proposal Development Envelope, which encompasses the Study Area (Biota, 2020).

The field survey for WHI and DFI was undertaken earlier than for DHI due to time constraints. The results of the surveys for WHI and DFI have been presented in a separate memo (Biologic, 2022). This memo only addresses the survey and results for DHI.

Conformance and Licensing

This assessment was carried out in a manner consistent with the following guidelines and recommendations from the Environmental Protection Authority (EPA), relevant survey-specific license conditions and, where relevant, Rio Tinto guidelines and standards:

- DoE (2013) Matters of National Environmental Significance: Significant impact guidelines 1.1;
- EPA (2018) Statement of Environmental Principles, Factors and Objectives;
- EPA (2016a) Environmental Factor Guideline: Flora and Vegetation;
- EPA (2016b) Technical Guidance – Flora and Vegetation Surveys for Environmental Impact Assessment; and
- Rio Tinto (2021a) for targeted flora surveys and data collection.

Flora specimen collections were conducted under a DBCA Regulation 62 “Flora Taking (Biological Assessment) Licences issued to Sam Coultas (FB62000017-2). In accordance with Section 40 of the *Biodiversity Conservation Act 2016* (BC Act), threatened species sampling was completed under a DBCA “Authorisation to Take or Disturb Threatened Species” issued to Sam Coultas (authorisation number TFL 60-1819).

680000 682000 684000 686000 688000 690000

7442000

7440000

7438000

Deposit H
Infrastructure

Legend

Study Area

Pilbara Region

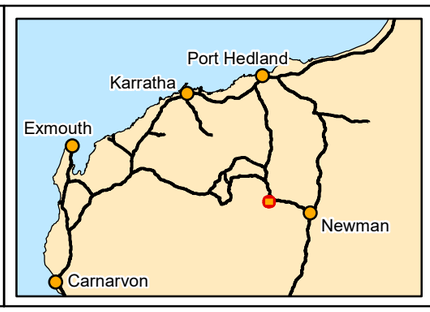
N

biologic Environmental Survey

Scale: 1:30,000

0 0.5 1 1.5 Km

Coordinate System: GDA2020 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA2020 Created 02/11/2022



RIO TINTO IRON ORE

Mt Ella, Deposit J and Deposit G Flora and Fauna Survey

Figure 1.1: Study Area and regional context

Background to Protection of Flora and Ecological Communities

Within Western Australia, native flora and ecological communities are protected under the BC Act and at a national level under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Any action that has the potential to impact on native flora or ecological communities needs to be approved by relevant state and/or federal departments as dictated by the state *Environmental Protection Act 1986* (EP Act) and the EPBC Act.

While all native flora and ecological communities are protected under these Acts, some species of flora and ecological communities that are determined to be at risk of extinction or decline are afforded extra protection under these Acts. These include species that are considered Threatened (Critically Endangered, Endangered and Vulnerable) under the EPBC Act and/or BC Act.

The EPBC Act identifies Threatened Ecological Communities (TECs) as ecological communities at risk of extinction. The BC Act provides for the statutory listing of TECs by the WA Minister for Environment (the Minister). The Minister has endorsed 69 ecological communities as Threatened under Critically Endangered (20), Endangered (17), Vulnerable (28) and Presumed Totally Destroyed (four).

Furthermore, any species or ecological communities that may be threatened but for which there is insufficient information available to allocate a threatened status under the BC Act, can also be listed as Priority species (Priority 1–4) or ecological communities (Priority 1-5) by the Western Australian Department of Biodiversity, Conservation and Attractions (DBCA).

For the purposes of this memo, these species are deemed to be significant species. A summary of applicable legislation and status codes is provided in Table 1.

Table 1: Significance assessment guidelines

Agreement, Act or List	Status Code
Federal	
Environment Protection and Biodiversity Conservation Act 1999 DAWE lists threatened flora, which are determined by the Threatened Species Scientific Committee (TSSC) according to criteria set out in the Act. The Act lists flora that are considered to be of conservation significance under one of eight categories (listed under 'Status Codes'). TECs are those that are at risk of extinction.	• Extinct (EX) • Extinct in the Wild (EW) • Critically Endangered (CE) • Endangered (EN) • Vulnerable (VU) • Conservation Dependent (CD) • Critically Endangered (CE) • Endangered (EN) • Vulnerable (VU)
State	
Biodiversity Conservation Act 2016 The BC Act provides for the listing of threatened native flora and ecological communities that need protection as critically endangered, endangered or vulnerable species or ecological communities because they are under identifiable threat of extinction (species) or collapsed (ecological communities).	• Schedule 1 (Critically Endangered) (S1 or CR) • Schedule 2 (Endangered) (S2 or EN) • Schedule 3 (Vulnerable) (S3 or VU) • Schedule 4 (Extinct) (S4 or EX)

Agreement, Act or List	Status Code
DBCA Priority list DBCA produces a list of Priority species and ecological communities (e.g., PECs) that have not been assigned statutory protection under the BC Act. This system gives a ranking from Priority 1 to Priority 4 for flora and Priority 1 to Priority 5 for ecological communities	• Priority 1 (P1) • Priority 2 (P2) • Priority 3 (P3) • Priority 4 (P4) • Priority 5 (PECs) (P5)

2. METHODS

2.1. Taxonomy and Nomenclature

Flora nomenclature used in this *memo* is consistent with the WAH's plant census, provided on Florabase© (WAH, 1998-). All species are current at the time of report preparation.

Plant taxa that could not be identified during the field survey were collected, assigned a unique number for tracking purposes, and pressed for subsequent identification. Identifications were carried out by Biologic's taxonomists, Mr Samuel Coultas and Dr Rachel Meissner, utilising Western Australian Herbarium's reference collection, taxonomic keys, and reference material. All taxa were checked against FloraBase© (WAH, 1998-) to ensure their currency and validity.

A representative specimen of all significant flora observed in the Survey Area was collected and submitted to the Rio Tinto sponsored botanist, Steve Dillon, for confirmation, in accordance with Rio Tinto's chain of custody requirements. The submitted specimens list and their confirmed identification is included in Appendix A.

2.2. Desktop Assessment

A desktop assessment was undertaken utilising information collated from the desktop assessment and field survey conducted by Biota (2020) for the broader West Angelas Beyond 2020 Development Envelope, which encompasses the Study Area. This assessment also reviewed aerial photography (Scale 1:30,000) of the Study Area and Google Earth Pro© imagery, along with data provided by Rio Tinto from their internal database (Rio Tinto, 2021b).

The desktop assessment was used to further refine sampling methods to ensure appropriate sampling was undertaken for all target species and to allow an accurate assessment of their occurrence or likelihood of occurrence within the Study Area.

2.3. Field Survey

Survey Timing and Personnel

The field survey was undertaken over three days on the 2nd to the 4th of May 2022 by Senior Botanist Sam Coultas with assistance from Alice Greenwood. Sam has over 10 years' experience undertaking flora surveys within the Pilbara region, including targeted surveys for the significant species that were the focus of this assessment (Table 2).

Table 2: Project Team and experience

Personnel	Position and Role	Qualification	Experience
Sam Coultas	Senior Botanist • field survey • reporting	BSc Environmental Biology	• 10 years' experience field survey • 10 years' experience EIA (consulting) • 10 years' experience botanical • 10 years' Pilbara botanica/ field experience
Alice Greenwood	Carbon Project Officer • field survey	BSc Environmental Biology	• 4 years' experience field survey • 3 years' experience botanical

Climate and Weather

Observed weather conditions prior to and during the survey are shown in Figure 2.1, alongside long-term climatic data for Newman Airport (station #007176). In the 12 months prior to the survey (June 2021–May 2022), mean minimum and maximum temperatures recorded at Newman Airport were variable compared the long-term averages for most months, with some months exceeding long-term averages by 2 °C or recording a mean less than 2 °C than the long term average (Figure 2.1). Rainfall in the 12 months preceding the survey was variable, with below long-term averages recorded through most months, except for November 2021 (13.8 mm v 12.4 mm) and February 2022 (73 mm v 72.3 mm), which had rainfall consistent with long-term averages Figure 2.1. In total, the rainfall received in the 12 months prior to the survey (June 2021 to May 2022; 219.60 mm) was well below the annual long-term average (315.2 mm) (BoM, 2021).

Observed minimum and maximum temperatures during the survey were mostly above the long-term average (Table 3) (BoM, 2021), however, the field survey occurred at the start of May 2022, so temperatures would have foreseeable fallen further as the month progressed. A total of 0.4 mm of rain fell during the first day (2nd of May) of the field trip (Table 3); with a further 4.2 mm recorded in the days leading into the field survey (BoM, 2021).

Table 3: Climatic conditions recorded for Newman Airport during the field survey

Date	Min. temp (°C)	Max. temp (°C)	Rainfall (mm)
02/05/2022	16.4	26.2	0.4
03/05/2022	14.7	30.5	0
04/05/2022	16.3	28.6	0
Average/ total	**15.8**	**28.4**	**0.4**

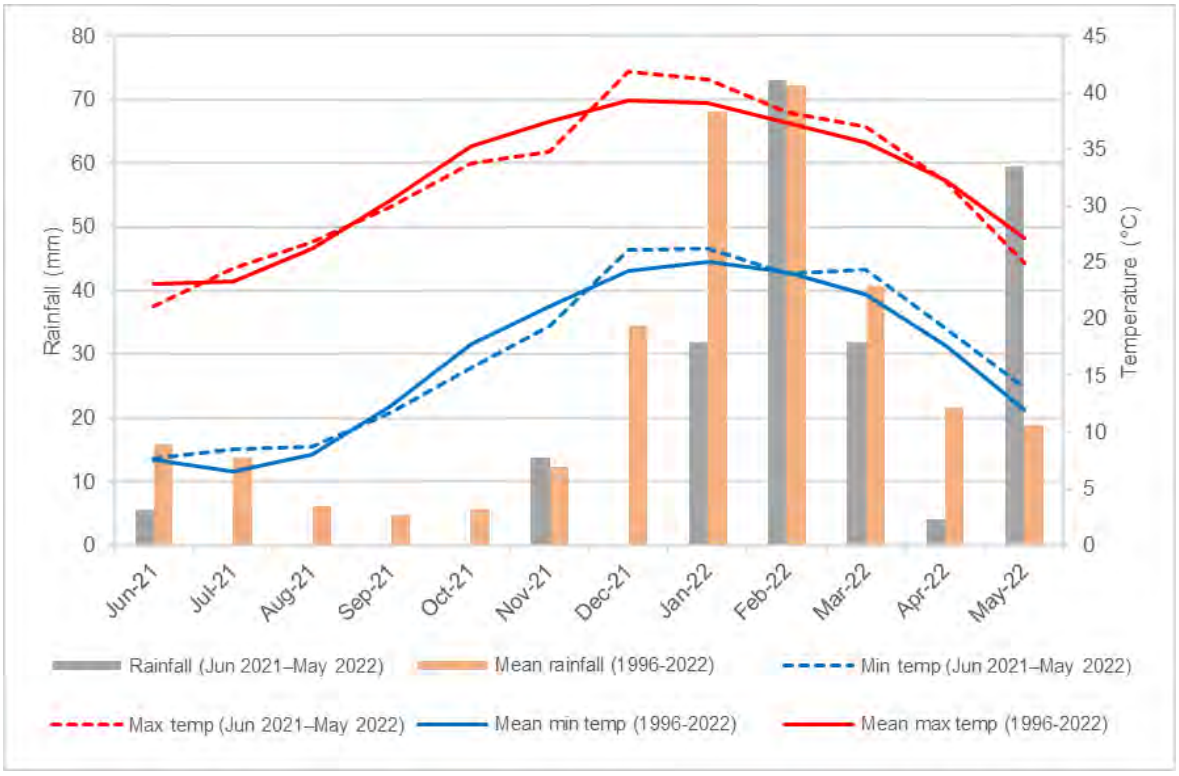


Figure 2.1: Monthly rainfall and long-term average rainfall for Newman Aero (Station ID 007176) (BoM, 2021) with approximate survey timing shown in shaded box

2.4. Sampling and Survey Methods

Reconnaissance Survey

Aerial photography (Scale 1:15,000) of the Survey Area and Google Earth Pro©, were used with previous vegetation mapping (Beard, 1975; Biologic, 2021; Shepherd *et al.*, 2002) to determine the mapped vegetation type boundaries prior to the field survey. Reconnaissance surveys are traditionally sampled at a low intensity via relevés (unmarked area within which data is collected; EPA, 2016a) and vegetation mapping points (unmarked area within which the vegetation unit and condition is broadly described).

Where practical, at least one sampling site (relevé) was established in each of the existing consolidated vegetation types (Figure 2.2), to ensure that each type occurring within the Study Area was captured by the survey and described appropriately in accordance with EPA (2016b)EPA (2016b) guidelines. Furthermore, the sample sites were compared against the existing consolidated mapping to determine if it was similar, or if a different vegetation type was warranted.

The entire Survey Area was accessible via vehicle and on foot, with all the major landforms and vegetation units traversed and sampled. A total of 36 relevé sites were sampled across the Study Area, while an additional eight vegetation mapping points were also sampled (Figure 2.2). Dominant vascular flora taxa within each relevé were recorded. Taxa that had not yet been recorded from the Survey Area were also recorded to document a comprehensive species list for the Survey Area. A brief summary of

the condition and vegetation assemblage at each site was also recorded to aid in producing vegetation unit descriptions (NVIS Technical Working Group, 2017). In addition, the following information was recorded at each relevé:

- relevé number;
- date of survey;
- personnel;
- a central GPS coordinate (GDA 94);
- site photograph of the representative vegetation unit, generally facing south-east;
- soil characteristics (texture and colour);
- geology (type, size and nature of any rocks, stones, gravel, or outcropping);
- topography (landform type and aspect);
- vegetation condition;
- vegetation structure, including the dominant flora species in the three traditional strata, upper, mid, and lower;
- disturbance (if present);
- approximate time since last fire; and
- GPS coordinates for significant or introduced flora.

Flora taxa observed opportunistically in the vicinity of sample sites, or while traversing the Study Area, were also recorded. For any populations of taxa known to be of significance or introduced, a GPS location and a count of the individuals present, or percentage foliage cover for a given area, were recorded.

Targeted Searches

Prior to the survey, a list of significant flora known, highly likely, likely, or possible, to occur within the Study Area was compiled as part of the desktop assessment. Field personnel familiarised themselves with photographs, reference samples and descriptions of these taxa before conducting the survey. Once on the ground, personnel actively searched while traversing the Study Area focussing on habitat and features considered likely to support significant flora (i.e., hill summits, gorges, and drainage lines) (Figure 2.2).

Where significant flora taxa were located in the field, a GPS coordinate of the individual was taken, or if the species existed within a small population, a central coordinate with an approximate 20 m radius was used. For larger populations the extent was mapped using a GPS to record the spatial extent of the population. Generalised information was collected for each occurrence, including an estimate of the number of individuals, reproductive status, condition and broad vegetation community and condition.

Threatened and Priority Flora Report Forms will be provided to the Parks and Wildlife Division (Parks and Wildlife) of DBCA, as required under the flora collecting permits. Significant flora specimens will be vouchered with the Western Australian Herbarium (WAH), where required and appropriate.

679000
682000
685000
688000
7443000
7440000
7437000

Legend

Study Area
Heritage site

Sampling Type

Relevé
Traverse

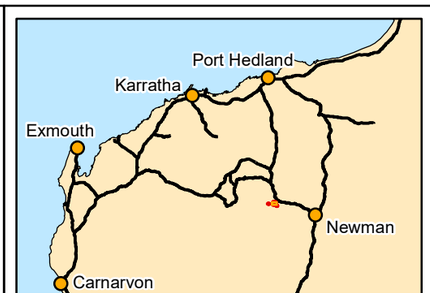
N

biologic Environmental Survey

Scale: 1:30,000

0 0.5 1 1.5 Km

Coordinate System: GDA2020 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA2020 Created 02/11/2022



RIO TINTO IRON ORE

Mt Ella, Deposit J and Deposit G Flora and Fauna Survey

Figure 2.2: Sample sites and traverses

The targeted searches also focused on significant environmental weeds (Weeds of National Significance and Declared Pests listed under Section 22 of the BAM Act). Any such weeds located in the Study Area had their locations noted and searches were conducted within a minimum radius of 20 m from the given specimen, to document the number of individual plants and map the spatial extent of the infestation.

2.5. Likelihood of Significant Flora Occurrence

The significant flora taxa identified from the database searches and literature review were assessed and ranked on the likelihood of occurring within the Study Area (Appendix B). The rankings were assigned using the following definitions presented in Table 4 and are intended to be an indicative guide only.

Table 4: Flora likelihood of occurrence decision matrix

Occurrence categories	Habitat categories (within the Study Area)			
	Core/ critical habitat present	Suitable habitat present/ within known distribution	Marginal habitat present/ adjacent to known distribution	No suitable habitat present/ outside of known distribution
Recorded in the Study Area	Confirmed	Confirmed	Confirmed	Confirmed
Recorded within <5 km	Highly Likely	Likely	Possible	Possible
Recorded within 5-15 km	Likely	Possible	Possible	Unlikely
Recorded within 15 - 50 km	Possible	Possible	Unlikely	Unlikely
Recorded >50 km	Possible	Unlikely	Unlikely	Highly Unlikely
Species considered locally/ regionally extinct	Unlikely	Unlikely	Highly Unlikely	Highly Unlikely

2.6. Limitations

No potential limitations which are expected to have significantly impacted the results of the survey and/or the determined likelihood of occurrence assessments for significant species within the Study Area, as outlined by EPA (2016b), were encountered during the survey.

.

3. RESULTS AND DISCUSSION

3.1 Desktop Assessment

A total of 48 significant vascular flora species were identified following a review of the desktop assessment completed for the West Angelas Beyond 2020 Detailed Flora and Vegetation Survey (Biota, 2020). Two significant flora taxa have previously been recorded within the Study Area according to data provided by Rio Tinto (Rio Tinto, 2021b) and DBCA (DBCA, 2021) (Figure 3.1):

- *Triodia* sp. Mt Ella (M.E. Trudgen 12739) (P3); and
- *Vittadinia* sp. Coondewanna Flats (S. van Leeuwen 4684) (P3).

The spatial data on significant flora indicates that there is only one record each of *Triodia* sp. Mt Ella (M.E. Trudgen 12739) and *Vittadinia* sp. Coondewanna Flats (S. van Leeuwen 4684) within the Study Area. The spatial data suggests that approximately 3,000 individuals of *Triodia* sp. Mt Ella (M.E. Trudgen 12739) occur at the known location, while population size was not documented for *Vittadinia* sp. Coondewanna Flats (S. van Leeuwen 4684).

The flora taxa of significance identified by the desktop assessment were assessed and ranked on the likelihood of occurring within the Study Area. The full list is presented in Appendix B. The two taxa mentioned above have been previously recorded within the Study Area and are therefore considered confirmed. Of the remaining taxa, six are considered Highly Likely to occur, and nine Possible (Table 5). The remaining 31 taxa were considered Unlikely (12) or Highly Unlikely (19) to occur within the Study Area (Appendix B).

Table 5: Significant flora likelihood of assessment results (confirmed to possible)

Taxon	Description (WAH, 1998-)	Location
Confirmed		
Triodia sp. Mt Ella (M.E. Trudgen 12739) (P3)	Light orange-brown to red-brown pebbly loam on hill slopes and in gullies.	Within Study Area
Vittadinia sp. Coondewanna Flats (S. van Leeuwen 3835) (P3)	Mainly on red clay on plains, low in the landscape.	Within Study Area
Highly Likely		
Aristida lazaridis (P2)	Major drainage areas through clayey flats.	1 km to the north
Euphorbia clementii (P3)	Gravelly hillsides, stony ground.	0.3 km to the south
Indigofera gilesii (P3)	Skeletal red-brown loam on rocky slopes, gorges, and creeklines.	<0.1 km to the south
Rhagodia sp. Hamersley (M. Trudgen 17794) (P3)	Mulga (*Acacia aneura*) and Snakewood (*A. xiphophylla*) vegetation on clay plains.	<0.1 km to the west
Themeda sp. Hamersley Station (M.E. Trudgen 11431) (P3)	Clay plains.	0.6 km to the south
Lepidium catapycnon (P4)	Skeletal soils on hill slopes.	0.2 km to the east

Taxon	Description (WAH, 1998-)	Location
Possible		
Acacia effusa (P3)	Stony red loam; scree	4.7 km to the south
Eremophila naaykensii (P3)	Skeletal red-brown silty loam on hill crests, cliff tops, gorges.	2 km to the south-west
Euphorbia stevenii (P3)	Clay soils.	7.7 km to the west
Hibiscus sp. Gurinbiddy Range (M.E. Trudgen 15708) (P2)	Hilltops, upper hillslopes.	2.5 km to the south-east
Olearia mucronata (P3)	Hills and rocky drainage channels.	7.4 km to the west
Rostellularia adscendens var. *latifolia* (P3)	Various; creeks, plains, low hills.	3.8 km to the north
Solanum kentrocaule (P3)	Hillsides and mountain crests, creek beds; skeletal red-brown soil over ironstone on basalt or scree.	3.2 km to the north
Swainsona thompsoniana (P3)	Creekline, claypan.	7.7 km to the west
Sida sp. Barlee Range (S. van Leeuwen 1642) (P4)	Steep slopes, rocky gullies and breakaways.	2.5 km to the south-east

580000
610000
640000
670000
700000
7470000
7440000
7410000
Juna Downs Rd
Packsaddle Rd
West Angelas Rd
MAC-E
MAC-C
Hope Downs 1
South Flank
Great Northern Hwy
Snowy Mount
Turee Creek Rd

Legend

- Study Area
- Operating Mine
- Local Road
- State Road

N

biologic Environmental Survey

Scale: 1:400,000

0 10 20 Km

Coordinate System: GDA2020 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA2020 Created 02/11/2022

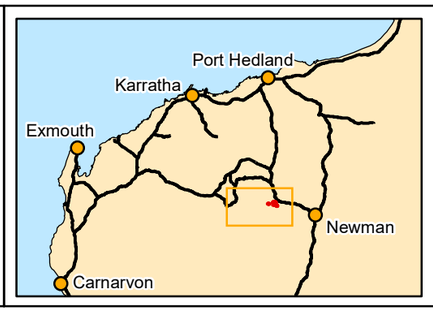


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Figure 3.1 Significant flora recorded in the desktop assessment

DBCA

T

- *Thryptomene wittweri*

P1

- *Rhodanthe ascendens*
- *Triodia* sp. Karijini (S. van Leeuwen 4111)

P2

- *Aristida lazaridis*
- *Eragrostis* sp. Mt Robinson (S. van Leeuwen 4109)
- *Eremophila pusilliflora*
- *Eremophila* sp. West Angelas (S. van Leeuwen 4068)
- *Euphorbia inappendiculata* var. *queenslandica*
- *Hibiscus* sp. Gurinbiddy Range (M.E. Trudgen MET 15708)
- *Isotropis parviflora*
- *Oxalis* sp. Pilbara (M.E. Trudgen 12725)
- *Tetratheca fordiana*
- *Teucrium pilbaranum*

P3

- *Acacia daweana*
- *Acacia effusa*
- *Acacia subtiliformis*
- *Aristida jerichoensis* var. *subspinulifera*
- *Dampiera metallorum*
- *Eremophila magnifica* subsp. *velutina*
- *Eremophila rigida*
- *Euphorbia clementii*
- *Euphorbia stevenii*
- *Goodenia lyrata*
- *Goodenia* sp. East Pilbara (A.A. Mitchell PRP 727)
- *Grevillea saxicola*
- *Indigofera gilesii*
- *Olearia mucronata*
- *Pilbara trudgenii*
- *Rhagodia* sp. Hamersley (M. Trudgen 17794)
- *Rostellularia adscendens* var. *latifolia*
- *Sida* sp. Hamersley Range (K. Newbey 10692)
- *Solanum kentrocaule*
- *Stackhousia clementii*
- *Swainsona thompsoniana*
- *Themeda* sp. Hamersley Station (M.E. Trudgen 11431)
- *Triodia basitricha*
- *Triodia* sp. Mt Ella (M.E. Trudgen 12739)
- *Xerochrysum boreale*
- *Vittadinia* sp. Coondewanna Flats (S. van Leeuwen 4684)

P4

- *Acacia bromilowiana*
- *Eremophila magnifica* subsp. *magnifica*
- *Lepidium catapycnon*
- *Ptilotus mollis*
- *Sida* sp. Barlee Range (S. van Leeuwen 1642)

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P1

- *Hibiscus* sp. Mt Brockman (E. Thoma ET 1354)

P2

- *Aristida lazaridis*
- *Eremophila pusilliflora*
- *Hibiscus* sp. Gurinbiddy Range (M.E. Trudgen MET 15708)
- *Isotropis parviflora*
- *Oxalis* sp. Pilbara (M.E. Trudgen 12725)
- *Tetratheca fordiana*

P3

- *Acacia daweana*
- *Acacia effusa*
- *Acacia subtiliformis*
- *Aristida jerichoensis* var. *subspinulifera*
- *Dampiera metallorum*
- *Euphorbia clementii*
- *Geijera salicifolia*
- *Goodenia* sp. East Pilbara (A.A. Mitchell PRP 727)
- *Grevillea saxicola*
- *Indigofera gilesii*
- *Olearia mucronata*
- *Pilbara trudgenii*
- *Rhagodia* sp. Hamersley (M. Trudgen 17794)
- *Rostellularia adscendens* var. *latifolia*
- *Sida* sp. Hamersley Range (K. Newbey 10692)
- *Solanum kentrocaule*
- *Themeda* sp. Hamersley Station (M.E. Trudgen 11431)
- *Triodia* sp. Mt Ella (M.E. Trudgen 12739)
- *Vittadinia* sp. Coondewanna Flats (S. van Leeuwen 4684)

P4

- *Acacia bromilowiana*
- *Eremophila magnifica* subsp. *magnifica*
- *Lepidium catapycnon*
- *Ptilotus mollis*
- *Sida* sp. Barlee Range (S. van Leeuwen 1642)

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3.2. Field Survey

Flora Records

A total of 71 confirmed vascular flora taxa were recorded from the Study Area, including four introduced taxa, while the remaining 67 taxa are native (Appendix C). The 71 confirmed vascular flora taxa are from 20 families and 49 genera. The diversity of the Study Area is lower than anticipated, however, it is within the bounds of a survey of this size, intensity, adequacy and timing. The West Angelas Revised Proposed Development Envelope has been surveyed quite extensively, with an extensive list of known taxa well understood. Previous flora and vegetation surveys of the West Angelas Revised Proposed Development Envelope has recorded the majority of the expected flora species likely to occur in the Study Area, including significant and introduced flora species.

Significant Flora

The targeted flora survey component of the field survey recorded a total of seven significant flora taxa, all listed as Priority flora (Figure 3.2; Appendix A):

- *Aristida lazaridis* (P2);
- *Hibiscus* sp. Gurinbiddy Range (M.E. Trudgen MET 15708) (P2);
- *Eremophila naaykensii* (P3);
- *Indigofera gilesii* (P3);
- *Rhagodia* sp. Hamersley (M. Trudgen 17794) (P3);
- *Triodia* sp. Mt Ella (M.E. Trudgen 12739) (P3); and
- *Eremophila magnifica* subsp. *magnifica* (P4).

Aristida lazaridis (P2) (Plate 1) was recorded from five separate populations (25-point locations) in the southern half of the Study Area, totalling 129 individuals. The individuals were recorded from drainage lines, flow lines and floodplains, in habitat consistent with current knowledge on preferred habitat. Five individuals were recorded near a topsoil stockpile area that could be considered marginal to unsuitable habitat. It is likely that these individuals have been transported to this location, through movement of soil, or other disturbances.

Hibiscus sp. Gurinbiddy Range (M.E. Trudgen MET 15708) (P2) (Plate 2) was recorded from three populations (14-point locations) within the Study Area, with a total of 57 individuals recorded (Figure 3.2). *Hibiscus* sp. Gurinbiddy Range (M.E. Trudgen MET 15708) was recorded predominantly within drainage/ flow lines associated with the H1 and H14 vegetation communities. *Hibiscus* sp. Gurinbiddy Range (M.E. Trudgen MET 15708) has been recorded extensively across the West Angelas Revised Proposal Development Envelope (Figure 3.1).

Eremophila naaykensii (P3) (Plate 3) was recorded from one population (two-point locations) within the Study Area (Figure 3.2), with a total of 32 individuals observed. The immediate area was traversed to identify any additional individuals, however, none were observed. *Eremophila naaykensii* was associated with the G2 vegetation community and is known to occur extensively across the West Angelas Revised Proposal Development Envelope (Figure 3.1).

679000
682000
685000
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7443000
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7437000

Legend

Study

Significant Species

- *Aristida lazaridis* - P2
- *Hibiscus* sp. Gurinbiddy Range (M.E. Trudgen MET 15708) - P2
- *Eremophila naaykensii* - P3
- *Indigofera gilesii* - P3
- *Rhagodia* sp. Hamersley (M. Trudgen 17794) - P3
- *Triodia* sp. Mt Ella (M.E. Trudgen 12739) - P3
- *Eremophila magnifica* subsp. *magnifica* - P4

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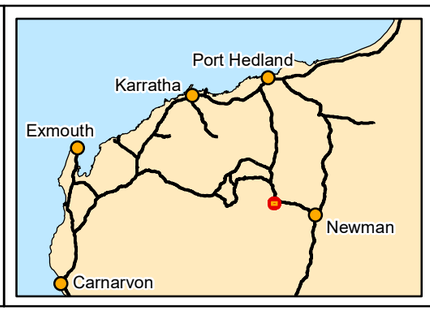
biologic Environmental Survey

Scale: 1:30,000

0 0.5 1 1.5 Km

Coordinate System: GDA2020 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA2020 Created 02/11/2022



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Mt Ella, Deposit J and Deposit G Flora and Fauna Survey

Figure 3.2: Significant flora recorded in the Study Area

Indigofera gilesii (P3) (Plate 4) was recorded from one population (32-point locations) within the Study Area, with a total of 432 individuals recorded (Figure 3.2). *Indigofera gilesii* was recorded predominantly within gullies and drainage lines associated with the D6 vegetation community. *Indigofera gilesii* has been recorded extensively across the West Angelas Revised Proposal Development Envelope (Figure 3.1).

Rhagodia sp. Hamersley (M. Trudgen 17794) (P3) (Plate 5) was observed from one population (two-point locations) within the Study Area, with two individuals recorded (Figure 3.2). This species was associated with the mulga sheet-flow plains of the M1 vegetation community. *Rhagodia* sp. Hamersley (M. Trudgen 17794) has been recorded extensively across the West Angelas Revised Proposal Development Envelope (Figure 3.1).

Triodia sp. Mt Ella (M.E. Trudgen 12739) (P3) (Plate 6) was recorded from five populations (27-point locations) within the Study Area, with a total of 418 individuals recorded (Figure 3.2). This species was predominantly associated with the H10 and H14 vegetation communities. *Triodia* sp. Mt Ella (M.E. Trudgen 12739) is known to occur extensively within the West Angelas Revised Proposal Development Envelope (Figure 3.1).

Eremophila magnifica subsp. *magnifica* (P4) (Plate 7) was recorded from one population (seven-point locations) within the Study Area (Figure 3.2), with a total of 29 individuals observed. One population numbered 21 individuals, while the other two occurrences supported seven individuals and one individual. The immediate area was traversed to identify any additional individuals; however, none were observed. *Eremophila magnifica* subsp. *magnifica* was associated with the H14 vegetation community, with one population occurring on the boundary with the H10 vegetation community. *Eremophila magnifica* subsp. *magnifica* is known to occur extensively within the West Angelas Revised Proposal Development Envelope (Figure 3.1).

Plate 1: *Aristida lazaridis* (P2) observed from DHl (Biologic photos).

Plate 2: *Hibiscus* sp. Gurinbiddy Range (M.E. Trudgen MET 15708) (P2) individuals observed from DHl (Biologic photos).

Plate 3: *Eremophila naaykensii* (P3) observed from the greater West Angelas and Angelo River region (Biologic photos).

Plate 4: *Indigofera gilesii* (P3) observed from the greater West Angelas region (Biologic photos).

Plate 5: *Rhagodia* sp. Hamersley (M. Trudgen 17794) (P3) observed from West Angelas and Rhodes Ridge (Biologic photos).

Plate 6: *Triodia* sp. Mt Ella (M.E. Trudgen 12739) (P3) observed from the greater West Angelas region (Biologic photos).

Plate 7: *Eremophila magnifica* subsp. *magnifica* (P4) observed from the DHI and the greater West Angelas region (Biologic photos).

Post-survey Likelihood of Occurrence for previously Confirmed Taxa

Following the May 2022 field survey of the Study Area, the likelihood of occurrence was revisited. Two Priority listed taxa were confirmed to occur within the Study Area prior to the field survey (Figure 3.1). Following the survey, one of these two taxa was not observed, *Vittadinia* sp. Coondewanna Flats (S. van Leeuwen 4684) (P3). Suitable habitat was present within the Study Area, however, the exact location was not visited, although searches through the suitable habitat and in close proximity to the location was undertaken (Figure 2.2). Furthermore, the data attributes for the location in the Study Area suggests the record is from 1998 (Trudgen & Ecaus, 1998), so there is the possibility that Vittadinia sp. Coondewanna Flats (S. van Leeuwen 4684) no longer occurs in this location.

Prior to the survey, *Triodia* sp. Mt Ella (M.E. Trudgen 12739) (P3) was known to occur in the Study Area. Following the field survey in May 2022, additional records of *Triodia* sp. Mt Ella (M.E. Trudgen 12739) were observed, confirming occurrence.

Introduced Flora

A total of four introduced flora taxa were recorded from the Study Area, including, **Bidens bipinnata, *Cenchrus ciliaris, *Malvastrum americanum,* and **Vachellia farnesiana*. Observations of introduced flora were low (Table 6), with **Bidens bipinnata* observed the highest number of times (five), while **Cenchrus ciliaris* was observed once. The number of occurrences for each of the four introduced flora taxa in the Study Area is unlikely to be complete, with additional occurrences likely to occur near previously disturbed areas, tracks and drainage lines.

Table 6: Introduced flora observations from the Study Area

Taxon	Occurrences	No. of Individuals	Vegetation Code
**Bidens bipinnata*	5	850	M1, P7
**Cenchrus ciliaris*	1	50	D11
**Malvastrum americanum*	3	110	P7
**Vachellia farnesiana*	2	6	P15, D11

Vegetation Types

The Study Area occurs within the consolidated vegetation mapping context area (Biologic, 2021), however, actual on-ground survey work is dated. As such, the vegetation of the Study Area was assessed via the sampling of relevés and vegetation mapping points to determine if the vegetation is consistent with the consolidated mapping, or if amendments are required. Prior to the field survey, the Study Area supported 12 vegetation types based on the consolidated mapping (Biologic, 2021):

- D6: ChCdAanPlTp - *Corymbia hamersleyana* and/or *Corymbia deserticola* subsp. *deserticola* low open woodland *Acacia 'aneura'*, *Petalostylis labicheoides* tall open shrubland *Triodia pungens* open hummock grassland.

- D11: ExAanEtPlANlEUsTHtTp - *Eucalyptus xerothermica* and/or *Acacia 'aneura'* low open woodland over *E. trivalva* low open mallee woodland *Petalostylis labicheoides, Androcalva luteiflora* open shrubland *Eulalia* sp. (Three Rivers Station, B.Forsyth AQ6789133) and/or *Themeda triandra* very open tussock grassland with *Triodia pungens* very open hummock grassland.
- H1: AanAayElERfoERlaTpTw - *Acacia 'aneura'* and/or *A. ayersiana*, (*Eucalyptus leucophloia* subsp. *leucophloia*) low woodland *Eremophila forrestii* subsp. *forrestii*, *E. latrobei* subsp. *latrobei* scattered shrubs *Triodia pungens, T. wiseana* very open hummock grassland.
- H4: AiTw - *Acacia inaequilatera* scattered tall shrubs *Triodia wiseana* open hummock grassland.
- H8: ElCdApTvTp - *Eucalyptus leucophloia* subsp. *leucophloia* and/or *Corymbia deserticola* subsp. *deserticola* low open woodland *Acacia pruinocarpa* scattered tall shrubs *Triodia vanleeuwenii* and/or *T. pungens* open hummock grassland.
- H10: ElEgAmPlTvTw - *Eucalyptus leucophloia* subsp. *leucophloia* scattered low trees over *E. gamophylla* low open mallee woodland *Acacia maitlandii, Petalostylis labicheoides* open shrubland *Triodia vanleeuwenii, T. wiseana* open hummock grassland.
- H14: ElTbrTw - *Eucalyptus leucophloia* subsp. *leucophloia* scattered low trees *Triodia brizoides*, (*T. wiseana*) open hummock grassland.
- M1: AanApTp/AanAcaApERfoTp - *Acacia 'aneura'*, *Acacia pruinocarpa* low open woodland/*Acacia 'aneura'*, *A. catenulata* subsp. *occidentalis* and/or *Acacia pruinocarpa* low woodland to low open forest - / *Eremophila forrestii* subsp. *forrestii* open shrubland *Triodia pungens* open hummock grassland/*Triodia pungens* very open hummock grassland.
- P5: AanApERfoTp - *Acacia 'aneura'* and/or *A. pruinocarpa* low woodland to low open forest *Eremophila forrestii* subsp. *forrestii* open shrubland *Triodia pungens* very open hummock grassland.
- P7: AanExERfoERloTHtTwTp - *Acacia 'aneura', Eucalyptus xerothermica* scattered low trees to low open woodland *Eremophila forrestii* subsp. *forrestii* and/or *E. longifolia* very open shrubland *Themeda triandra* scattered tussock grasses over *Triodia wiseana* and/or *T. pungens* open hummock grassland.
- P14: EtErEsTspp - *Eucalyptus trivalva, E. repullulans, E. socialis* subsp. *eucentrica* low open mallee woodland *Triodia wiseana*, (*T. angusta, T. pungens, T. longiceps*) open hummock grassland.
- P15: ASpASeARla - *Astrebla pectinata, Astrebla elymoides* and *Aristida latifolia* open tussock grassland

Following the review of the on-ground floristic assemblage and vegetation type determination, the vegetation type mapping for the Study Area was altered (Table 7 and Figure 3.3). The vegetation types within the Study Area expanded to include 14 vegetation types and two mapping units (Disturbed and Rehabilitated) (Table 7).

Table 7: Vegetation types recorded from the Study Area

Code	Description	Photo (from the Study Area)
D6 ChCdAanPlTp	*Corymbia hamersleyana* and/or *Corymbia deserticola* subsp. *deserticola* low open woodland over *Acacia 'aneura', Petalostylis labicheoides* tall open shrubland over *Triodia pungens* open hummock grassland	
D11 ExAanEtPlANlEUsTHtTp	*Eucalyptus xerothermica* and/or *Acacia 'aneura'* low open woodland over *E. trivalva* low open mallee woodland *Petalostylis labicheoides, Androcalva luteiflora* open shrubland over *Eulalia symonii* and/or *Themeda triandra* very open tussock grassland with *Triodia pungens* very open hummock grassland.	

Code	Description	Photo (from the Study Area)
G2 AanCALcCfCAPmPTo ERImARbTp	*Acacia 'aneura', Callitris columellaris* and/or *Corymbia ferriticola* low woodland over *Capparis mitchellii* scattered tall shrubs over *Ptilotus obovatus* low open shrubland over *Eriachne mucronata* and/or *Aristida burbidgeae* very open tussock grassland with *Triodia pungens* scattered hummock grasses	
H1 AanAayElERfoERlaTpTw	*Acacia 'aneura'* and/or *A. ayersiana,* (*Eucalyptus leucophloia* subsp. *leucophloia*) low woodland over *Eremophila forrestii* subsp. *forrestii, E. latrobei* subsp. *latrobei* scattered shrubs over *Triodia pungens, T. wiseana* very open hummock grassland	

Code	Description	Photo (from the Study Area)
H4 AiTw	*Acacia inaequilatera* scattered tall shrubs over *Triodia wiseana* open hummock grassland.	
H8 ElCdApTvTp	*Eucalyptus leucophloia* subsp. *leucophloia* and/or *Corymbia deserticola* subsp. *deserticola* low open woodland over *Acacia pruinocarpa* scattered tall shrubs over *Triodia vanleeuwenii* and/or *T. pungens* open hummock grassland	

Code	Description	Photo (from the Study Area)
H10 ElEgAmPlTvTw	*Eucalyptus leucophloia* subsp. *leucophloia* scattered low trees over *E. gamophylla* low open mallee woodland over *Acacia maitlandii, Petalostylis labicheoides* open shrubland over *Triodia vanleeuwenii, T. wiseana* open hummock grassland	
H14 ElTbrTw	*Eucalyptus leucophloia* subsp. *leucophloia scattered* low trees over *Triodia brizoides,* (*T. wiseana*) open hummock grassland.	

Code	Description	Photo (from the Study Area)
M1 AanApTp/ AanAcaApERfoTp	*Acacia 'aneura'*, *Acacia pruinocarpa* low open woodland/*Acacia 'aneura'*, *A. catenulata* subsp. *occidentalis* and/or *Acacia pruinocarpa* low woodland to low open forest - / *Eremophila forrestii* subsp. *forrestii* open shrubland *Triodia pungens* open hummock grassland/*Triodia pungens* very open hummock grassland	
P5 AanApERfoTp	*Acacia 'aneura'* and/or *A. pruinocarpa* low woodland to low open forest over *Eremophila forrestii* subsp. *forrestii* open shrubland over *Triodia pungens* very open hummock grassland	

Code	Description	Photo (from the Study Area)
P7 AanExERfoERloTHtTwTp	*Acacia 'aneura', Eucalyptus xerothermica* scattered low trees to low open woodland over *Eremophila forrestii* subsp. *forrestii* and/or *E. longifolia* very open shrubland over *Themeda triandra* scattered tussock grasses over *Triodia wiseana* and/or *T. pungens* open hummock grassland	
P14 EtErEsTspp	*Eucalyptus trivalva, E. repullulans, E. socialis* subsp. *eucentrica* low open mallee woodland over *Triodia wiseana,* (*T. angusta, T. pungens, T. longiceps*) open hummock grassland.	

Code	Description	Photo (from the Study Area)
P15 ASpASeARla	*Astrebla pectinata, Astrebla elymoides* and *Aristida latifolia* open tussock grassland	
P16 AanERfoCHf	*Acacia 'aneura'* tall open shrubland over *Eremophila forrestii* subsp. *forrestii, Rhagodia eremaea* open shrubland over *Chrysopogon fallax* scattered tussock grasses	

Code	Description	Photo (from the Study Area)
Dis Disturbed	Disturbed areas, including mine pits, roads, rail, tracks and associated infrastructure.	
Reh Rehabilitated	Former cleared areas now rehabilitated	No photo available

679000 682000 685000 688000

7443000 7440000 7437000

Legend

Study Area

Vegetation Type

D6
D11
G2
H1
H4
H8
H10
H14
M1
P5
P7
P14
P15
P16
Disturbed
Rehabilitated

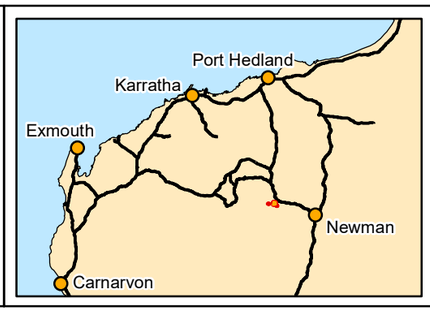
N

biologic Environmental Survey

Scale: 1:30,000

0 0.5 1 1.5 Km

Coordinate System: GDA2020 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA2020 Created 02/11/2022



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Mt Ella, Deposit J and Deposit G Flora and Fauna Survey

Figure 3.3: Vegetation Types in the Study Area

Significant Vegetation

Prior to the on-ground survey work, the Priority Ecological Community (PEC), West Angelas Cracking-Clays, was mapped as occurring in the Study Area. Following the survey, the extent of the PEC was reviewed, with the boundary altered to reflect the on-ground observations. The remainder of the vegetation mapped within the Study Area did not represent any known TECs or PECs from within and adjacent to the West Angelas Revised Proposal Development Envelope.

Vegetation type P15 (*Astrebla pectinata, Astrebla elymoides* and *Aristida latifolia* open tussock grassland) is consistent with the PEC and occurs in the central portion of the Study Area (Figure 3.3). Prior to the survey, only a small portion of the Study Area was representative of the PEC, with the patch extending beyond the Study Area to the west. The patch within the Study Area was revised, while a portion of the previously mapped P7 vegetation type was amended to P15 (the PEC) as it supported *Astrebla* spp. and was consistent with characteristics, landforms, soils and habitat for the PEC (i.e., basalt derived cracking-clay soils).

Of the vegetation types mapped in the Study Area, nine supported significant flora (Table 8). Utilising the broad hierarchy of significance for vegetation, developed by Rio Tinto, at the local scale (only considering the vegetation types and data available for the Study Area), eight of the 14 vegetation types are locally significant, with vegetation type P15 considered regionally significant and the remaining five (H8, M1, P5, P14, and P16) vegetation types of negligible significance.

Vegetation type P15 is a Priority 1 ecological community (as discussed above) and meets the broad scope and features relevant for a Regionally Significant vegetation type. Of the eight locally significant vegetation types, six are of Moderate local significance (D11, G2, H1, H4, H14, and P7) as they supported Priority 2 flora (*Aristida lazaridis, Hibiscus* sp. Gurinbiddy Range (M.E. Trudgen MET 15708)) and some high density Priority 3 flora (Table 8). Two vegetation types, D6 and H10, were of Low local significance as they supported Priority 3 and 4 flora, while vegetation type M1 supported two individuals of *Rhagodia* sp. Hamersley (M. Trudgen 17794) (P3), however, as it was only two individuals, the significance was downgraded to Negligible.

Table 8: Vegetation Significance Ranking

Vegetation Code	Significance Ranking	Significant Features
P15	Regional Significance	• Consistent with the West Angelas Cracking-Clay Priority 1 Ecological Community
D11	Moderate	• Supports eight-point locations and 17 individuals of *Aristida lazaridis* (P2)
G2	Moderate	• Supports four-point locations and 32 individuals of *Hibiscus* sp. Gurinbiddy Range (M.E. Trudgen MET 15708) (P2). • Supports two-point locations and 32 individuals of *Eremophila naaykensii* (P3).

Vegetation Code	Significance Ranking	Significant Features
H1	Moderate	• Supports five-point locations and 25 individuals of *Hibiscus* sp. Gurinbiddy Range (M.E. Trudgen MET 15708) (P2). • Supports one point location and 20 individuals of *Triodia* sp. Mt Ella (M.E. Trudgen 12739) (P3).
H4	Moderate	• Supports two-point locations and six individuals of *Aristida lazaridis* (P2). • Supports two-point locations and eight individuals of *Indigofera gilesii* (P3).
H14	Moderate	• Supports five-point locations and 19 individuals of *Hibiscus* sp. Gurinbiddy Range (M.E. Trudgen MET 15708) (P2). • Supports 13-point locations and 71 individuals of *Indigofera gilesii* (P3). • Supports 11-point locations and 173 individuals of *Triodia* sp. Mt Ella (M.E. Trudgen 12739) (P3). • Supports six-point locations and 22 individuals of *Eremophila magnifica* subsp. *magnifica* (P4).
P7	Moderate	• Supports 15-point locations and 106 individuals of *Aristida lazaridis* (P2)
D6	Low	• Supports 13-point locations and 296 individuals of *Indigofera gilesii* (P3)
H10	Low	• Supports four-point locations and 57 individuals of *Indigofera gilesii* (P3) • Supports 15-point locations and 225 individuals of *Triodia* sp. Mt Ella (M.E. Trudgen 12739) (P3). • Supports one-point location and seven individuals of *Eremophila magnifica* subsp. *magnifica* (P4)
M1	Negligible	• Supports two-point locations and two individuals of *Rhagodia* sp. Hamersley (M. Trudgen 17794) (P3).

Vegetation Condition

The condition of the vegetation within the Study Area ranged from Good to Excellent based on the condition rating scale developed by Trudgen (1988) and presented in EPA (2016b). The majority of the Study Area was Excellent with the drainage, floodplain and flat areas returning a lower vegetation condition rating of Very Good. A small portion of the Study Area in the north was rated as Good condition. The Study Area also included areas that have been cleared for mining and exploration activities, with these areas denoted as cleared.

Disturbances associated with weeds and cattle were low, and is likely reflective of the Study Area mostly consisting of hills and slopes that generally do not support high weed loads and cattle presence. Weed presence was mostly restricted to the drainage lines, floodplains and flats, while the presence and density was low compared to other areas of the West Angelas Revised Proposed Development Envelope.

4. SUMMARY

The Study Area supports seven Priority listed flora, *Aristida lazaridis* (P2); *Hibiscus* sp. Gurinbiddy Range (M.E. Trudgen MET 15708) (P2); *Eremophila naaykensii* (P3); *Indigofera gilesii* (P3); *Rhagodia* sp. Hamersley (M. Trudgen 17794) (P3); *Triodia* sp. Mt Ella (M.E. Trudgen 12739) (P3); and *Eremophila magnifica* subsp. *magnifica* (P4), while the Priority 1 ecological community West Angelas Cracking-Clays is also present in the Study Area. Due to the presence of these significant features, the nine of the 14 vegetation types are of significance.

Vegetation type P15 is Regionally Significant as it is representative of the West Angelas Cracking-Clays PEC, while the remaining seven vegetation types are of Moderate to Low local significance as they support Priority 2, 3 and 4 flora taxa. The remaining five vegetation types mapped within the Study Area are of Negligible significance.

The significant features recorded from the Study Area are not solely located within the Study Area with extensive occurrences/populations known across the West Angelas Revised Proposed Development Envelope.

5. REFERENCES

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Appendix A: Rio Tinto Sponsored Botanist Chain of Custody

Chain of Custody Form – Significant Specimens

Consultant to fill in the information in the tables below, and to indicate approximate study area on Figure 1. All specimen co-ordinates are to be provided in MGA Z50.

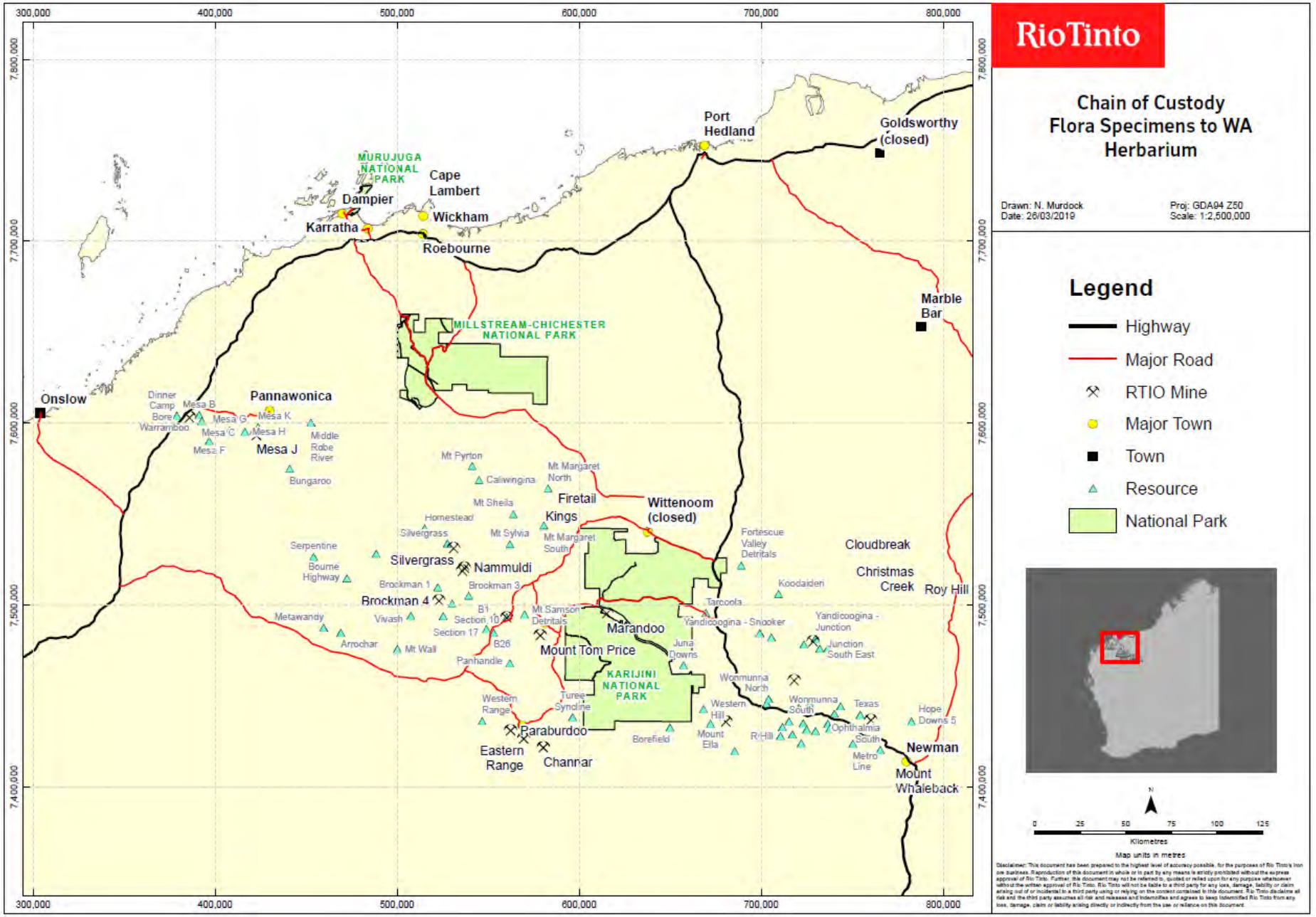
Please refer to the Herbarium Specimen Submission Procedure (RTIO-HSE-0336396) for guidelines on what should be submitted to the RTIO Sponsored Taxonomist for identification.

Consultant Company: Biologic Environmental Survey
Consultant Contact Name: Sam Coultas
Consultant Contact Number: 0400 507 407
Consultant Job Reference: 21082 Mt Ella Dep J trip 2
Specimen Submission Date: 20/07/2022

Rio Tinto Project Manager / Botanist: Stephanie Stack / Hayden Ajduk
Rio Tinto Contact Number:
Rio Tinto Study Area: West Angelas (Deposit J, Mt Ella East, Deposit H infrastructure corridor)
Rio Tinto AR Number (if applicable):

Nearest Named Location to Study Area: West Angelas
Distance and Direction to Nearest Town: 90 km W of Newman
Central Co-ordinate of Study Area: -23.179868°, 118.773998°
Field Survey Date/s: 28/04/2022 - 04/05/2022

Collection No.	Cosultants ID	Cosultants ID notes	Latitude	Longitude	Plant description and habitat	Reason for submission	S. Dillon ID	Comment
SCAGOpp13	Acacia bromilowiana (P4)		-23.21689029	118.8851531	Gnarled shrub, regrowth from recent burn. Shaded side of steep ironstone hill summit	Conservation significant	*Aacia bromilowiana*	P4. Nearest record *c*. 7.7 km WNW.
DJW09-01	Acacia subtiliformis (P3)		-23.2204442	118.7083369	Tall, slender shrub. Growing on calcrete outcrops	Conservation significant	*Acacia subtiliformis*	P3. Nearest record *c*. 41.7 km E.
SCopp	Aristida lazaridis (P2)		-23.1452895	118.8185417	Tussock grass. Minor drainage line	Conservation significant	*Aristida lazaridis*	P2. Nearest record *c*. 7.5 km SE.
SCAGOpp08	Eremophila aff. magnifica	Rachel M: Closest I could get without flowers (fruiting calyx not quite enough) - looks closest to magnifica in all but leaf size - some specimens upstairs have new growth or axiallary growth which approximates the same leaf size - could possibly be a hybrid but not knowing what else was growing around it cannot work it out. Sam C: Potentially matches Eremophila sp. that Biota collected in Stage 2 of Angelo River. Looks like a hybrid between E. magnifica and something else. Always growing with/nearby to E. mag. in same habitat. We picked up better material during the most recent trip during Angelo River targeted. This material will be submitted for ID in the coming weeks	-23.2197375	118.8479451	Low rounded shrub. Growing with and near Eremophila magnifica on rounded ironstone hill slope with outcropping	Interesting specimen	*Eremophila magnifica* × [possibly *petrophylla*]	Leaves smell like nutmeg when crushed (but not as strongly as *E. magnifica*). Not just a diminutive form of *E. magnifica* as the pedicels and sepals have glandular and eglandular hairs (no gladular hairs on *E. magnifica*). I generated a list of the *Eremophila* that have been lodged within a 20 km radius of this specimen and the only likely candidate as the other parent is *E. petrophylla* (which is the same section of *Eremophila* as *E. magnifica*). Flowers and fruits may be useful along with observations of what other *Eremophila* occur nearby.
Scopp	Eremophila magnifica subsp. magnifica (P4)		-23.2197136	118.8479458	Shrub, on ironstone hill slope with outcropping	Conservation significant	*Eremophila magnifica* subsp. *velutina*	P3. Nearest record *c*. 22.9 km NNW.
SCAGOpp04	Eremophila magnifica subsp. velutina (P3)		-23.11142	118.789565	Shrub, on ironstone hill slope with outcropping	Conservation significant	*Eremophila magnifica* subsp. *velutina*	P3. Nearest record *c*. 9.4 km NNW.
SCopp	Eremophila naaykensii (P3)		-23.11262664	118.8242033	Shrub, on ironstone hill slope with outcropping	Conservation significant	*Eremophila naaykensii*	P3. Nearest record *c*. 6.6 km WSW.
SCAGopp03	Hibiscus sp. Gurinbiddy Range (M.E. Trudgen MET 15708) (P2)		-23.2199266	118.8455809	Erect, slender shrub. Shaded gully/cliff	Conservation significant	*Hibiscus* sp. Gurinbiddy Range (M.E. Trudgen MET 15708)	P2. Nearest record *c*. 5 km NW.
MEE02-01	Indigofera gilesii (P3)		-23.2228768	118.849109	Erect shrub. Ironstone gully	Conservation significant	*Indigofera gilesii*	P3. Nearest record *c*. 3.3 km N.
SCAGOPP09	Pilbara trudgenii (P3)		-23.2165454	118.884697	Shrub. Growing out of cliff face on southern shaded side of Mt Ella summit	Conservation significant	*Pilbara trudgenii*	P3. Nearset record *c*. 17.5 km NW.
MEE01-01	Rhagodia sp. Hamersley (M.Trudgen 17794) (P3)		-23.2195583	118.8456763	Slender shrub, mulga hardpan plain	Conservation significant	*Rhagodia* sp. Hamersley (M. Trudgen 17794)	P3. Nearest record *c*. 2.3 km NW.
MEE15-01	Solanum kentrocaule (P3)		-23.2167919	118.8698904	Spikey shrub, rocky gully of massive ironstone hills	Conservation significant	*Solanum kentrocaule*	P3. Nearest record *c*. 15.3 km NNW
SCopp	Triodia sp. Mt Ella (M.E. Trudgen 12739) (P3)		-23.2239975	118.8703377	Steep slopes of massive ironstone gully	Conservation significant	*Triodia* sp. Mt Ella (M.E. Trudgen 12739)	P3. Nearest record *c*. 4 km W.


RioTinto
Chain of Custody
Flora Specimens to WA
Herbarium
Drawn: N. Murdock
Date: 26/03/2019
Proj: GDA94 Z50
Scale: 1:2,500,000
Legend
Highway
Major Road
RTIO Mine
Major Town
Town
Resource
National Park
Kilometres
Map units in metres
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MURUJUGA NATIONAL PARK
MILLSTREAM-CHICHESTER NATIONAL PARK
KARIJINI NATIONAL PARK
Port Hedland
Goldsworthy (closed)
Cape Lambert
Dampier
Wickham
Karratha
Roebourne
Marble Bar
Onslow
Pannawonica
Dinner Camp Bore
Warramboo
Mesa B
Mesa G
Mesa K
Mesa C
Mesa H
Mesa F
Mesa J
Middle Robe River
Bungaroo
Mt Pyrton
Caliwingina
Mt Margaret North
Firetail
Mt Sheila
Homestead
Kings
Wittenoom (closed)
Silvergrass
Mt Sylvia
Mt Margaret South
Fortescue Valley Detritals
Cloudbreak
Serpentine
Bourne Highway
Silvergrass
Nammuldi
Christmas Creek
Roy Hill
Brockman 1
Brockman 3
Brockman 4
Koodaideri
Tarcoola
Metawandy
Vivash
B1
Section 10
Mt Samson Detritals
Yandicoogina - Snooker
Yandicoogina - Junction
Section 17
B26
Marandoo
Arrochar
Mt Wall
Mount Tom Price
Junction South East
Panhandle
Juna Downs
Wonmunna North
Turee Syndrome
Western Range
Wonmunna South
Texas
Western Hill
Hope Downs 5
Paraburdoo
Borefield
Mount Ella
R Hill
Ophthalmia
Eastern Range
Channar
Metro Line
Newman
Mount Whaleback
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800,000
7,800,000
7,700,000
7,600,000
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7,400,000

Appendix B: Deposit H Infrastructure Flora Likelihood of Occurrence

Species	Conservation Status			Habitat	Likelihood of Occurrence		Comments
	EPBC Act	BC Act	DBCA		Pre-Survey	Post-Survey	
Triodia sp. Mt Ella (M.E. Trudgen 12739)			P3	Light orange-brown to red-brown pebbly loam on hill slopes and in gullies.	Confirmed	Confirmed	Confirmed within DHI
Indigofera gilesii			P3	Skeletal red-brown loam on rocky slopes, gorges, and creeklines.	Highly Likely	Confirmed	Confirmed within DHI
Aristida lazaridis			P2	Major drainage areas through clayey flats.	Highly Likely	Confirmed	Confirmed within DHI
Rhagodia sp. Hamersley (M. Trudgen 17794)			P3	Mulga (*Acacia aneura*) and Snakewood (*A. xiphophylla*) vegetation on clay plains.	Highly Likely	Confirmed	Confirmed within DHI
Hibiscus sp. Gurinbiddy Range (M.E. Trudgen MET 15708)			P2	Hilltops, upper hillslopes.	Possible	Confirmed	Confirmed within DHI
Eremophila naaykensii			P3	Skeletal red-brown silty loam on hill crests, cliff tops, gorges.	Possible	Confirmed	Confirmed within G2 vegetation community
Eremophila magnifica subsp. *magnifica*			P4	Rocky hillslopes, breakaways.	Highly unlikely	Confirmed	Confirmed within H14 vegetation community
Vittadinia sp. Coondewanna Flats (S. van Leeuwen 4684)			P3	Mainly on red clay on plains, low in the landscape.	Confirmed	Possible	A confirmed record within DHI, but was not found during the field survey. Suitable habitat present, while individuals may have been missed
Euphorbia clementii			P3	Gravelly hillsides, stony ground.	Highly Likely	Possible	Suitable habitat present in DHI, however, no individuals were observed, but the possibility that individuals were missed.
Themeda sp. Hamersley Station (M.E. Trudgen 11431)			P3	Clay plains.	Highly Likely	Possible	Potential specimen collected but ID was inconclusive. Potential habitat in P16 vegetation community. The taxonomy of the genus *Themeda* is complex and in need of revision.
Lepidium catapycnon			P4	Skeletal soils on hill slopes.	Highly likely	Possible	Marginal habitat present within H14 vegetation community, however no individuals were recorded

Species	Conservation Status			Habitat	Likelihood of Occurrence		Comments
	EPBC Act	BC Act	DBCA		Pre-Survey	Post-Survey	
Euphorbia stevenii			P3	Clay soils.	Possible	Possible	Marginal habitat present within P16 vegetation community, while individuals may have been missed
Isotropis parviflora			P3	Undulating ironstone plains.	Unlikely	Possible	Suitable habitat present in DHI, however, no individuals were observed, but the possibility that individuals were missed.
Aristida jerichoensis var. *subspinulifera*			P3	Hardpan clay plains.	Unlikely	Possible	Marginal habitat present within P16 vegetation community, while individuals may have been missed
Dolichocarpa sp. Hamersley Station (A.A. Mitchell PRP 1479)			P3	Stony undulating clay plains.	Unlikely	Possible	Marginal habitat present within P16 vegetation community, while individuals may have been missed
Rhodanthe ascendens			P1	Cracking clay.	Highly unlikely	Possible	Potential habitat present within P16 vegetation community, while individuals may have been missed
Rostellularia adscendens var. *latifolia*			P3	Various; creeks, plains, low hills.	Possible	Unlikely	Marginal habitat present within DHI, however no individuals were recorded.
Olearia mucronata			P3	Hills and rocky drainage channels.	Possible	Unlikely	Restricted to upper hillslopes, breakaways, gullies and rock outcropping. Marginal habitat present in H14 vegetation community, with no individuals recorded
Sida sp. Barlee Range (S. van Leeuwen 1642)			P4	Steep slopes, rocky gullies and breakaways.	Possible	Unlikely	Restricted to upper hillslopes, breakaways, gullies and rock outcropping. Marginal habitat present in H14 vegetation community, with no individuals recorded

Species	Conservation Status			Habitat	Likelihood of Occurrence		Comments
	EPBC Act	BC Act	DBCA		Pre-Survey	Post-Survey	
Solanum kentrocaule			P3	Hillsides and mountain crests, creek beds; skeletal red-brown soil over ironstone on basalt or scree.	Possible	Unlikely	Restricted to upper hillslopes, breakaways, gullies and rock outcropping. Marginal habitat present in H14 vegetation community, with no individuals recorded
Swainsona thompsoniana			P3	Creekline, claypan.	Possible	Unlikely	Marginal habitat presnet, with no individuals recorded.
Eremophila pusilliflora			P2	Alluvial plains.	Unlikely	Unlikely	No suitable habitat observed within the Study Area
Xerochrysum boreale			P3	Loamy, sandy or gravelly soils on plains.	Unlikely	Unlikely	Marginal habitat is present, however no individuals were recorded.
Acacia bromilowiana			P4	Skeletal loam soils on rocky hills, breakaways, scree slopes, gorges and rocky creek beds.	Unlikely	Unlikely	Marginal habitat present within DHI, however no individuals were recorded.
Goodenia lyrata			P3	Near claypans.	Unlikely	Unlikely	Marginal habitat within P16 vegetation community, no individuals recorded
Acacia effusa			P3	Stony red loam; scree	Possible	Highly unlikely	Suitable habitat present, however, it would have been easily identifiable during the survey, and was not observed
Acacia daweana			P3	Stony red loamy soils on low rocky rises and along drainage lines.	Unlikely	Highly unlikely	Suitable habitat present, however, it would have been easily identifiable during the survey, and was not observed. Furthermore, nearest known record is further to the south
Acacia subtiliformis			P3	Calcrete platforms.	Unlikely	Highly unlikely	No suitable habitat (calcrete) is present within the Study Area

Species	Conservation Status			Habitat	Likelihood of Occurrence		Comments
	EPBC Act	BC Act	DBCA		Pre-Survey	Post-Survey	
Pilbara trudgenii			P3	Skeletal red stony soil over ironstone; hill summits, steep slopes, screes, cliff faces.	Unlikely	Highly unlikely	Restricted to upper hillslopes, breakaways, gullies and rock outcropping. Marginal habitat present in H14 vegetation community, with no individuals recorded
Sida sp. Hamersley Range (K. Newbey 10692)			P3	Base of rocky cliff habitats in red skeletal stony soils or ironstone.	Unlikely	Highly unlikely	Restricted to upper hillslopes, breakaways, gullies and rock outcropping. Marginal habitat present in H14 vegetation community, no nearby records
Stackhousia clementii			P3	Skeletal soils, sandstone hills.	Unlikely	Highly unlikely	Marginal habitat present within H14 vegetation community, however no nearby records
Eragrostis sp. Mt Robinson (S. van Leeuwen 4109)			P2	Red-brown skeletal soils, ironstone; steep slopes, summits of tall hills.	Highly unlikely	Highly unlikely	Poorly understood and currently only known from Mt Robinson
Eremophila sp. West Angelas (S. van Leeuwen 4068)			P2	Skeletal red-brown soil on hill summits high in the landscape.	Highly unlikely	Highly unlikely	Restricted to steep gorges and gullies, summits and high in the landscape. Marginal habitat present within H14 vegetation community, no nearby records
Euphorbia inappendiculata var. *queenslandica*			P2	Heavy clay soils on open plains and gentle slopes.	Highly unlikely	Highly unlikely	Potential habitat present within P16 vegetation community, but >30km to nearest record
Hibiscus sp. Mt Brockman (E. Thoma ET 1354)			P1	Gorges, rocky areas.	Highly unlikely	Highly unlikely	Restricted to steep gorges and gullies, summits and high in the landscape. Marginal habitat present within H14 vegetation community, no nearby records
Triodia sp. Karijini (S. van Leeuwen 4111)			P1	Skeletal dark orange-brown to red-brown soil on upper slopes and summits of mountains.	Highly unlikely	Highly unlikely	Restricted to steep gorges and gullies, summits and high in the landscape. Marginal habitat present within H14 vegetation community, no nearby records

Species	Conservation Status			Habitat	Likelihood of Occurrence		Comments
	EPBC Act	BC Act	DBCA		Pre-Survey	Post-Survey	
Oxalis sp. Pilbara (M.E. Trudgen 12725)			P2	Red-brown loam on rocky hillslopes and in gorges.	Highly unlikely	Highly unlikely	Restricted to breakaways, gullies, gorges and shaded areas. No suitable habitat present in the Study Area
Tetratheca fordiana			P2	Shale pockets amongst ironstone on free rock faces.	Highly unlikely	Highly unlikely	Restricted to steep gorges and gullies, summits and high in the landscape. Marginal habitat present within H14 vegetation community, no nearby records
Teucrium pilbaranum			P2	Crab hole floodplains; margins of calcrete tables.	Highly unlikely	Highly unlikely	No suitable habitat is present in the Study Area
Dampiera metallorum			P3	Skeletal red-brown gravelly soil over banded ironstone; steep slopes and hill summits at high elevation.	Highly unlikely	Highly unlikely	Restricted to steep slopes, summits and high in the landscape. Marginal habitat within H14 vegetation community, with no individuals recorded
Eremophila magnifica subsp. velutina			P3	Skeletal soils over ironstone on summits and breakaways.	Highly unlikely	Highly unlikely	Restricted to upper hillslopes, breakaways, gullies and rock outcropping. Marginal habitat present within H14 vegetation community, no nearby records
Eremophila rigida			P3	Red sand alluvium. Hardpan plains and stony clay depressions.	Highly unlikely	Highly unlikely	Mostly occurs within the Gascoyne bioregion
Geijera salicifolia			P3	Skeletal and stony soils in massive rock scree, rockpiles and gorges.	Highly unlikely	Highly unlikely	Mostly restricted massive rock screes, rockpiles and gorges. Marginal habitat present in H14 vegetation community, no nearby records
Goodenia sp. East Pilbara (A.A. Mitchell PRP 727)			P3	Red-brown clay soil, typically on calcrete platforms.	Highly unlikely	Highly unlikely	No suitable habitat (calcrete) is present within the Study Area

Species	Conservation Status			Habitat	Likelihood of Occurrence		Comments
	EPBC Act	BC Act	DBCA		Pre-Survey	Post-Survey	
Grevillea saxicola			P3	Upper scree slopes on banded ironstone, usually with Mulga.	Highly unlikely	Highly unlikely	Restricted to upper hillslopes, breakaways, gullies and rock outcropping. Marginal habitat present in H14 vegetation community, with no individuals recorded
Triodia basitricha			P3	Slopes or crests of rocky hills.	Highly unlikely	Highly unlikely	Restricted to upper hillslopes, breakaways, gullies and rock outcropping. Marginal habitat within H14 vegetation community, no nearby records
Ptilotus mollis			P4	Stony hills and screes.	Highly unlikely	Highly unlikely	Restricted to upper hillslopes, breakaways, gullies and rock outcropping. Marginal habitat present within H14 vegetation community, no nearby records
Thryptomene wittweri	VU	VU		Breakaways and stony creek beds on high mountains (>1,000 m in elevation).	Highly unlikely	Highly unlikely	Restricted to Mt Meharry in the Pilbara

Appendix C: Flora Recorded from the Study Area

Amaranthaceae

Amaranthus undulatus
Ptilotus gomphrenoides
Ptilotus obovatus var. *obovatus*

Apocynaceae

Cynanchum viminale

Asteraceae

**Bidens bipinnata*
Leiocarpa semicalva subsp. *semicalva*
Streptoglossa bubakii

Bignoniaceae

Pandorea pandorana

Boraginaceae

Heliotropium pachyphyllum

Brassicaceae

Stenopetalum decipiens

Capparaceae

Capparis mitchellii

Chenopodiaceae

Maireana tomentosa
Rhagodia eremaea
Rhagodia sp. Hamersley (M. Trudgen 17794) (Priority 3)

Convolvulaceae

Duperreya commixta
Ipomoea plebeia

Euphorbiaceae

Adriana tomentosa

Fabaceae

Acacia dictyophleba
Acacia maitlandii
Acacia pruinocarpa
Acacia synchronicia
Acacia tetragonophylla
Indigofera fractiflexa subsp. *fractiflexa*
Indigofera gilesii (Priority 3)

Indigofera rugosa
Isotropis iophyta
Senna artemisioides subsp. ×*artemisioides*
Senna artemisioides subsp. *helmsii*
Senna artemisioides subsp. *oligophylla*
Senna glaucifolia
Senna glutinosa subsp. ×*luerssenii*
Senna glutinosa subsp. *glutinosa*
Senna glutinosa subsp. *pruinosa*
Tephrosia rosea var. Fortescue creeks (M.I.H. Brooker 2186)
**Vachellia farnesiana*
Vigna sp. Hamersley Clay (A.A. Mitchell PRP 113)

Goodeniaceae

Goodenia stellata

Hemerocallidaceae

Tricoryne sp. Hamersley Range (S. van Leeuwen 915)

Malvaceae

Gossypium australe
Hibiscus sp. Gurinbiddy Range (M.E. Trudgen MET 15708) (Priority 2)
**Malvastrum americanum*
Sida fibulifera
Sida sp. L (A.M. Ashby 4202)

Moraceae

Ficus brachypoda

Poaceae

Aristida inaequiglumis
Aristida lazaridis (Priority 2)
Astrebla pectinata
**Cenchrus ciliaris*
Chrysopogon fallax
Cymbopogon ambiguus
Cynodon convergens
Digitaria ctenantha
Diplachne fusca
Enneapogon polyphyllus
Eragrostis xerophila
Iseilema membranaceum
Paraneurachne muelleri
Schizachyrium fragile
Themeda triandra

Poaceae (cont'd)

Triodia brizoides
Triodia pungens
Triodia sp. Mt Ella (M.E. Trudgen 12739) (Priority 3)

Proteaceae

Grevillea berryana
Hakea lorea subsp. *lorea*

Pteridaceae

Cheilanthes sieberi subsp. *sieberi*

Rubiaceae

Psydrax latifolia
Psydrax suaveolens

Scrophulariaceae

Eremophila latrobei subsp. *filiformis*
Eremophila magnifica subsp. *magnifica* (Priority 4)
Eremophila naaykensii (Priority 3)
Eremophila platycalyx

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D.2: West Angelas Beyond 2020 Mt Ella East and Dep J Detailed and Targeted Survey

Biologic Environmental Survey Pty Ltd
PO Box 179
Floreat, WA, 6014

22 December 2022

Attn: Elizabeth Mason

Rio Tinto Iron Ore

Dear Elizabeth,

Please find below a memo summarising the reconnaissance and targeted flora and vegetation survey completed by Biologic Environmental Survey Pty Ltd (Biologic) within unsurveyed areas for the Deposit J and Mt. Ella East Infrastructure area for the West Angelas Project Envelope.

If you have any queries, please do not hesitate to contact me.

Yours sincerely,

Clinton van den Bergh
Principal Botanist | Manager of Botany
Clinton@biologicenv.com.au
(08) 6365 5066 | 0439 910 881

1. INTRODUCTION AND OBJECTIVES

Biologic were commissioned to undertake a two-season detailed baseline flora and vegetation survey of historically surveyed and unsurveyed areas of the Mt Ella East and Deposit J surveys areas within the West Angelas Project Envelope (herein collectively referred to as the Study Area) (Figure 1.1). The Study Area is located within the West Angelas Revised Proposed Development Envelope and comprises two survey areas covering a total of 2,081.39 hectares (ha) (Figure 1.1), that encompasses:

- Deposit J area – 556.48 ha; and
- Mt Ella East area – 1,524.91 ha.

The overarching objective of this assessment was to undertake a two-season detailed and targeted flora and vegetation survey to identify the occurrence of flora and vegetation within the Study Area, with a particular focus on significant species (as per EPA, 2020), to inform future development and environmental approvals within the West Angelas Development Envelope. Significant species that were the focus of this survey are based on species identified in a previous desktop assessment completed for the broader West Angelas Revised Proposal Development Envelope, which encompasses the Study Area (Biota, 2020).

Due to the existence of previous field surveys and significant flora records, the objective of this survey was to 'fill-in' previously unsurveyed areas within the West Angelas project and expand understanding of the presence and distribution of significant flora in a local and regional context. Therefore, not all portions of the study area were needed to be accessed and surveyed to fulfill the outlined scope of this survey. Furthermore, a substantial portion (416.78 ha) of the Deposit J survey area was not accessible at the time of the survey, and was not surveyed.

Biota (2020) have recently completed a two-season survey across a substantial portion of the West Angelas Development Envelope. Biota (2020) provide a detailed discussion on the background environment and regional context. As such, this report does not provide any detail on the background environment.

660000 670000 680000 690000 700000

7450000 7440000 7430000

Great Northern Hwy

West Angelas

Port Hedland
Karratha
Newman

LEGEND

- West Angelas Project Envelope
- Operating Mine
- State Road
- Rail

IBRA Region
- Pilbara

IBRA Subregion
- Chichester
- Fortescue
- Hamersley
- Roebourne

N

biologic Environmental Survey

Scale 1:120,000

0 2 4 6 Km

Coordinate System: GDA2020 MGA Zone 50
Transverse Mercator Created: 22/12/2022

Port Hedland
Karratha
Tom Price
Paraburdoo
Newman

RIO TINTO IRON ORE

West Angelas Mt Ella East and Deposit J

Figure 1.1: West Angelas Project Envelope

1.1. Conformance and Licensing

This assessment was carried out in a manner consistent with the following guidelines and recommendations from the Environmental Protection Authority (EPA), relevant survey-specific license conditions and, where relevant, Rio Tinto guidelines and standards:

- DoE (2013) Matters of National Environmental Significance: Significant impact guidelines 1.1;
- EPA (2018) Statement of Environmental Principles, Factors and Objectives;
- EPA (2016a) Environmental Factor Guideline: Flora and Vegetation;
- EPA (2016b) Technical Guidance – Flora and Vegetation Surveys for Environmental Impact Assessment; and
- Rio Tinto (2021a) for targeted flora surveys and data collection.

Flora specimen collections were conducted under a DBCA Regulation 62 "Flora Taking (Biological Assessment) Licences issued to Sam Coultas (FB62000017-2), Emma Marsh (FB62000233-4) and Kaylin Geelhoed (FB62000238-1b). In accordance with Section 40 of the *Biodiversity Conservation Act 2016* (BC Act), threatened species sampling was completed under a DBCA "Authorisation to Take or Disturb Threatened Species" issued to Sam Coultas (authorisation number TFL 60-1819).

1.2. Background to Protection of Flora and Ecological Communities

Within Western Australia, all native flora and ecological communities are protected under the BC Act and at a national level under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Any action that has the potential to impact on native flora or ecological communities needs to be approved by relevant state and/or federal departments as dictated by the state *Environmental Protection Act 1986* (EP Act) and the EPBC Act.

While all native flora and ecological communities are protected under these Acts, some species of flora and ecological communities that are determined to be at risk of extinction or decline are afforded extra protection under these Acts. These include species that are considered Threatened (Critically Endangered, Endangered and Vulnerable) under the EPBC Act and/or BC Act.

The EPBC Act identifies Threatened Ecological Communities (TECs) as ecological communities at risk of extinction. The BC Act provides for the statutory listing of TECs by the WA Minister for Environment (the Minister). The Minister has endorsed 69 ecological communities as Threatened under Critically Endangered (20), Endangered (17), Vulnerable (28) and Presumed Totally Destroyed (four).

Furthermore, any species or ecological communities that may be threatened but for which there is insufficient information available to allocate a threatened status under the BC Act, can also be listed as Priority species (Priority 1–4) or ecological communities (Priority 1-5) by the Western Australian Department of Biodiversity, Conservation and Attractions (DBCA).

For the purposes of this memo, these species are deemed to be significant species. A summary of applicable legislation and status codes is provided in Table 1.1.

Table 1.1: Significance assessment guidelines

Agreement, Act or List	Status Code
Federal	
Environment Protection and Biodiversity Conservation Act 1999 DAWE lists threatened flora, which are determined by the Threatened Species Scientific Committee (TSSC) according to criteria set out in the Act. The Act lists flora that are considered to be of conservation significance under one of eight categories (listed under 'Status Codes'). TECs are those that are at risk of extinction.	• Extinct (EX) • Extinct in the Wild (EW) • Critically Endangered (CE) • Endangered (EN) • Vulnerable (VU) • Conservation Dependent (CD) • Critically Endangered (CE) • Endangered (EN) • Vulnerable (VU)
State	
Biodiversity Conservation Act 2016 The BC Act provides for the listing of threatened native flora and ecological communities that need protection as critically endangered, endangered or vulnerable species or ecological communities because they are under identifiable threat of extinction (species) or collapsed (ecological communities).	• Schedule 1 (Critically Endangered) (S1 or CR) • Schedule 2 (Endangered) (S2 or EN) • Schedule 3 (Vulnerable) (S3 or VU) • Schedule 4 (Extinct) (S4 or EX)
DBCA Priority list DBCA produces a list of Priority species and ecological communities (e.g., PECs) that have not been assigned statutory protection under the BC Act. This system gives a ranking from Priority 1 to Priority 4 for flora and Priority 1 to Priority 5 for ecological communities	• Priority 1 (P1) • Priority 2 (P2) • Priority 3 (P3) • Priority 4 (P4) • Priority 5 (PECs) (P5)

2. METHODS

2.1. Taxonomy and Nomenclature

Flora nomenclature used in this *memo* is consistent with the WAH's plant census, provided on Florabase© (WAH, 1998-). All species are current at the time of report preparation.

Plant taxa that could not be identified during the field survey were collected, assigned a unique number for tracking purposes, and pressed for subsequent identification. Identifications were carried out by Biologic's taxonomists, Mr Samuel Coultas and Dr Rachel Meissner, utilising Western Australian Herbarium's reference collection, taxonomic keys, and reference material. All taxa were checked against FloraBase© (WAH, 1998-) to ensure their currency and validity.

A representative specimen of all significant flora observed in the Survey Area was collected and submitted to the Rio Tinto sponsored botanist, Steve Dillon, for confirmation, in accordance with Rio Tinto's chain of custody requirements. The submitted specimens list and their confirmed identification is included in Appendix A.

2.2. Desktop Assessment

A desktop assessment was undertaken utilising information collated from the desktop assessment and field survey conducted by Biota (2020) for the broader West Angelas Beyond 2020 Development Envelope, which encompasses the Study Area. This assessment also reviewed aerial photography (Scale 1:30,000) of the Study Area and Google Earth Pro© imagery, along with data provided by Rio Tinto from their internal database (Rio Tinto, 2021b). Additionally, the results of the targeted flora survey of the Mt Ella East and Deposit J area completed by Biologic (2021a) was reviewed and considered in this assessment.

The desktop assessment also reviewed the consolidated vegetation mapping completed by Biologic (2021b) to ensure adequate representation and coverage of flora sampling sites across the survey areas. The sampling also took into consideration the vast amount of work completed across the West Angelas Development Envelope by Biota (2020) and others (ecologia, 2013; Trudgen & Ecaus, 1998).

The desktop assessment was used to further refine sampling methods to ensure appropriate sampling was undertaken for all target species and to allow an accurate assessment of their occurrence or likelihood of occurrence within the Study Area.

2.3. Field Survey

2.1.1. Survey Timing and Personnel

The targeted flora survey was undertaken over two seasons, consisting with baseline detailed flora and vegetation surveys as specified by the EPA (2016b). The first survey or phase was undertaken over four days on the 28th to the 1st of May 2022 by Senior Botanist Sam Coultas with assistance from Alice Greenwood. Sam has over 10 years' experience undertaking flora surveys within the Pilbara region, including targeted surveys for the significant species that were the focus of this assessment (Table 2.1).

The second site visit or phase 2 was undertaken over four days on the 9th to the 12th of August by Botanists Kaylin Geelhoed and Emma Marsh. Both Kaylin and Emma have over three years' experience completing botanical surveys across the Pilbara (Table 2.1) and have completed surveys across West Angelas and Angelo River, supporting experienced and senior botanists. Kaylin and Emma have completed targeted surveys for the significant species that were the focus of this assessment.

Table 2.1: Project Team and experience

Biologic Personnel	Project Involvement	Licencing	Qualification	Experience
Phase 1 (28 April to 1 May 2022)				
Sam Coultas Senior Botanist	Field team lead	FB62000017-2 TFL 2223-0028	BSc Environmental Biology	10 yrs field survey 10 yrs EIA (consulting) 10 yrs botanical 10 yrs Pilbara botanica/ field experience
Alice Greenwood Botanist	Field Survey	-	BSc Environmental Biology	4 yrs field survey 3 yrs Botanical
Phase 2 (9 to 12 August 2022)				
Kaylin Geelhoed Botanist	Field survey	FB62000238-1b	BSc Conservation and Wildlife Biology, Marine Science	3 yrs Field survey 3 yrs EIA (consulting) 3 yrs Botanical 3 yrs Pilbara botanical/ field experience
Emma Marsh Botanist	Field survey, Data entry & processing, data analysis support.	FB62000233-4	BSc Conservation and Wildlife Biology	3 yrs Field survey 4 yrs EIA (consulting) 3 yrs Botanical 3 yrs Pilbara botanical/ field experience

2.1.2. Climate and Weather

Observed weather conditions prior to and during the survey are shown in Figure 2.1, alongside long-term climatic data for Newman Airport (station #007176). In the 16 months prior to the survey (June 2021–August 2022), mean minimum and maximum temperatures recorded at Newman Airport were variable compared to the long-term averages for most months, with some months exceeding long-term averages by 2 °C or recording a mean less than 2 °C than the long term average (Figure 2.1). Rainfall in the months preceding the surveys was variable, with below long-term averages recorded through most months, except for November 2021 (13.8 mm v 12.4 mm), February 2022 (73 mm v 72.3 mm) and June 2022 (22.8 mm v 15.8 mm), which had rainfall consistent with long-term averages (Figure 2.1). During the month of May 2022, rainfall far exceeded the monthly average with 59.40 mm falling (compared to the long-term average of 19 mm). In total, the rainfall received in the months prior to the survey (June 2021 to August 2022; 232.40 mm) was well below the annual long-term average (350.0 mm) (BoM, 2021).

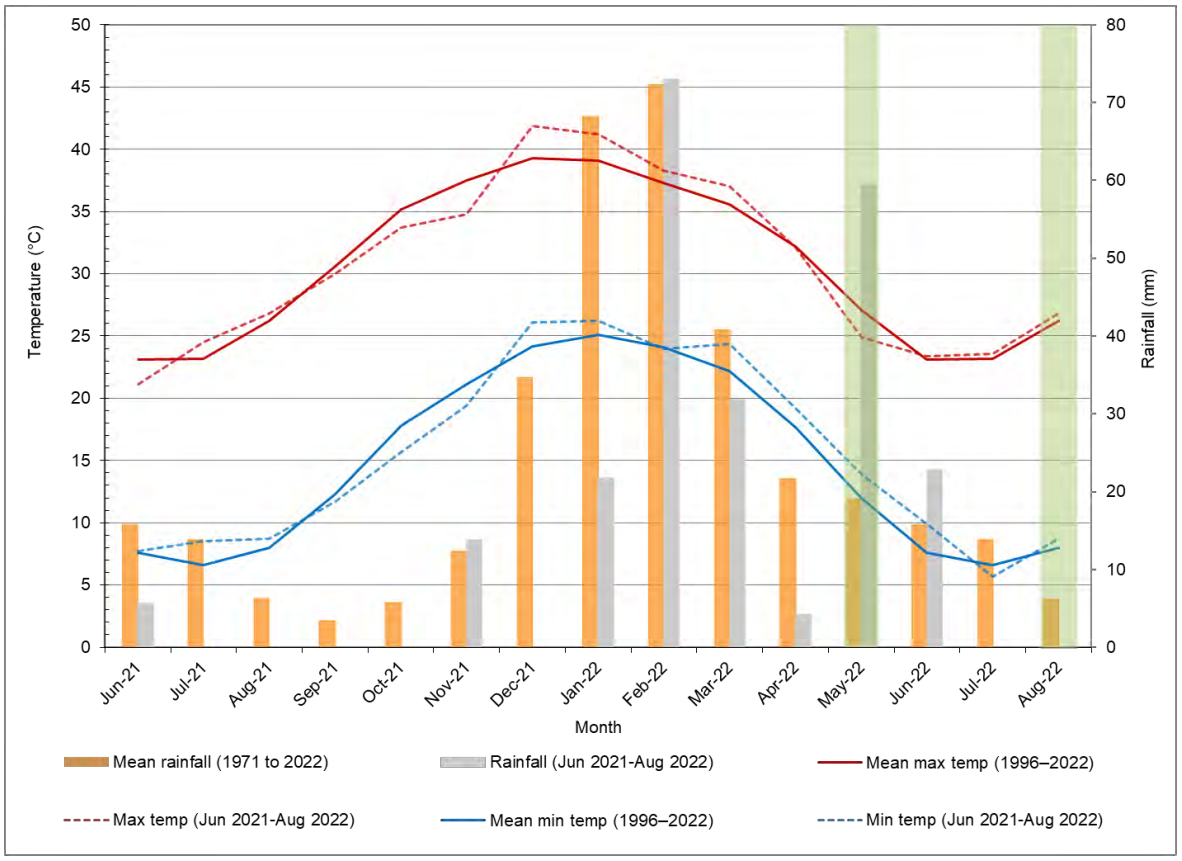


Figure 2.1: Monthly rainfall and long-term average rainfall for Newman Aero (Station ID 007176) (BoM, 2021) (Green columns indicate field survey timing)

Observed minimum and maximum temperatures during the surveys were mostly below the long-term average (Table 2.2) (BoM, 2021), however, the first field survey occurred at the end of April/ start of May 2022, so temperatures would have foreseeably fallen further as the month progressed. Rain was received at the Newman Airport station (007176) three of the four field days during the first survey, with 1.4 mm of rain on the 29th of May, with a further 0.2 mm and 2.6 mm (Table 2.2) recorded over

the subsequent field survey days (BoM, 2021). The temperatures and weather patterns leading into and during the second field survey in August were consistent with long-term averages, while no rainfall was recorded during the second field survey (Table 2.2).

Table 2.2: Climatic conditions recorded for Newman Airport during the Field Trip 1 survey

Date	Min. temp (°C)	Max. temp (°C)	Rainfall (mm)
Phase 1			
28/04/2022	17.0	24.5	0.0
29/04/2022	17.7	24.3	1.4
30/04/2022	18.1	24.7	0.2
01/05/2022	16.3	24.2	2.6
Average/ total	**17.4**	**24.4**	**4.2**
Phase 2			
09/08/2022	14.1	20.2	0.0
10/08/2022	7.5	19.2	0.0
11/08/2022	1.0	21.4	0.0
12/08/2022	0.8	24.1	0.0
Average/ total	**5.8**	**21.2**	**0.0**

2.4. Sampling and Survey Methods

2.1.3. Detailed Survey

Aerial photography (Scale 1:15,000) of the Survey Area and Google Earth Pro©, were used with previous vegetation mapping (Beard, 1975; Biologic, 2021b; Shepherd *et al.*, 2002) to determine the mapped vegetation type boundaries prior to the field survey.

A two-season detailed flora and vegetation survey was carried out across the Study Area. Detailed surveys require quadrat data for replicated and delineated representation of vegetation composition to support vegetation determination. A combination of quadrats, relevés, meandering traverses, and opportunistic sampling is appropriate for a detailed flora survey (EPA, 2016b). These techniques are described in Table 2.3. A total of 14 quadrats and 12 relevés were sampled (Figure 2.2).

Biologic utilised a helicopter to access areas with limited vehicle tracks and steep or difficult to access terrain. Survey effort was focused on sampling the existing consolidated vegetation types with at least one sample site, with additional sites sampled to provide spatial distribution and to capture variation in the vegetation communities. The vegetation types were not sampled with three sites per type as required by the EPA (2016b), due to the greater West Angelas area having already been comprehensively sampled by Biota (2020) recently.

675000 680000 685000 690000

7435000

7430000

West Angelas

LEGEND

- West Angelas Project Envelope
- Operating Mine
- Rail
- Vegetation Survey Area
- Heritage Site

Site Type

- Quadrat
- Relevé
- Traverse

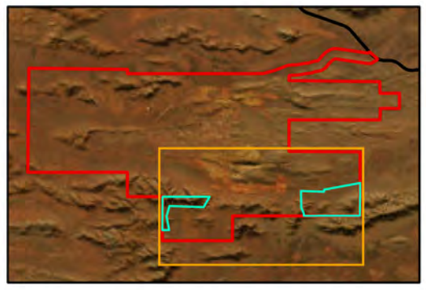
N

biologic Environmental Survey

Scale 1:50,000

0 1 2 Km

Coordinate System: GDA2020 MGA Zone 50
Transverse Mercator Created: 22/12/2022



RIO TINTO IRON ORE

West Angelas Mt Ella East and Deposit J

Figure 2.2: Sample sites and traverses

Prior to field mobilisation, site locations were selected using a combination of aerial imagery, surface geology layers, contour mapping, specialist knowledge of Pilbara vegetation communities and the consolidated vegetation mapping completed by Biologic (2021b). These sites were selected to be representative of the vegetation in the Study Area. Parts of the Study Area that looked unusual from the aerial imagery or appeared to represent potential habitat for significant flora and vegetation were also targeted. A substantial portion of the Deposit J survey area was not sampled as it coincided with a Rights Reserve site and permission was not obtained to sample the flora and vegetation. Survey effort is presented in Figure 2.2, quadrat site data presented in Appendix B.

Table 2.3: Detailed field survey techniques

Approach	Description
Quadrat	A comprehensive and replicable survey technique for gathering information during a detailed flora and vegetation assessment. A clearly defined area of set proportions, giving a consistent assessment of flora and vegetation across the Study Area. Each quadrat represents a vegetation type, and each vegetation type must be represented by a minimum of three quadrat sites. Information collected at each quadrat includes: • Site code, date, location, botanist; • One photograph, from the north-west corner of the site; • Soil characteristics (texture and colour); • Geology (type, size and nature of any rocks, stones, gravel, or outcropping); • Topography (landform type and aspect); • Brief description of the vegetation structure in line with NVIS classifications (NVIS Technical Working Group, 2017); • Vegetation condition; • Disturbances (including fire); • Flora and vegetation information (including dominant cover, structure); and • Comprehensive recording of every vascular flora species within the quadrat boundary (including overhang from plants rooted outside the quadrat boundary), along with their height and cover and number of individuals where necessary (50 x 50 m for a Pilbara botanical survey).
Relevé	Relevés used in a detailed survey are employed to support the vegetation mapping and survey effort. They are a lower intensity survey technique or sampled where quadrats are too dangerous to set up (such as steep gorges or embankments) or the landform does not support adequate area for a detailed quadrat. Information collected at each relevé is the same as that of a quadrat site, excluding the comprehensive collection of every species within the quadrat boundary.
Traverse/ Meandering Traverse	A traverse is an unmarked route along which data is collected. Traverses are useful for identifying the boundaries and characteristics of vegetation types, selecting sites for detailed survey, and targeting significant flora or vegetation. Information recorded along a traverse is the same as a relevé, with the addition of noting vegetation changes and relationships between vegetation and substrate.
Opportunistic (Supplementary) Sampling	Flora and vegetation not recorded through other sampling methods are opportunistically sampled as encountered in the survey. Opportunistic sampling also included recording locations of significant, introduced (weed) and unknown species.
Targeted Sampling	Areas likely to support significant flora or vegetation are targeted during the survey. Including areas with existing records of significant flora. Areas are selected based on existing records from database searches, geology, vegetation mapping and known Environmentally Sensitive Areas (ESAs; such as PEC/ TEC or GDE). Where possible, unusual, and restricted geological features are sampled. When potentially significant flora taxa are encountered during a survey, sufficient information is recorded in compliance with a Threatened and Priority Flora Report Form (TPRF) pursuant to the conditions of the flora taking licencing and authorisation to collect threatened flora.

2.1.4. Targeted Searches

Prior to the survey, a list of significant flora known, highly likely, likely, or possible, to occur within the Study Area was compiled as part of the desktop assessment. Field personnel familiarised themselves with photographs, reference samples and descriptions of these taxa before conducting the survey. Once on the ground, personnel actively searched while traversing the Study Area focussing on habitat and features considered likely to support significant flora (i.e., hill summits, gorges, and drainage lines) (Figure 2.2).

Where significant flora taxa were located in the field, a GPS coordinate of the individual was taken, or if the species existed within a small population, a central coordinate with an approximate 20 m radius was used. For larger populations the extent was mapped using a GPS to record the spatial extent of the population. Generalised information was collected for each occurrence, including an estimate of the number of individuals, reproductive status, condition and broad vegetation community and condition.

Threatened and Priority Flora Report Forms will be provided to the Parks and Wildlife Division (Parks and Wildlife) of DBCA, as required under the flora collecting permits. Significant flora specimens will be vouchered with the Western Australian Herbarium (WAH), where required and appropriate.

The targeted searches also focused on significant environmental weeds (Weeds of National Significance and Declared Pests listed under Section 22 of the BAM Act). Any such weeds located in the Study Area had their locations noted and searches were conducted within a minimum radius of 20 m from the given specimen, to document the number of individual plants and map the spatial extent of the infestation.

2.1.5. Vegetation

Vegetation was sampled using quadrats, relevés, and vegetation mapping notes, including information on disturbance and condition, as outlined in Table 2.3. The sampling methods were carried out in accordance with EPA guidelines (EPA, 2016c).

Vegetation Mapping

The current nationally adopted classification system for vegetation descriptions is the Native Vegetation Information System (NVIS) (NVIS Technical Working Group, 2017). NVIS seeks to manage national vegetation data to help improve vegetation planning and management within Australia including standardising scale and technical wording for vegetation associations. Vegetation types and condition is mapped in accordance with the scale for NVIS level V.

The Study Area has previously been mapped by Biologic (2021b) as part of a larger consolidated mapping project across the West Angelas Revised Proposal Development Envelope. This mapping was reviewed prior to the field survey to ensure the major vegetation types were sampled, with areas of lower mapping confidence targeted to ensure the mapping was accurate.

Vegetation assemblages were ground truthed during the survey, with site photographs and full descriptions recorded at each sampling site. The floristic data collected from the quadrats was

compared against the existing vegetation types for the Study Area and surrounds to assist in vegetation type determination. The vegetation boundaries were drawn interpreting the sampling data with aerial imagery, ground-truthing knowledge, geology, consolidated mapping and historical sampling data.

Vegetation Condition

Vegetation condition was defined within the Study Aera using the vegetation condition scale for the Eremaean Botanical Province in EPA (2016a), which has been adapted from Keighery (1994) and Trudgen (1988). The vegetation condition was determined based on the level of disturbance observed in the sampling area. Condition was recorded at each quadrat and relevé, while additional notes were taken while traversing the Survey Area to broadly map vegetation condition boundaries. The vegetation condition mapping was digitised using GIS software, in the same manner as the vegetation mapping.

2.5. Likelihood of Significant Flora Occurrence

The significant flora taxa identified from the database searches and literature review were assessed and ranked on the likelihood of occurring within the Study Area (Appendix C). The rankings were assigned using the following definitions presented in Table 2.4 and are intended to be an indicative guide only.

Table 2.4: Flora likelihood of occurrence decision matrix

Occurrence categories	Habitat categories (within the Study Area)			
	Core/ critical habitat present	Suitable habitat present/ within known distribution	Marginal habitat present/ adjacent to known distribution	No suitable habitat present/ outside of known distribution
Recorded in the Study Area	Confirmed	Confirmed	Confirmed	Confirmed
Recorded within <5 km	Highly Likely	Likely	Possible	Possible
Recorded within 5-15 km	Likely	Possible	Possible	Unlikely
Recorded within 15 - 50 km	Possible	Possible	Unlikely	Unlikely
Recorded >50 km	Possible	Unlikely	Unlikely	Highly Unlikely
Species considered locally/ regionally extinct	Unlikely	Unlikely	Highly Unlikely	Highly Unlikely

2.6. Limitations

As outlined by EPA (2016b), potential limitations may significantly impacted the results of the survey and/or the determined likelihood of occurrence assessments for significant species within the Study Area. During Field Trips 1 & 2, access issues were identified as a significant survey constraint within the Deposit J portion of the Study Area. A portion of the Deposit J survey area, including areas that may support populations of significant flora, were categorised as “Heritage exclusion” zones and access was prohibited for cultural reasons.

Access across the high summits, steep faces and slopes of the Study Area was limited, with a helicopter utilised to access the portions of the Study area that were difficult or unable to be accessed on foot or via vehicle. As a result, there are portions of the Study Area that have not been sampled due to safety concerns. Where possible, photos (from a safe location) were taken of the inaccessible areas so the vegetation mapping could be completed a relatively higher degree of confidence, however, this was not always achievable.

The team completing the Phase 2 survey did not meet the minimum 5 years’ experience to lead flora and vegetation surveys in the Pilbara (Table 2.1). However, this is not considered to be a constraint as both team members have extensive recent experience across West Angelas and the adjacent Angelo River. Furthermore, the Phase 1 trip, which included the establishment of sites, was completed by an experienced botanist. Phase 2 involved the re-sampling of sites and additional targeted searches, as such, the limited experience of the Phase 2 team was not considered a limitation to the survey. No other potential survey constraints were identified during the field survey.

3. RESULTS AND DISCUSSION

3.1 Desktop Assessment

3.1.1. Significant Flora

A total of 48 significant vascular flora species were identified following a review of the desktop assessment completed for the West Angelas Beyond 2020 Detailed Flora and Vegetation Survey (Biota, 2020). A total of 13 significant flora taxa have previously been recorded within the Study Area according to data provided by Rio Tinto (Rio Tinto, 2021b) and DBCA (DBCA, 2021) (Figure 3.1):

- *Hibiscus* sp. Mt Brockman (E. Thoma ET 1354) (P1);
- *Aristida lazaridis* (P2);
- *Tetratheca fordiana* (P2);
- *Acacia subtiliformis* (P3);
- *Aristida jerichoensis* var. *subspinulifera* (P3); and
- *Indigofera gilesii* (P3);
- *Olearia mucronata* (P3);
- *Rhagodia* sp. Hamersley (M. Trudgen 17794) (P3);
- *Rostellularia adscendens* var. *latifolia* (P3);
- *Solanum kentrocaule* (P3);
- *Triodia* sp. Mt Ella (M.E. Trudgen 12739) (P3).
- *Acacia bromilowiana* (P4);
- *Lepidium catapycnon* (P4);

Recent correspondence from Rio Tinto indicates that the record of *Hibiscus* sp. Mt Brockman (E. Thoma ET 1354) is actually the Priority 2 taxon *Hibiscus* sp. Gurinbiddy Range (M.E. Trudgen MET 15708). *Hibiscus* sp. Mt Brockman (E. Thoma ET 1354) is mostly known from the Tom Price-Brockman region, west of Karijini National Park (WAH, 1998-). For the purposes of this report, *Hibiscus* sp. Mt Brockman (E. Thoma ET 1354) is referred to as *Hibiscus* sp. Gurinbiddy Range (M.E. Trudgen MET 15708).

The flora taxa of significance identified by the desktop assessment were assessed and ranked on the likelihood of occurring within the Study Area. The full list is presented in Appendix C. The 13 taxa mentioned above have been previously recorded within the Study Area and are therefore considered confirmed. Of the remaining taxa, two are considered Highly Likely to occur, five Likely and nine Possible (Table 3.1). The remaining 18 taxa were considered Unlikely (10) or Highly Unlikely (nine) to occur within the Study Area (Appendix C).

Table 3.1: Significant flora likelihood of assessment results (confirmed to possible)

Taxon	Description (WAH, 1998-)	Location
Confirmed		
Aristida lazaridis (P2)	Major drainage areas through clayey flats.	Within Study Area
Hibiscus sp. Gurinbiddy Range (M.E. Trudgen MET 15708) (P2)	Gorges, rocky areas.	Within Study Area
Tetratheca fordiana (P2)	Shale pockets amongst ironstone on free rock faces.	Within Study Area
Acacia subtiliformis (P3)	Calcrete platforms.	Within Study Area
Aristida jerichoensis var. *subspinulifera* (P3)	Hardpan clay plains.	Within Study Area
Indigofera gilesii (P3)	Skeletal red-brown loam on rocky slopes, gorges, and creeklines.	Within Study Area
Olearia mucronata (P3)	Hills and rocky drainage channels.	Within Study Area
Rhagodia sp. Hamersley (M. Trudgen 17794) (P3)	Mulga (*Acacia aneura*) and snakewood (*A. xiphophylla*) vegetation on clay plains.	Within Study Area
Rostellularia adscendens var. *latifolia* (P3)	Various; creeks, plains, low hills.	Within Study Area
Solanum kentrocaule (P3)	Hillsides and mountain crests, creek beds; skeletal red-brown soil over ironstone on basalt or scree.	Within Study Area
Triodia sp. Mt Ella (M.E. Trudgen 12739) (P3)	Light orange-brown to red-brown pebbly loam on hill slopes and in gullies.	Within Study Area
Acacia bromilowiana (P4)	Skeletal loam soils on rocky hills, breakaways, scree slopes, gorges and rocky creek beds.	Within Study Area
Lepidium catapycnon (P4)	Skeletal soils on hill slopes.	Within Study Area
Highly Likely		
Oxalis sp. Pilbara (M.E. Trudgen 12725) (P2)	Red-brown loam on rocky hillslopes and in gorges.	0.1 km E
Pilbara trudgenii (P3)	Skeletal red stony soil over ironstone; hill summits, steep slopes, screes, cliff faces.	0.1 km E
Likely		
Acacia effusa (P3)	Stony red loam; scree	2.1 km ENE
Dampiera metallorum (P3)	Skeletal red-brown gravelly soil over banded ironstone; steep slopes and hill summits at high elevation.	1.3 km W
Geijera salicifolia (P3)	Skeletal and stony soils in massive rock scree, rockpiles and gorges.	0.8 km W
Sida sp. Hamersley Range (K. Newbey 10692) (P3)	Base of rocky cliff habitats in red skeletal stony soils or ironstone.	0.90km E
Sida sp. Barlee Range (S. van Leeuwen 1642) (P4)	Steep slopes, rocky gullies and breakaways.	2.6 km WNW
Possible		
Eremophila sp. West Angelas (S. van Leeuwen 4068) (P2)	Skeletal red-brown soil on hill summits high in the landscape.	10.3 km NNW
Acacia daweana (P3)	Stony red loamy soils on low rocky rises and along drainage lines.	9.4 km S
Euphorbia stevenii (P3)	Clay soils.	5.5 km NNW

Taxon	Description (WAH, 1998-)	Location
Dolichocarpa sp. Hamersley Station (A.A. Mitchell PRP 1479) (P3)	Clay plains.	4.2 km N
Grevillea saxicola (P3)	Upper scree slopes on banded ironstone, usually with Mulga.	5.9 km W
Isotropis parviflora (P3)	Undulating ironstone plains.	2.2 km S
Themeda sp. Hamersley Station (M.E. Trudgen 11431) (P3)	Clay plains.	1.5 km W
Vittadinia sp. Coondewanna Flats (S. van Leeuwen 3835) (P3)	Mainly on red clay on plains, low in the landscape.	1.1 km NNW
Xerochrysum boreale (P3)	Loamy, sandy or gravelly soils on plains.	19.3 km NNW

3.1.2. Significant Vegetation

Two TECs listed under the BC Act are recognised for the Pilbara region of Western Australia (DBCA, 2018). These TECs are not listed under the commonwealth EPBC Act. The database searches indicated that no TECs occur within and surrounding (within 50 km) the Study Area.

The greater West Angelas area is known to support occurrences of the West Angelas Cracking-Clay PEC, with the nearest occurrence located 4.5 km to the north of the Deposit J survey area. The West Angelas Revised Proposal Development Envelope has recently been mapped (Biologic, 2021b), including the occurrence of the PEC. Based on the consolidated vegetation mapping, the PEC is not expected to occur in the Study Area.

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7435000 7430000 7425000

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P1

- *Hibiscus* sp. Mt Brockman (E. Thoma ET 1354)

P2

- *Aristida lazaridis*
- *Hibiscus* sp. Gurinbiddy Range (M.E. Trudgen MET 15708)
- *Isotropis parviflora*
- *Oxalis* sp. Pilbara (M.E. Trudgen 12725)

P3

- *Acacia effusa*
- *Acacia subtiliformis*
- *Aristida jerichoensis* var. *subspinulifera*
- *Dampiera metallorum*
- *Euphorbia clementii*
- *Geijera salicifolia*
- *Indigofera gilesii*
- *Olearia mucronata*
- *Pilbara trudgenii*
- *Rhagodia* sp. Hamersley (M. Trudgen 17794)
- *Rostellularia adscendens* var. *latifolia*
- *Solanum kentrocaule*
- *Themeda* sp. Hamersley Station (M.E. Trudgen 11431)
- *Triodia* sp. Mt Ella (M.E. Trudgen 12739)

P4

- *Acacia bromilowiana*
- *Eremophila magnifica* subsp. *magnifica*
- *Lepidium catapycnon*

West Angelas

Deposit J

Mt Ella East

DBCA

P2

- *Aristida lazaridis*
- *Hibiscus* sp. Gurinbiddy Range (M.E. Trudgen MET 15708)
- *Oxalis* sp. Pilbara (M.E. Trudgen 12725)
- *Tetratheca fordiana*

P3

- *Acacia effusa*
- *Aristida jerichoensis* var. *subspinulifera*
- *Dampiera metallorum*
- *Euphorbia clementii*
- *Euphorbia stevenii*
- *Indigofera gilesii*
- *Rhagodia* sp. Hamersley (M. Trudgen 17794)
- *Sida* sp. Hamersley Range (K. Newbey 10692)
- *Swainsona thompsoniana*
- *Themeda* sp. Hamersley Station (M.E. Trudgen 11431)
- *Triodia* sp. Mt Ella (M.E. Trudgen 12739)

P4

- *Acacia bromilowiana*
- *Eremophila magnifica* subsp. *magnifica*

LEGEND

- West Angelas Project Envelope
- Vegetation Survey Area
- Operating Mine
- Rail

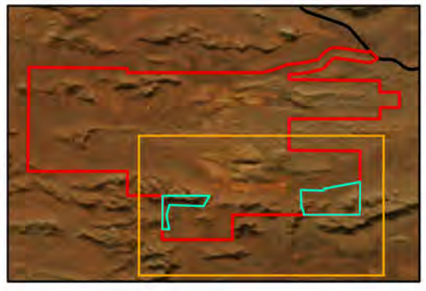
N

biologic Environmental Survey

Scale 1:60,000

0 1 2 3 Km

Coordinate System: GDA2020 MGA Zone 50
Transverse Mercator Created: 22/12/2022



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West Angelas Mt Ella East and Deposit J

Figure 3.1: Significant flora records from the desktop assessment

3.2. Field Survey

3.1.3. Flora Records

A total of 239 confirmed vascular flora taxa were recorded from the Study Area, including five introduced taxa, while the remaining 234 taxa are native (Appendix D). The 239 confirmed vascular flora taxa represent 43 families and 110 genera. The floristic diversity is consistent with what is expected for a survey of this size and intensity. It is likely that additional flora taxa may be present in the more inaccessible areas, while only a portion of the Deposit J survey area was surveyed.

Well-represented families include Fabaceae (45 species), Malvaceae (31 species) Poaceae and (28 species), while for genera include Acacia (24 species), Eremophila (11 species) and Senna (10 species). The West Angelas Revised Proposed Development Envelope has been surveyed quite extensively, with an extensive list of known taxa well understood. Previous flora and vegetation surveys of the West Angelas Revised Proposed Development Envelope has recorded the majority of the expected flora species likely to occur in the Study Area.

3.1.4. Significant Flora

The targeted flora survey component of the field survey recorded a total of 13 significant flora taxa, all listed as Priority flora (Figure 3.2):

- *Eremophila* sp. West Angelas (S. van Leeuwen 4068) (P2);
- *Hibiscus* sp. Gurinbiddy Range (M.E. Trudgen MET 15708) (P2);
- *Oxalis* sp. Pilbara (M. E. Trudgen 12725) (P2)
- *Acacia subtiliformis* (P3);
- *Eremophila magnifica* subsp. *velutina* (P3);
- *Eremophila naaykensii* (P3);
- *Indigofera gilesii* (P3);
- *Pilbara trudgenii* (P3)
- *Rhagodia* sp. Hamersley (M. Trudgen 17794) (P3)
- *Solanum kentrocaule* (P3);
- *Triodia* sp. Mt Ella (M.E. Trudgen 12739) (P3);
- *Acacia bromilowiana* (P4); and
- *Eremophila magnifica* subsp. *magnifica* (P4).

Targeted survey work completed by Biologic (2021a) in the Study Area in 2021 recorded seven Priority listed taxa, all of which were recorded during the recent survey work in the Study Area, *Hibiscus* sp. Gurinbiddy Range (M.E. Trudgen MET 15708) (P2); *Indigofera gilesii* (P3); *Rhagodia* sp. Hamersley (M. Trudgen 17794); *Solanum kentrocaule* (P3); *Triodia* sp. Mt Ella (M.E. Trudgen 12739) (P3); *Acacia bromilowiana* (P4); and *Eremophila magnifica* subsp. *magnifica* (P4).

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Significant Species

- *Hibiscus* sp. Gurinbiddy Range (M.E. Trudgen MET 15708) - P2
- *Oxalis* sp. Pilbara (M.E. Trudgen 12725) - P2
- *Eremophila magnifica* subsp. *velutina* - P3
- *Eremophila naaykensii* - P3
- *Indigofera gilesii* - P3
- *Pilbara trudgenii* - P3
- *Rhagodia* sp. Hamersley (M. Trudgen 17794) - P3
- *Solanum kentrocaule* - P3
- *Triodia* sp. Mt Ella (M.E. Trudgen 12739) - P3
- *Eremophila magnifica* subsp. *magnifica* - P4

West Angelas

Deposit J

Mt Ella East

LEGEND

- West Angelas Project Envelope
- Vegetation Survey Area
- Operating Mine
- Rail

N

biologic Environmental Survey

Scale 1:50,000

0 1 2 Km

Coordinate System: GDA2020 MGA Zone 50
Transverse Mercator Created: 02/11/2022

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West Angelas Mt Ella East and Deposit J

Figure 3.2: Significant flora recorded

Eremophila sp. West Angelas (S. van Leeuwen 4068)

Eremophila sp. West Angelas (S. van Leeuwen 4068) (P2) (Plate 1) was recorded from one point location, totalling one individual during the recent survey work within the Study Area (Figure 3.2). The individual was recorded from the summit of the Mt Ella East survey area, from vegetation type H13. The individual occurred on a small, rocky breakaway near the summit. *Eremophila* sp. West Angelas (S. van Leeuwen 4068) is limited in its occurrence across the West Angelas Revised Proposal Development Envelope (Figure 3.1), with known records on the hills and summits to the north of the West Angelas accommodation camp.

Hibiscus sp. Gurinbiddy Range (M.E. Trudgen MET 15708)

Hibiscus sp. Gurinbiddy Range (M.E. Trudgen MET 15708) (P2) (Plate 2) was recorded from three populations (45 point locations), totalling 311 individuals during the recent survey work within the Study Area (Figure 3.2). Individuals were predominantly recorded in gullies and gorges, with the majority of the records from the Mt Ella East survey area. Only one point location, totalling six individuals, was recorded from the Deposit J survey area. The individuals were recorded from vegetation types H3, H13 and H15. *Hibiscus* sp. Gurinbiddy Range (M.E. Trudgen MET 15708) has been recorded extensively across the West Angelas Revised Proposal Development Envelope (Figure 3.1).

Oxalis sp. Pilbara (M. E. Trudgen 12725)

Oxalis sp. Pilbara (M.E. Trudgen 12725) (P2) (Plate 3) was recorded from three populations (five point locations), totalling 128 individuals during the recent survey work within the Study Area (Figure 3.2). All individuals were recorded from the Mt Ella East survey area, predominantly along breakaways and narrow gullies across vegetation types H3 and H13. *Oxalis* sp. Pilbara (M.E. Trudgen 12725) has been recorded extensively across the West Angelas Revised Proposal Development Envelope (Figure 3.1Figure 3.1).

Acacia subtiliformis

Acacia subtiliformis (P3) (Plate 4) was recorded from one point location, totalling 150 individuals during the recent survey work within the Study Area (Figure 3.2). The point location was recorded from vegetation type P14, which is described as having several flora species that are predominantly recorded from calcrete geologies, consistent with *Acacia subtiliformis*. *Acacia subtiliformis* occurs sporadically across the West Angelas Revised Proposal Development Envelope (Figure 3.1), with further known records from adjacent areas, including Angelo River.

Eremophila magnifica subsp. *velutina*

Eremophila magnifica subsp. *velutina* (P3) (Plate 5) was recorded from two populations (six point locations), totalling 63 individuals during the recent survey work within the Study Area (Figure 3.2). The recorded were all from Mt Ella East survey area, from low hills and hillslopes, from vegetation type H15. *Eremophila magnifica* subsp. *velutina* has not been recorded from the West Angelas Project Envelope previously, with the nearest records located to the north.

Eremophila naaykensii

Eremophila naaykensii (P3) (Plate 6) was recorded from one point location with only one individual observed (Figure 3.2). The individual was observed from near the eastern boundary of the Mt Ella East survey area, high in the landscape on vegetation type H15. *Eremophila naaykensii* occurs extensively along the range between the Mt Ella East and Deposit J survey areas, in the south of the West Angelas Revised Proposal Development Envelope and in the north-west (Figure 3.1).

Indigofera gilesii

Indigofera gilesii (P3) (Plate 7) was recorded from five populations (50 point locations), totalling 222 individuals during the recent survey work within the Study Area (Figure 3.2). Individuals were recorded from a combination of gullies, hillslopes, breakaways and hillcrests, generally associated with exposed rocks/boulders. The individuals were observed from vegetation types H3, H9, H13 and H15. *Indigofera gilesii* has been recorded extensively across the West Angelas Revised Proposal Development Envelope (Figure 3.1).

Pilbara trudgenii

Pilbara trudgenii (P3 (Plate 8) was recorded from one population (five point locations), totalling 28 individuals during the recent survey work within the Study Area (Figure 3.2). Individuals were recorded from the summit of Mt Ella East and were associated with vegetation types H13 and H15. *Pilbara trudgenii* is known to occur in the West Angelas Revised Proposal Development Envelope (Figure 3.1), across Western Hill and the Deposit J area.

Rhagodia sp. Hamersley (M. Trudgen 17794)

Rhagodia sp. Hamersley (M. Trudgen 17794) (P3) (Plate 9) was recorded from two populations (three point locations), totalling 15 individuals during the recent survey work within the Study Area (Figure 3.2). This species was associated with the base of hills within the H3 vegetation type, occasionally extending into the H15 vegetation type. *Rhagodia* sp. Hamersley (M. Trudgen 17794) is known to occur in the West Angelas Revised Proposal Development Envelope (Figure 3.1).

Solanum kentrocaule

Solanum kentrocaule (P3) (Plate 10) was recorded from ten populations (61 point locations), totalling 205 individuals during the recent survey work within the Study Area (Figure 3.2). The individuals were generally observed higher in the landscape within gullies/gorges and rocky substrates, consistent with habitat preferences (WAH, 1998-). Individuals were recorded from vegetation types D3, H3, H9, H13, and H15, while the majority of the point locations were from the Mt Ella East survey area (56 point locations). *Solanum kentrocaule* is known to occur in the West Angelas Revised Proposal Development Envelope (Figure 3.1).

Triodia sp. Mt Ella (M.E. Trudgen 12739)

Triodia sp. Mt Ella (M.E. Trudgen 12739) (P3) (Plate 11) was recorded from eight populations (116 point locations), totalling in excess of 12,354 individuals during the recent work within the Study Area

(Figure 3.2). The individuals were recorded quite extensively across the Mt Ella East survey area, from the lower hillslopes to the summits, including Mt Ella (Figure 3.2). Records of *Triodia* sp. Mt Ella (M.E. Trudgen 12739) within the Deposit J survey area were limited to the accessible areas, however, it is likely that additional individuals will occur across the exclusion zone of Deposit J. Individuals of *Triodia* sp. Mt Ella (M.E. Trudgen 12739) were mostly recorded from vegetation type H15, but also G2, H3, H0, and H13. *Triodia* sp. Mt Ella (M.E. Trudgen 12739) is known to occur extensively in the West Angelas Revised Proposal Development Envelope (Figure 3.1).

Acacia bromilowiana

Acacia bromilowiana (P4) (Plate 12) was recorded from one point location, totalling 40 individuals during the recent survey work within the Study Area (Figure 3.2). The individuals were recorded from the summit of the Mt Ella East survey area, from vegetation type H13. The individuals occurred on a small, rocky breakaway near the summit. *Acacia bromilowiana* is known to occur in the West Angelas Revised Proposal Development Envelope (Figure 3.1).

Eremophila magnifica subsp. *magnifica*

Eremophila magnifica subsp. *magnifica* (P4) (Plate 13) was recorded from two populations (13 point locations), totalling 121 individuals during the recent survey work within the Study Area (Figure 3.2). All the individuals were recorded from vegetation type H15, within the Mt Ella East survey area. *Eremophila magnifica* subsp. *magnifica* is known to occur in the West Angelas Revised Proposal Development Envelope (Figure 3.1).

3.1.5. Flora of 'Other' Significance

In addition to the 13 Priority flora records, a further taxon, *Eremophila* aff. *magnifica*, was recorded from the Mt Ella East survey area. A collection of an unusual *Eremophila*, which had similarities to *Eremophila magnifica*, was collected near a collection of *Eremophila magnifica* subsp. *velutina*. Upon taxonomic review, it was determined to have affinities to *Eremophila magnifica* but may potentially represent a hybrid with another *Eremophila* species as the other parent. The specimen is also similar to collections made by Biota and Biologic across the Angelo River biological surveys, located immediately to the south.

The specimen was forwarded to the Rio Tinto sponsored botanist at the Western Australian Herbarium, with the confirmation coming back as *Eremophila magnifica* × ? [*possible petrophila*]. Notes provided by the Rio Tinto sponsored botanist suggest that the leaves smell like nutmeg when crushed, but not as strongly as *Eremophila magnifica*, with the pedicels and sepals having glandular and eglandular hairs (no glandular hairs on *Eremophila magnifica*), suggesting it is not a diminutive form of *Eremophila magnifica*. Other *Eremophila* species that occur in the area suggest that *Eremophila petrophila* could be the other parent, which occurs in the same section of *Eremophila* as *Eremophila magnifica*. A more comprehensive determination could be made with flowers and fruits, along with observations of other *Eremophila* species that occur nearby.

Plate 1: *Eremophila* sp. West Angelas (S. van Leeuwen 4068) (P2) individuals from the West Angelas region (Biologic photos).

Plate 2: *Hibiscus* sp. Gurrinbiddy Range (M.E. Trudgen MET 15708)(P2) individuals from the West Angelas region (Biologic photos).

Plate 3: *Oxalis* sp. Pilbara (M.E. Trudgen MET 15708) (P2) individuals from the West Angelas region (Biologic photos).

Plate 4: *Acacia subtiliformis* (P3) individuals from the West Angelas region (Biologic photos).

Plate 5: *Eremophila magnifica* subsp. *velutina* (P3) individuals from the West Angelas region (Biologic photos).

Plate 6: *Eremophila naaykensii* (P3) individuals from the West Angelas region (Biologic photos).

Plate 7: *Indigofera gilesii* (P3) individuals from the West Angelas region (Biologic photos).

Plate 8: *Pilbara trudgenii* (P3) individuals from the West Angelas region (Biologic photos).

Plate 9: *Rhagodia* sp. Hamersley Ella (M.E. Trudgen 17794) (P3) individuals from the West Angelas region (Biologic photos).

Plate 10: *Solanum kentrocaule* (P3) individuals from the West Angelas region (Biologic photos).

Plate 11: *Triodia* sp. Mt Ella (M.E. Trudgen 12739) (P3) individuals from the West Angelas region (Biologic photos).

Plate 12: *Acacia bromilowiana* (P4) individuals from the West Angelas region (Biologic photos)

Plate 13: *Eremophila magnifica* subsp. *magnifica* (P4) individuals from the West Angelas region (Biologic photos).

3.1.6. Post-survey Likelihood of Occurrence for previously Confirmed Taxa

Following the April/May and August 2022 field survey of the Study Area, the likelihood of occurrence for the previously confirmed taxa was revisited. Prior to the field survey, 13 Priority listed taxa were confirmed to occur within the Study Area (Figure 3.1). Following the survey, seven of the 13 taxa were not observed; *Aristida lazaridis* (P2), *Aristida jerichoensis* var. *subspinulifera* (P3), *Rostellularia adscendens* var. *latifolia* (P3), *Hibiscus* sp. Mt Brockman (E. Thoma ET 1354) (P1), *Tetratheca fordiana* (P2), *Olearia mucronata* (P3) and *Lepidium catapycnon* (P4).

Aristida lazaridis is known from five records within Mt Ella East survey area, representing 24 individuals. Records within Mt Ella East survey area were unable to be visited, however, Biologic (2021a) visited these locations and did not record any individuals, suggesting the record is erroneous or the GPS coordinates are not accurate. Suitable habitat for this species within vegetation types P4 and P8 were unable to be extensively surveyed, and it is possible that this species is currently located within these unsurveyed areas.

Aristida jerichoensis var. *subspinulifera* is known from 20 records within Mt Ella East survey area, representing 1,278 individuals. Records within Mt Ella East survey area were unable to be visited, however, Biologic (2021a) completed more intensive searches of suitable habitats in the north of the Mt Ella East survey area and did not record any individuals. Suitable habitat for this species within vegetation types P1 and P4 were unable to be extensively surveyed, and it is possible that this species is currently located within these unsurveyed areas.

Rostellularia adscendens var. *latifolia* is known from one record within the Deposit J survey area, representing one individual. It is an herb to small shrub, growing to 0.3 m in height. It is generally annual in lifeform (although can be perennial in some situations) and can be heavily grazed by livestock. Previous records of this species were not visited due to access and time constraints. It is assumed that previously recorded populations are still extant within the Study Area.

As discussed above, the *Hibiscus* sp. Mt Brockman (E. Thoma ET 1354) record is now known to represent Hibiscus sp. Gurinbiddy Range (M.E. Trudgen MET 15708) (P2), which was confirmed to occur in the Study Area during the recent survey work.

Tetratheca fordiana is known from nine records within Deposit J survey area, representing 470 individuals. These records were unable to be visited due to access and heritage constraints. Suitable habitat for these species within vegetation types G2 and H15 were unable to be extensively surveyed, and it is possible that this species is currently located within these unsurveyed areas. It is assumed that previously recorded populations are still extant within the Study Area.

Olearia mucronata is known from one record within Deposit J survey area, representing one individual. This record was unable to be visited due to access and heritage constraints. Suitable habitat for these species within vegetation type H15 were unable to be extensively surveyed, and it is possible that this species is currently located within these unsurveyed areas. It is assumed that previously recorded populations are still extant within the Study Area.

Lepidium catapycnon is known from three records within Deposit J survey area, representing 104 individuals. Previous records of this species were not visited, due to access and time constraints. It is assumed that previously recorded populations are still extant within the Study Area.

3.1.7. Introduced Flora

A total of five introduced flora taxa were recorded from the Study Area. The five taxa, **Bidens bipinnata, *Cenchrus ciliaris, *Flaveria trinervia, *Malvastrum americanum,* and **Setaria verticillata*, were recorded sporadically across the Study Area. The five introduced taxa have previously been recorded from the West Angelas Revised Proposal Development Envelope (Biologic, 2021a, 2022a, 2022b; Biota, 2020). None of these species are categorised as Weeds of National Significance or Declared Pests listed under Section 22 of the BAM Act.

3.1.8. Vegetation Types

The Study Area occurs within the consolidated vegetation mapping context area (Biologic, 2021b), however, actual on-ground survey work is dated. As such, the vegetation of the Study Area was assessed via the sampling of quadrats, relevés and traverses to determine if the vegetation is consistent with the consolidated mapping, or if amendments are required. Review of the consolidated mapping (Biologic, 2021b) indicated that the Study Area supported the following vegetation types:

- D3: ExChPlApyTErTHtTp - *Eucalyptus xerothermica* and/or *Corymbia hamersleyana* low open woodland over *Petalostylis labicheoides, Acacia pyrifolia* tall open shrubland over *Tephrosia rosea* var. Fortescue Creeks (M.I.H. Brooker 2186) low open shrubland over *Triodia pungens* open hummock grassland.
- D11: ExAanEtPlANIEUsTHtTp - *Eucalyptus xerothermica* and/or *Acacia 'aneura'* low open woodland over *E. trivalva* low open mallee woodland over *Petalostylis labicheoides, Androcalva luteiflora* open shrubland over *Eulalia simonii* and/or *Themeda triandra* very open tussock grassland with *Triodia pungens* very open hummock grassland.

- G2: ElCdApTvTp - *Acacia 'aneura', Callitris columellaris* and/or *Corymbia ferriticola* low woodland over *Capparis mitchellii* scattered tall shrubs over *Ptilotus obovatus* low open shrubland over *Eriachne mucronata* and/or *Aristida burbidgeae* very open tussock grassland with *Triodia pungens* scattered hummock grasses.
- H3: AcaElAanTp - *Acacia catenulata* subsp*. occidentalis, (Eucalyptus leucophloia* subsp*. leucophloia, A. 'aneura')* low open forest over *Triodia pungens* open hummock grassland.
- H9: ElCdEgTv - *Eucalyptus leucophloia* subsp*. leucophloia* and/or *Corymbia deserticola subsp. deserticola* low open woodland over *E. gamophylla* low open mallee woodland over *Triodia vanleeuwenii* open hummock grassland.
- H15: ElTpTw - *Eucalyptus leucophloia* subsp*. leucophloia* low open woodland over *Triodia pungens* and/or *T. wiseana* open hummock grassland.
- P1: AanAayApTvTp - *Acacia 'aneura', A. ayersiana, A. pruinocarpa* low open woodland over *Triodia vanleeuwenii, T. pungens* open hummock grassland.
- P4: AanApAayTp - *Acacia 'aneura', A. pruinocarpa, A. ayersiana* woodland over *Triodia pungens* open hummock grassland.
- P8: AanTHtARcTp - *Acacia 'aneura'* scattered tall shrubs over *Themeda triandra* scattered tussock grasses to tussock grassland with *Aristida contorta* scattered bunch grasses to bunch grassland over *Triodia pungens* scattered hummock grasses.
- P12: EgTpTv - *Eucalyptus gamophylla* low open mallee woodland over *Triodia pungens* and/or *T. vanleeuwenii* open hummock grassland.
- P14: EtErEsTspp - *Eucalyptus trivalva, E. repullulans, E. socialis* subsp*. eucentrica* low open mallee woodland over *Triodia wiseana, (T. angusta, T. pungens, T. longiceps)* open hummock grassland.

The consolidated vegetation mapping for the Study Area was consistent with the on-ground observations (Table 3.2 and Figure 3.3), with some minor amendments to the boundaries between vegetation types. The amended vegetation type mapping does not take into consideration all the new and historic disturbance layers. For example, some new disturbance from exploration drilling operations is observable within the Study Area.

Table 3.2: Vegetation types recorded from the Study Area

Code	Location	Sample Sites	Description	Photo (from the Study Area)
D3 ExChPlApyTErTHtTp	Deposit J & Mt Ella East	DJW-08; MEE-06; MEE-15	*Eucalyptus xerothermica* and/or *Corymbia hamersleyana* low open woodland over *Petalostylis labicheoides, Acacia pyrifolia* tall open shrubland over *Tephrosia rosea* var. Fortescue Creeks (M.I.H. Brooker 2186) low open shrubland over *Triodia pungens* open hummock grassland	
D7 ChAmoTHtTp	Mt Ella East	MEE-18	*Corymbia hamersleyana* low open woodland *Acacia monticola* tall shrubland *Themeda triandra* very open tussock grassland over *Triodia pungens* very open hummock grassland	

Code	Location	Sample Sites	Description	Photo (from the Study Area)
D11 ExAanEtPlANlEUsTHtTp	Mt Ella East	Not sampled	*Eucalyptus xerothermica* and/or *Acacia 'aneura'* low open woodland over *E. trivalva* low open mallee woodland over *Petalostylis labicheoides, Androcalva luteiflora* open shrubland over *Eulalia simonii* and/or *Themeda triandra* very open tussock grassland with *Triodia pungens* very open hummock grassland.	 Photo from Biota (2020)
G2 AanCALcCfCAPmPTo ERImARbTp	Deposit J	DJW-11	*Acacia 'aneura', Callitris columellaris* and/or *Corymbia ferriticola* low woodland over *Capparis mitchellii* scattered tall shrubs over *Ptilotus obovatus* low open shrubland over *Eriachne mucronata* and/or *Aristida burbidgeae* very open tussock grassland with *Triodia pungens* scattered hummock grasses.	
H3 AcaElAanTp	Deposit J & Mt Ella East	MEE-01	*Acacia catenulata* subsp. *occidentalis, (Eucalyptus leucophloia* subsp. *leucophloia, A. 'aneura')* low open forest over *Triodia pungens* open hummock grassland.	

Code	Location	Sample Sites	Description	Photo (from the Study Area)
H9 ElCdEgTv	Deposit J & Mt Ella East	DJW-01; DJW-02; MEE-13	*Eucalyptus leucophloia* subsp. *leucophloia* and/or *Corymbia deserticola subsp. deserticola* low open woodland over *E. gamophylla* low open mallee woodland over *Triodia vanleeuwenii* open hummock grassland.	
H13 ElEsppTwTsm	Deposit J & Mt Ella East	EKR-01 MEE-09	*Eucalyptus leucophloia* subsp. *leucophloia* low open woodland over *Eucalyptus* spp. low open mallee woodland *Triodia wiseana*, *T.* sp. Mt Ella (M.E. Trudgen 12739) open hummock grassland	
H15 ElTpTw	Deposit J & Mt Ella East	DJW-04; DJW-12; MEE-02; MEE-07; MEE-11; MEE-14	*Eucalyptus leucophloia* subsp. *leucophloia* low open woodland over *Triodia pungens* and/or *T. wiseana* open hummock grassland.	

Code	Location	Sample Sites	Description	Photo (from the Study Area)
P1 AanAayApTvTp	Mt Ella East	Not sampled	*Acacia 'aneura', A. ayersiana, A. pruinocarpa* low open woodland over *Triodia vanleeuwenii, T. pungens* open hummock grassland.	 Photo from Biota (2020)
P4 AanApAayTp	Mt Ella East	MEE-03	*Acacia 'aneura', A. pruinocarpa, A. ayersiana* woodland over *Triodia pungens* open hummock grassland.	
P8 AanTHtARcTp	Mt Ella East	Not sampled	*Acacia 'aneura'* scattered tall shrubs over *Themeda triandra* scattered tussock grasses to tussock grassland with *Aristida contorta* scattered bunch grasses to bunch grassland over *Triodia pungens* scattered hummock grasses.	 Photo from Biota (2020)

Code	Location	Sample Sites	Description	Photo (from the Study Area)
P12 EgTpTv	Mt Ella East	MEE-05; MEE-04; MEE-17; MEE-16	*Eucalyptus gamophylla* low open mallee woodland over *Triodia pungens* and/or *T. vanleeuwenii* open hummock grassland.	
P14 EtErEsTspp	Deposit J	DJW-03; DJW-06; DJW-09; DJW-10	*Eucalyptus trivalva, E. repullulans, E. socialis* subsp. *eucentrica* low open mallee woodland over *Triodia wiseana, (T. angusta, T. pungens, T. longiceps)* open hummock grassland.	

675000 680000 685000 690000

7435000

7430000

West Angelas

Deposit J

Mt Ella East

LEGEND

West Angelas Project Envelope

Vegetation Survey Area

Operating Mine

Rail

Vegetation Unit

D3

D7

D11

D13

G2

H3

H5

H9

H13

H15

P1

P4

P8

P12

P14

Disturbed

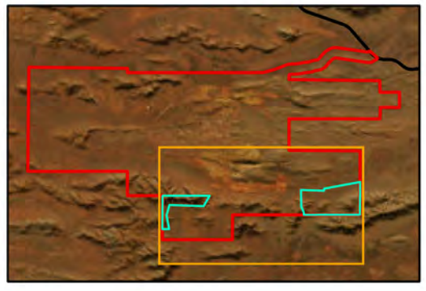
N

biologic Environmental Survey

Scale 1:50,000

0 1 2 Km

Coordinate System: GDA2020 MGA Zone 50
Transverse Mercator Created: 22/12/2022



RIO TINTO IRON ORE

West Angelas Mt Ella East and Deposit J

Figure 3.3: Vegetation types

3.1.9. Significant Vegetation

The vegetation mapped within the Study Area did not represent any known TECs or PECs from within and adjacent to the West Angelas Revised Proposal Development Envelope. No groundwater-dependent vegetation, determined by the lack of *Eucalyptus camaldulensis, E. victrix* and *Melaleuca argentea* individuals, was identified within the Study Area.

Biologic (2022c) has completed a vegetation significance assessment across the West Angelas Revised Proposal Development Envelope, utilising the framework developed by Rio Tinto. The vegetation significance assessment identified that the Study Area supports vegetation types that are of local significance as they support populations of Priority 2, Priority 3 and Priority 4 flora species.

The 13 vegetation types mapped as occurring in the Study Area were variously ranked as:

- High Local Significance: D11, H15, and P8.

Vegetation types D11, H15 and P8 were ranked as High local significance due to extensive populations of Priority 2 flora species known to occur within the vegetation types across the West Angelas Revised Proposal Development Envelope.

- Moderate Local Significance: G2, H9, and H13.

Vegetation types G2, H9 and H13 were ranked as Moderate local significance due to extensive populations of Priority 3 flora species and the occurrence of Priority 2 flora species within the vegetation types across the West Angelas Revised Proposal Development Envelope.

- Low Local Significance: D3, D7, H3, P1, P4, P12, and P14.

Vegetation types D3, D7, H3, P1, P4, P12 and P14 were ranked Low local significance due to limited occurrences of Priority 2 and Priority 3 flora species and some occurrences of Priority 4 flora species within the vegetation types across the West Angelas Revised Proposal Development Envelope.

3.1.10. Vegetation Condition

The condition of the vegetation within the Study Area is Very Good to Excellent (Figure 3.4) based on the condition rating scale developed by Trudgen (1988) and presented in EPA (2016b). Hills and slopes within the Study Area were generally categorised as Excellent, while alluvial plains and valleys were generally categorised as Very Good. Areas where exploration tracks and drill pads have been created were categorised as Cleared (Completely Degraded).

Disturbances within the Study Area included exploration drilling, weed presence, low levels of grazing on the plains and impacts from recent fires (less than 5 years ago). In general, these disturbances did not alter the vegetation substantially, warranting lower condition ratings.

675000
680000
685000
690000
7435000
7430000

West Angelas

Deposit J

Mt Ella East

LEGEND

- West Angelas Project Envelope
- Vegetation Survey Area
- Operating Mine
- Rail

Vegetation Condition

- Excellent
- Very Good
- Cleared/ Disturbance Footprint

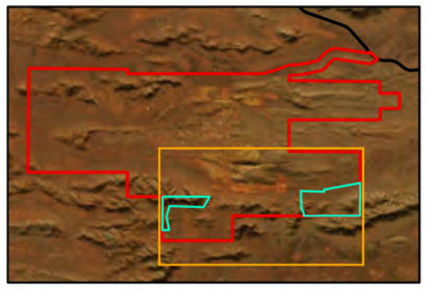
N

biologic Environmental Survey

Scale 1:50,000

0 1 2 Km

Coordinate System: GDA2020 MGA Zone 50
Transverse Mercator Created: 22/12/2022



RIO TINTO IRON ORE

West Angelas Mt Ella East and Deposit J

Figure 3.4: Vegetation condition

4. SUMMARY

A two-phase detailed flora and vegetation survey was completed within the Study Area, which included the Deposit J and Mt Ella East survey areas. The Study Area is located within the West Angelas Revised Proposal Development Envelope and it was identified that recent on-ground survey work was limited, requiring further field surveys. In addition, the Study Area has been mapped by Biologic (2021b), with the vegetation types consolidated across the West Angelas Revised Proposal Development Envelope.

The two-phase survey was completed in autumn (28 April to 1 May) 2022 and winter (9 to 12 August) 2022, with the survey led by an experienced botanist from Biologic. A total of 14 quadrats and 12 relevés were sampled, with the 14 quadrats established in autumn 2022 and resampled in winter 2022. Access was limited across the Study Area due to a heritage exclusion zone, as well as steep slopes, summits and rocky breakaways. A helicopter was utilised during both phases to access the Study Area.

The key outcomes of the flora and vegetation survey were:

- 239 confirmed vascular flora taxa, inclusive of five introduced taxa, were recorded from the Study Area.
- 13 significant flora taxa were recorded from the Study Area:
    - *Eremophila* sp. West Angelas (S. van Leeuwen 4068) (P2);
    - *Hibiscus* sp. Gurinbiddy Range (M.E. Trudgen MET 15708) (P2);
    - *Oxalis* sp. Pilbara (M. E. Trudgen 12725) (P2)
    - *Acacia subtiliformis* (P3);
    - *Eremophila magnifica* subsp. *velutina* (P3);
    - *Eremophila naaykensii* (P3);
    - *Indigofera gilesii* (P3);
    - *Pilbara trudgenii* (P3)
    - *Rhagodia* sp. Hamersley (M. Trudgen 17794) (P3)
    - *Solanum kentrocaule* (P3);
    - *Triodia* sp. Mt Ella (M.E. Trudgen 12739) (P3);
    - *Acacia bromilowiana* (P4); and
    - *Eremophila magnifica* subsp. *magnifica* (P4).
- A further six Priority listed flora have previously been observed within the Study Area, but were not observed during this survey:
    - *Aristida lazaridis* (P2);
    - *Tetratheca fordiana* (P2);
    - *Aristida jerichoensis* var. *subspinulifera* (P3);
    - *Rostellularia adscendens* var. *latifolia* (P3);
    - *Olearia mucronata* (P3); and
    - *Lepidium catapycnon* (P4)

- Five introduced flora taxa, **Bidens bipinnata*, **Cenchrus ciliaris*, **Flaveria trinervia*, **Malvastrum americanum*, and **Setaria verticillata*, were recorded from the Study Area.
- The existing consolidated vegetation mapping was consistent with on-ground observations, with amendments to boundaries and occurrences undertaken.
- 13 vegetation types have been mapped within the Study Area.
- The vegetation types within the Study Area is of local significance as they support populations of Priority 2, Priority 3 and Priority 4 flora species:
    - Vegetation types D11, H15, P8 are ranked as High Local Significance;
    - Vegetation types G2, H9 and H13 are ranked as Moderate Local Significance; and
    - Vegetation types D3, D7, H3, P1, P4, P12, and P14 are ranked as Low Local Significance.
- The condition of the vegetation within the Study Area was Very Good to Excellent.

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Appendix A: Rio Tinto Sponsored Botanist Chain of Custody

Chain of Custody Form – Significant Specimens

Consultant to fill in the information in the tables below, and to indicate approximate study area on Figure 1. All specimen co-ordinates are to be provided in MGA Z50.

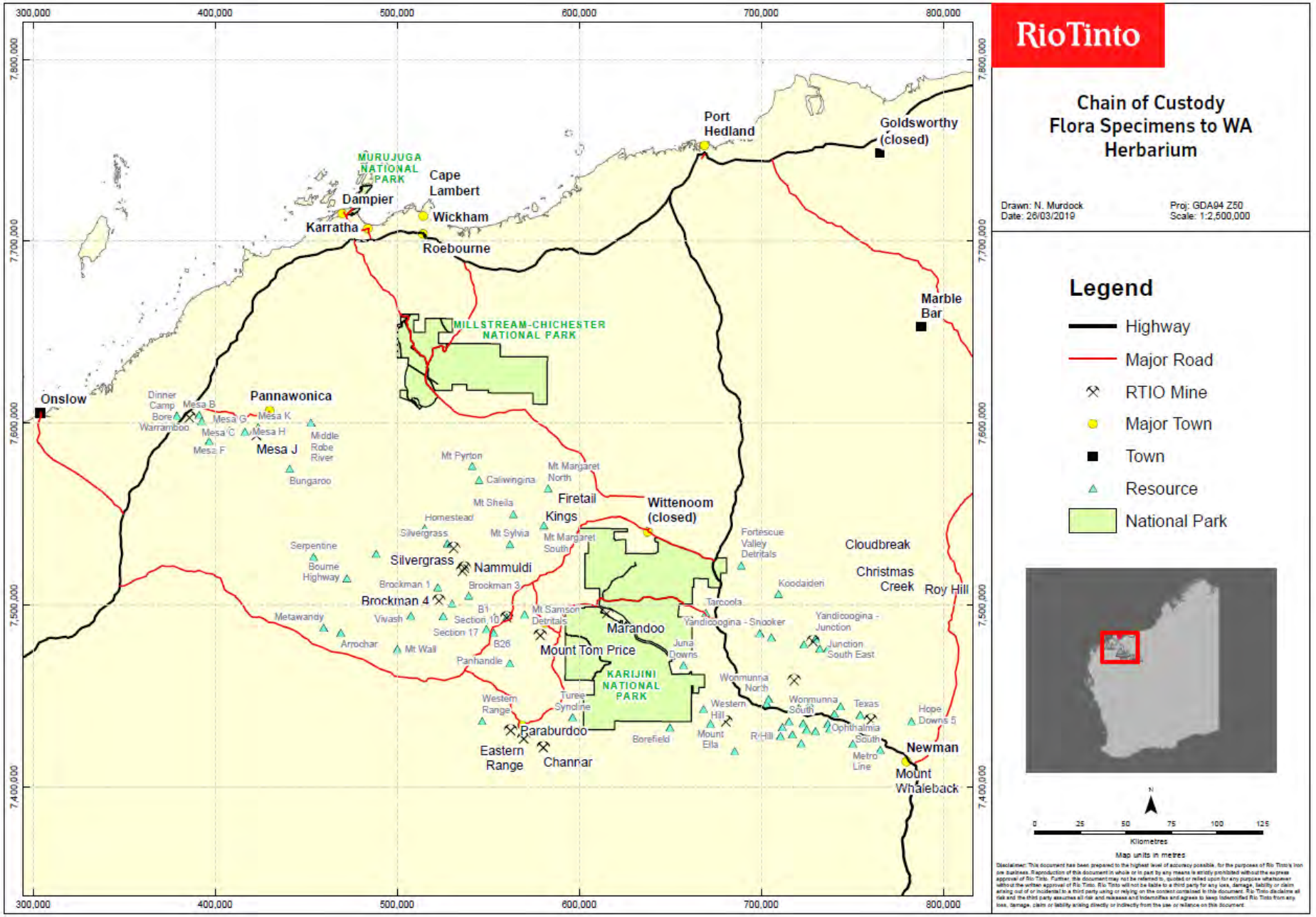
Please refer to the Herbarium Specimen Submission Procedure (RTIO-HSE-0336396) for guidelines on what should be submitted to the RTIO Sponsored Taxonomist for identification.

Consultant Company: Biologic Environmental Survey
Consultant Contact Name: Sam Coultas
Consultant Contact Number: 0400 507 407
Consultant Job Reference: 21082 Mt Ella Dep J trip 2
Specimen Submission Date: 20/07/2022

Rio Tinto Project Manager / Botanist: Stephanie Stack / Hayden Ajduk
Rio Tinto Contact Number:
Rio Tinto Study Area: West Angelas (Deposit J, Mt Ella East, Deposit H infrastructure corridor)
Rio Tinto AR Number (if applicable):

Nearest Named Location to Study Area: West Angelas
Distance and Direction to Nearest Town: 90 km W of Newman
Central Co-ordinate of Study Area: -23.179868°, 118.773998°
Field Survey Date/s: 28/04/2022 - 04/05/2022

Collection No.	Cosultants ID	Cosultants ID notes	Latitude	Longitude	Plant description and habitat	Reason for submission	S. Dillon ID	Comment
SCAGOpp13	Acacia bromilowiana (P4)		-23.21689029	118.8851531	Gnarled shrub, regrowth from recent burn. Shaded side of steep ironstone hill summit	Conservation significant	*Aacia bromilowiana*	P4. Nearest record *c*. 7.7 km WNW.
DJW09-01	Acacia subtiliformis (P3)		-23.2204442	118.7083369	Tall, slender shrub. Growing on calcrete outcrops	Conservation significant	*Acacia subtiliformis*	P3. Nearest record *c*. 41.7 km E.
SCopp	Aristida lazaridis (P2)		-23.1452895	118.8185417	Tussock grass. Minor drainage line	Conservation significant	*Aristida lazaridis*	P2. Nearest record *c*. 7.5 km SE.
SCAGOpp08	Eremophila aff. magnifica	Rachel M: Closest I could get without flowers (fruiting calyx not quite enough) - looks closest to magnifica in all but leaf size - some specimens upstairs have new growth or axiallary growth which approximates the same leaf size - could possibly be a hybrid but not knowing what else was growing around it cannot work it out. Sam C: Potentially matches Eremophila sp. that Biota collected in Stage 2 of Angelo River. Looks like a hybrid between E. magnifica and something else. Always growing with/nearby to E. mag. in same habitat. We picked up better material during the most recent trip during Angelo River targeted. This material will be submitted for ID in the coming weeks	-23.2197375	118.8479451	Low rounded shrub. Growing with and near Eremophila magnifica on rounded ironstone hill slope with outcropping	Interesting specimen	*Eremophila magnifica* × [possibly *petrophylla*]	Leaves smell like nutmeg when crushed (but not as strongly as *E. magnifica*). Not just a diminutive form of *E. magnifica* as the pedicels and sepals have glandular and eglandular hairs (no gladular hairs on *E. magnifica*). I generated a list of the *Eremophila* that have been lodged within a 20 km radius of this specimen and the only likely candidate as the other parent is *E. petrophylla* (which is the same section of *Eremophila* as *E. magnifica*). Flowers and fruits may be useful along with observations of what other *Eremophila* occur nearby.
Scopp	Eremophila magnifica subsp. magnifica (P4)		-23.2197136	118.8479458	Shrub, on ironstone hill slope with outcropping	Conservation significant	*Eremophila magnifica* subsp. *velutina*	P3. Nearest record *c*. 22.9 km NNW.
SCAGOpp04	Eremophila magnifica subsp. velutina (P3)		-23.11142	118.789565	Shrub, on ironstone hill slope with outcropping	Conservation significant	*Eremophila magnifica* subsp. *velutina*	P3. Nearest record *c*. 9.4 km NNW.
SCopp	Eremophila naaykensii (P3)		-23.11262664	118.8242033	Shrub, on ironstone hill slope with outcropping	Conservation significant	*Eremophila naaykensii*	P3. Nearest record *c*. 6.6 km WSW.
SCAGopp03	Hibiscus sp. Gurinbiddy Range (M.E. Trudgen MET 15708) (P2)		-23.2199266	118.8455809	Erect, slender shrub. Shaded gully/cliff	Conservation significant	*Hibiscus* sp. Gurinbiddy Range (M.E. Trudgen MET 15708)	P2. Nearest record *c*. 5 km NW.
MEE02-01	Indigofera gilesii (P3)		-23.2228768	118.849109	Erect shrub. Ironstone gully	Conservation significant	*Indigofera gilesii*	P3. Nearest record *c*. 3.3 km N.
SCAGOPP09	Pilbara trudgenii (P3)		-23.2165454	118.884697	Shrub. Growing out of cliff face on southern shaded side of Mt Ella summit	Conservation significant	*Pilbara trudgenii*	P3. Nearset record *c*. 17.5 km NW.
MEE01-01	Rhagodia sp. Hamersley (M.Trudgen 17794) (P3)		-23.2195583	118.8456763	Slender shrub, mulga hardpan plain	Conservation significant	*Rhagodia* sp. Hamersley (M. Trudgen 17794)	P3. Nearest record *c*. 2.3 km NW.
MEE15-01	Solanum kentrocaule (P3)		-23.2167919	118.8698904	Spikey shrub, rocky gully of massive ironstone hills	Conservation significant	*Solanum kentrocaule*	P3. Nearest record *c*. 15.3 km NNW
SCopp	Triodia sp. Mt Ella (M.E. Trudgen 12739) (P3)		-23.2239975	118.8703377	Steep slopes of massive ironstone gully	Conservation significant	*Triodia* sp. Mt Ella (M.E. Trudgen 12739)	P3. Nearest record *c*. 4 km W.


RioTinto
Chain of Custody
Flora Specimens to WA
Herbarium
Drawn: N. Murdock
Date: 26/03/2019
Proj: GDA94 Z50
Scale: 1:2,500,000
Legend
Highway
Major Road
RTIO Mine
Major Town
Town
Resource
National Park
Kilometres
Map units in metres
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MURUJUGA NATIONAL PARK
MILLSTREAM-CHICHESTER NATIONAL PARK
KARIJINI NATIONAL PARK
Port Hedland
Goldsworthy (closed)
Cape Lambert
Dampier
Wickham
Karratha
Roebourne
Marble Bar
Onslow
Pannawonica
Dinner Camp Bore
Warramboo
Mesa B
Mesa G
Mesa K
Mesa C
Mesa H
Mesa F
Mesa J
Middle Robe River
Bungaroo
Mt Pyrton
Caliwingina
Mt Margaret North
Firetail
Mt Sheila
Homestead
Kings
Wittenoom (closed)
Silvergrass
Mt Sylvia
Mt Margaret South
Fortescue Valley Detritals
Cloudbreak
Serpentine
Bourne Highway
Silvergrass
Nammuldi
Christmas Creek
Roy Hill
Brockman 1
Brockman 3
Brockman 4
Koodaideri
Tarcoola
Metawandy
Vivash
B1
Section 10
Mt Samson Detritals
Yandicoogina - Snooker
Yandicoogina - Junction
Section 17
B26
Marandoo
Arrochar
Mt Wall
Mount Tom Price
Junction South East
Panhandle
Juna Downs
Wonmunna North
Turee Syndrome
Western Range
Wonmunna South
Texas
Western Hill
Hope Downs 5
Paraburdoo
Borefield
Mount Ella
R Hill
Ophthalmia
Eastern Range
Channar
Metro Line
Newman
Mount Whaleback
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7,400,000

Appendix B: Floristic Sample Data

Sample Data to be provided

Appendix C: Mt Ella East and Deposit J Survey Areas Flora Likelihood of Occurrence

Species	Conservation Status			Habitat	Likelihood of Occurrence		Comments
	EPBC Act	BC Act	DBCA		Pre-Survey	Post-Survey	
Hibiscus sp. Gurinbiddy Range (M.E. Trudgen MET 15708)			P2	Hilltops, upper hillslopes.	Confirmed	Confirmed	Confirmed within DJ and MEE. The historical record of *Hibiscus* sp. Mt Brockman (E. Thoma ET 1354) is actually *Hibiscus* sp. Gurinbiddy Range (M.E. Trudgen MET 15708).
Indigofera gilesii			P3	Skeletal red-brown loam on rocky slopes, gorges, and creeklines.	Confirmed	Confirmed	Confirmed within MEE
Triodia sp. Mt Ella (M.E. Trudgen 12739)			P3	Light orange-brown to red-brown pebbly loam on hill slopes and in gullies.	Confirmed	Confirmed	Confirmed within DJ and MEE
Rhagodia sp. Hamersley (M. Trudgen 17794)			P3	Mulga (*Acacia aneura*) and Snakewood (*A. xiphophylla*) vegetation on clay plains.	Confirmed	Confirmed	Confirmed within MEE
Acacia subtiliformis			P3	Calcrete platforms.	Confirmed	Confirmed	Confirmed within the Dep J area.
Solanum kentrocaule			P3	Hillsides and mountain crests, creek beds; skeletal red-brown soil over ironstone on basalt or scree.	Confirmed	Confirmed	Confirmed within DJ and MEE
Acacia bromilowiana			P4	Skeletal loam soils on rocky hills, breakaways, scree slopes, gorges and rocky creek beds.	Confirmed	Confirmed	Observed within MEE area
Oxalis sp. Pilbara (M.E. Trudgen 12725)			P2	Red-brown loam on rocky hillslopes and in gorges.	Highly likely	Confirmed	Confirmed within MEE
Pilbara trudgenii			P3	Skeletal red stony soil over ironstone; hill summits, steep slopes, screes, cliff faces.	Highly likely	Confirmed	Confirmed within MEE
Eremophila magnifica subsp. *velutina*			P3	Skeletal soils over ironstone on summits and breakaways.	Unlikely	Confirmed	Confirmed within MEE
Eremophila naaykensii			P3	Skeletal red-brown silty loam on hill crests, cliff tops, gorges.	Unlikely	Confirmed	Confirmed within MEE
Eremophila magnifica subsp. *magnifica*			P4	Rocky hillslopes, breakaways.	Unlikely	Confirmed	Confirmed within MEE

Species	Conservation Status			Habitat	Likelihood of Occurrence		Comments
	EPBC Act	BC Act	DBCA		Pre-Survey	Post-Survey	
Tetratheca fordiana			P2	Shale pockets amongst ironstone on free rock faces.	Confirmed	Highly likely	Previous records were unable to be verified due to access constraints.
Aristida jerichoensis var. *subspinulifera*			P3	Hardpan clay plains.	Confirmed	Likely	Confirmed records within MEE were not able to be visited during the field survey due to access constraints. Suitable habitat present.
Aristida lazaridis			P2	Major drainage areas through clayey flats.	Confirmed	Possible	A confirmed record within MEE was not able to be visited during the field survey due to access constraints. Suitable habitat present.
Rostellularia adscendens var. *latifolia*			P3	Various; creeks, plains, low hills.	Confirmed	Possible	Previous records and habitat were searched but no individuals were recorded. However, present individuals or populations may have been missed.
Olearia mucronata			P3	Hills and rocky drainage channels.	Confirmed	Possible	Previous records were not able to be inspected due to access issues. Suitable habitat present.
Lepidium catapycnon			P4	Skeletal soils on hill slopes.	Confirmed	Possible	Previous records and surrounding habitat were searched but no individuals were recorded. However, present populations may have been missed.
Acacia effusa			P3	Stony red loam; scree	Likely	Possible	Suitable habitat present but no individuals observed. However, currently present individuals and populations may have been missed.

Species	Conservation Status			Habitat	Likelihood of Occurrence		Comments
	EPBC Act	BC Act	DBCA		Pre-Survey	Post-Survey	
Dampiera metallorum			P3	Skeletal red-brown gravelly soil over banded ironstone; steep slopes and hill summits at high elevation.	Likely	Possible	Suitable habitat present but no individuals observed. However, currently present individuals and populations may have been missed.
Geijera salicifolia			P3	Skeletal and stony soils in massive rock scree, rockpiles and gorges.	Likely	Possible	Suitable habitat present but no individuals observed. However, currently present individuals and populations may have been missed.
Sida sp. Hamersley Range (K. Newbey 10692)			P3	Base of rocky cliff habitats in red skeletal stony soils or ironstone.	Likely	Possible	Suitable habitat present but no individuals observed. However, currently present individuals and populations may have been missed.
Sida sp. Barlee Range (S. van Leeuwen 1642)			P4	Steep slopes, rocky gullies and breakaways.	Likely	Possible	Suitable habitat present but no individuals observed. However, currently present individuals and populations may have been missed.
Grevillea saxicola			P3	Upper scree slopes on banded ironstone, usually with Mulga.	Possible	Possible	Suitable habitat within Study Area but was unable to be inspected due to access constraints.
Eragrostis sp. Mt Robinson (S. van Leeuwen 4109)			P2	Red-brown skeletal soils, ironstone; steep slopes, summits of tall hills.	Highly unlikely	Unlikely	Suitable habitat present, but poorly understood and outside current known range.
Goodenia sp. East Pilbara (A.A. Mitchell PRP 727)			P3	Red-brown clay soil, typically on calcrete platforms.	Highly unlikely	Unlikely	Marginal habitat within the Study Area but no individuals recorded.
Isotropis parviflora			P2	Undulating ironstone plains.	Possible	Unlikely	No suitable habitat within Study Area.

Species	Conservation Status			Habitat	Likelihood of Occurrence		Comments
	EPBC Act	BC Act	DBCA		Pre-Survey	Post-Survey	
Eremophila sp. West Angelas (S. van Leeuwen 4068)			P2	Skeletal red-brown soil on hill summits high in the landscape.	Possible	Unlikely	Historical records and surrounding habitat for this species were searched, but no individuals were recorded. Potential specimens for this species were collected for taxonomic identification and were confirmed to not be representative of this species.
Vittadinia sp. Coondewanna Flats (S. van Leeuwen 3835)			P3	Mainly on red clay on plains, low in the landscape.	Possible	Unlikely	Suitable habitat is not present within the Study Area.
Dolichocarpa sp. Hamersley Station (A.A. Mitchell PRP 1479)			P3	Stony undulating clay plains.	Possible	Unlikely	Suitable habitat is not present within the Study Area.
Euphorbia stevenii			P3	Clay soils.	Possible	Unlikely	Suitable habitat is not present within the Study Area
Themeda sp. Hamersley Station (M.E. Trudgen 11431)			P3	Clay plains.	Possible	Unlikely	Suitable habitat is not present within the Study Area
Xerochrysum boreale			P3	Loamy, sandy or gravelly soils on plains.	Possible	Unlikely	Suitable habitat is not present within the Study Area
Acacia daweana			P3	Stony red loamy soils on low rocky rises and along drainage lines.	Possible	Unlikely	Suitable habitat present but no individuals observed. However, currently present individuals and populations may have been missed.
Eremophila pusilliflora			P2	Alluvial plains.	Unlikely	Unlikely	Outside known range. Suitable habitat present but was unable to be assessed due to access constraints.
Stackhousia clementii			P3	Skeletal soils, sandstone hills.	Unlikely	Unlikely	Suitable habitat present but no individuals observed. No nearby records.

Species	Conservation Status			Habitat	Likelihood of Occurrence		Comments
	EPBC Act	BC Act	DBCA		Pre-Survey	Post-Survey	
Triodia basitricha			P3	Slopes or crests of rocky hills.	Unlikely	Unlikely	Suitable habitat present but outside current known range.
Ptilotus mollis			P4	Stony hills and screes.	Unlikely	Unlikely	Suitable habitat present but outside current known range.
Thryptomene wittweri	VU	VU		Breakaways and stony creek beds on high mountains (>1,000 m in elevation).	Highly unlikely	Highly unlikely	Restricted to Mt Meharry in the Pilbara
Hibiscus sp. Mt Brockman (E. Thoma ET 1354)			P1	Gorges, rocky areas.	Highly Unlikely	Highly Unlikely	Recent communications from Rio Tinto indicate that the record of *Hibiscus* sp. Mt Brockman (E. Thoma ET 1354) in the Study Area is actually *Hibiscus* sp. Gurinbiddy Range (M.E. Trudgen MET 15708) (P2). As such, the taxon is highly unlikely to occur as it is mostly known from the Brockman region, west of Karijini National Park
Rhodanthe ascendens			P1	Cracking clay.	Highly unlikely	Highly unlikely	No suitable habitat present within the Study Area
Triodia sp. Karijini (S. van Leeuwen 4111)			P1	Skeletal dark orange-brown to red-brown soil on upper slopes and summits of mountains.	Highly unlikely	Highly unlikely	Suitable habitat present in the Study Area but outside know range.
Euphorbia inappendiculata var. *queenslandica*			P2	Heavy clay soils on open plains and gentle slopes.	Highly unlikely	Highly unlikely	No suitable habitat present within the Study Area
Teucrium pilbaranum			P2	Crab hole floodplains; margins of calcrete tables.	Highly unlikely	Highly unlikely	No suitable habitat is present in the Study Area
Eremophila rigida			P3	Red sand alluvium. Hardpan plains and stony clay depressions.	Highly unlikely	Highly unlikely	Mostly occurs within the Gascoyne bioregion
Euphorbia clementii			P3	Gravelly hillsides, stony ground.	Unlikely	Highly unlikely	Outside known range, no suitable habitat.
Goodenia lyrata			P3	Near claypans.	Unlikely	Highly unlikely	No suitable habitat present within the Study Area
Swainsona thompsoniana			P3	Creekline, claypan.	Unlikely	Highly unlikely	No suitable habitat present.

Appendix D: Flora Recorded from the Study Area

Acanthaceae

Dipteracanthus australasicus subsp. *australasicus*

Amaranthaceae

Alternanthera nana
Amaranthus cuspidifolius
Gomphrena cunninghamii
Ptilotus astrolasius
Ptilotus calostachyus
Ptilotus clementii
Ptilotus exaltatus
Ptilotus fusiformis
Ptilotus obovatus
Ptilotus obovatus var. *obovatus*
Ptilotus rotundifolius
Ptilotus schwartzii

Apocynaceae

Cynanchum floribundum
Leichhardtia australis
Vincetoxicum lineare

Araliaceae

Astrotricha hamptonii
Trachymene oleracea

Asparagaceae

Thysanotus exiliflorus

Asteraceae

**Bidens bipinnata*
Chrysocephalum gilesii
**Flaveria trinervia*
Olearia fluvialis
Olearia stuartii
Peripleura arida
Pilbara trudgenii (P3)
Pluchea dentex
Pterocaulon sphacelatum
Rhodanthe margarethae
Senecio hamersleyensis
Streptoglossa decurrens

Boraginaceae

Halgania gustafsenii var. *gustafsenii*
Heliotropium inexplicitum

Boraginaceae (cont'd)

Heliotropium tenuifolium
Trichodesma zeylanicum
Trichodesma zeylanicum var. *zeylanicum*

Brassicaceae

Lepidium muelleri-ferdinandii
Lepidium oxytrichum

Capparaceae

Capparis lasiantha
Capparis mitchellii
Capparis spinosa subsp. *nummularia*

Caryophyllaceae

Polycarpaea longiflora

Chenopodiaceae

Dysphania kalpari
Dysphania melanocarpa
Dysphania saxatilis
Enchylaena tomentosa
Enchylaena tomentosa var. *tomentosa*
Maireana tomentosa
Rhagodia eremaea
Rhagodia sp. Hamersley (M. Trudgen 17794)
Salsola australis

Cleomaceae

Arivela viscosa

Convolvulaceae

Bonamia pilbarensis
Duperreya commixta
Evolvulus alsinoides var. *villosicalyx*

Cucurbitaceae

Cucumis variabilis

Cupressaceae

Callitris columellaris

Cyperaceae

Fimbristylis dichotoma

Dilleniaceae

Hibbertia glaberrima

Euphorbiaceae

Euphorbia biconvexa
Euphorbia boophthona

Fabaceae

Acacia adoxa var. *adoxa*
Acacia adsurgens
Acacia aneura
Acacia aptaneura
Acacia ayersiana
Acacia bivenosa
Acacia bromilowiana (P4)
Acacia catenulata subsp. *occidentalis*
Acacia dictyophleba
Acacia elachantha
Acacia hamersleyensis
Acacia inaequilatera
Acacia maitlandii
Acacia monticola
Acacia pachyacra
Acacia pruinocarpa
Acacia pteraneura
Acacia pyrifolia
Acacia pyrifolia var. *pyrifolia*
Acacia rhodophloia
Acacia sibirica
Acacia steedmanii subsp. *borealis*
Acacia subtiliformis (P3)
Acacia tenuissima
Acacia tumida var. *pilbarensis*
Glycine canescens
Gompholobium oreophilum
Indigofera fractiflexa subsp. *fractiflexa*
Indigofera gilesii (P3)
Indigofera monophylla
Mirbelia viminalis
Petalostylis labicheoides
Rhynchosia minima
Senna artemisioides (DC.) Randell subsp. ×*artemisioides*
Senna artemisioides subsp. *filifolia*
Senna artemisioides subsp. *helmsii*
Senna artemisioides subsp. *oligophylla*
Senna ferraria
Senna glutinosa subsp. *glutinosa*

Fabaceae (cont'd)

Senna glutinosa subsp. ×*luerssenii*
Senna glutinosa subsp. *pruinosa*
Senna notabilis
Senna sp. Meekatharra (E. Bailey 1-26)
Tephrosia oxalidea
Tephrosia rosea var. Fortescue creeks (M.I.H. Brooker 2186)
Tephrosia sp. NW Eremaean (S. van Leeuwen et al. PBS 0356)

Goodeniaceae

Dampiera candicans
Goodenia cusackiana
Goodenia microptera
Goodenia muelleriana
Goodenia stellata
Goodenia stobbsiana
Goodenia triodiophila
Scaevola browniana subsp. *browniana*
Scaevola parvifolia subsp. *pilbarae*
Scaevola spinescens

Gyrostemonaceae

Codonocarpus cotinifolius

Lamiaceae

Clerodendrum floribundum
Clerodendrum floribundum var. *floribundum*
Newcastelia clavipetala

Lauraceae

Cassytha capillaris

Loranthaceae

Amyema fitzgeraldii

Malvaceae

Abutilon amplum
Abutilon cunninghamii
Abutilon fraseri subsp. *fraseri*
Abutilon lepidum
Abutilon macrum
Abutilon sp. Dioicum (A.A. Mitchell PRP 1618)
Androcalva luteiflora
Brachychiton acuminatus
Corchorus crozophorifolius
Corchorus lasiocarpus

Malvaceae (cont'd)

Corchorus lasiocarpus subsp. *parvus*
Corchorus sidoides subsp. *sidoides*
Gossypium robinsonii
Hibiscus burtonii
Hibiscus coatesii
Hibiscus sp. Gurinbiddy Range (M.E. Trudgen MET 15708) (P2)
Hibiscus sp. Mt Robinson (G. Byrne 3537)
Hibiscus sturtii var. *campylochlamys*
Malvastrum americanum
Melhania oblongifolia
Seringia exastia
Sida arenicola
Sida echinocarpa
Sida fibulifera
Sida sp. dark green fruits (S. van Leeuwen 2260)
Sida sp. Golden calyces glabrous (H.N. Foote 32)
Sida sp. L (A.M. Ashby 4202)
Sida sp. Shovelanna Hill (S. van Leeuwen 3842)
Sida sp. spiciform panicles (E. Leyland s.n. 14/8/90)
Triumfetta clementii
Triumfetta maconochieana

Moraceae

Ficus brachypoda

Myrtaceae

Calytrix carinata
Corymbia deserticola subsp. *deserticola*
Corymbia ferriticola
Corymbia hamersleyana
Eucalyptus gamophylla
Eucalyptus kingsmillii
Eucalyptus leucophloia
Eucalyptus leucophloia subsp. *leucophloia*
Eucalyptus socialis subsp. *eucentrica*
Eucalyptus xerothermica

Nyctaginaceae

Boerhavia coccinea
Boerhavia repleta

Oleaceae

Jasminum didymum
Jasminum didymum subsp. *lineare*

Oxalidaceae

Oxalis sp. Pilbara (M.E. Trudgen 12725) (P2)

Phyllanthaceae

Nellica maderaspatensis

Poaceae

Amphipogon sericeus
Aristida burbidgeae
Aristida contorta
Aristida holathera
Aristida inaequiglumis
Cenchrus ciliaris
Cymbopogon ambiguus
Digitaria ammophila
Digitaria brownii
Digitaria ctenantha
Enneapogon caerulescens
Enneapogon lindleyanus
Enneapogon polyphyllus
Eragrostis setifolia
Eriachne lanata
Eriachne mucronata
Eriachne pulchella subsp. *dominii*
Eulalia aurea
Panicum effusum
Paraneurachne muelleri
Paspalidium clementii
Setaria verticillata
Themeda triandra
Triodia longiceps
Triodia pungens
Triodia sp. Mt Ella (M.E. Trudgen 12739) (P3)
Triodia vanleeuwenii
Triodia wiseana

Proteaceae

Grevillea berryana
Grevillea wickhamii
Grevillea wickhamii subsp. *hispidula*
Grevillea wickhamii subsp. *macrodonta*
Hakea chordophylla
Hakea lorea subsp. *lorea*

Pteridaceae

Cheilanthes brownii
Cheilanthes sieberi

Pteridaceae (cont'd)

Pellaea reynoldsii

Rhamnaceae

Cryptandra monticola
Ventilago viminalis

Rubiaceae

Dolichocarpa crouchiana
Pomax rupestris
Psydrax latifolia
Psydrax suaveolens

Santalaceae

Santalum lanceolatum

Sapindaceae

Dodonaea coriacea
Dodonaea lanceolata var. *lanceolata*
Dodonaea pachyneura
Dodonaea viscosa subsp. *mucronata*

Scrophulariaceae

Eremophila forrestii subsp. *forrestii*
Eremophila jucunda subsp. *pulcherrima*
Eremophila lachnocalyx
Eremophila latrobei subsp. *glabra*
Eremophila latrobei subsp. *latrobei*
Eremophila longifolia
Eremophila magnifica subsp. *magnifica* (P4)
Eremophila magnifica subsp. *velutina* (P3)
Eremophila naaykensii (P3)
Eremophila petrophila subsp. *petrophila*
Eremophila sp. West Angelas (S. van Leeuwen 4068) (P2)

Solanaceae

Nicotiana occidentalis
Nicotiana simulans
Solanum centrale
Solanum cleistogamum
Solanum horridum
Solanum kentrocaule
Solanum lasiophyllum

Surianaceae

Stylobasium spathulatum

Urticaceae

Parietaria cardiostegia

Violaceae

Afrohybanthus aurantiacus

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D.3: West Angelas Beyond 2020 Deposit H and Deposit F North Reconnaissance Survey

Metadata Statement

Date: 30/05/2022

Title: Metadata Statement – Beyond 2020 Deposit F and Deposit H Additional Areas - RTIO-HSE-0359919

Abstract:

Project Background and Study Area Location:

This dataset contains the boundary polygon, field sites, vegetation mapping, conservation significant flora records and fauna habitat mapping of a targeted survey by Rio Tinto Botanist Julijanna Hantzis and Rio Tinto Ethnobiologist Caroline Gill for proposed amendments to Beyond 2020 Deposit F and Deposit H Additional Areas. The survey was conducted on the 15th - 17th November 2021. One priority flora species was recorded during the site visit.

Scope of Survey:

This report describes the methodology employed for the flora, vegetation and conservation significant fauna habitat assessment of the study area and documents the results of the survey. This report identifies vegetation, flora, and threatened fauna habitats of relevance to the study area.

This report is intended as a supporting document for the consolidated desktop assessment conducted by Biologic Environmental Survey and has been prepared based on a review of existing information for the study area, combined with a field survey.

This report includes a description of the:

- Local environment of the study area including flora, vegetation, and threatened fauna habitats;
- Methods employed during the field survey;
- Locations and populations of conservation listed flora;
- Vegetation associations occurring in the study area, an assessment on their condition and conservation significance for the locality and sub-region, including mapping; and
- Fauna habitats present, assessment of their significance for the locality and sub-region, including mapping;

Climate:

The closest Meteorological station providing rainfall data is the Newman Aero weather station (station ID: 007176) located 95 km east of the study area. The Newman climate is generally semi-arid with a summer rainfall season and relatively dry winter season, which varies in temperature from year to year. Annual rainfall is variable with tropical lows producing large rainfall events (between 100 mm to 200 mm in a few days) to isolated thunderstorm events in the dry (winter) season. For Newman the mean annual rainfall for the period 1974 to 2022 is 313.5 mm, with most precipitation occurring between January and February, coinciding with the cyclone season (**Figure 1**). Newman Aero received 0 mm of rainfall in the three months preceding the 2021 survey (BoM 2021) (**Figure 1**). This is 15.6 mm less than the long-term average for this period. Less than ideal growing conditions for annuals.

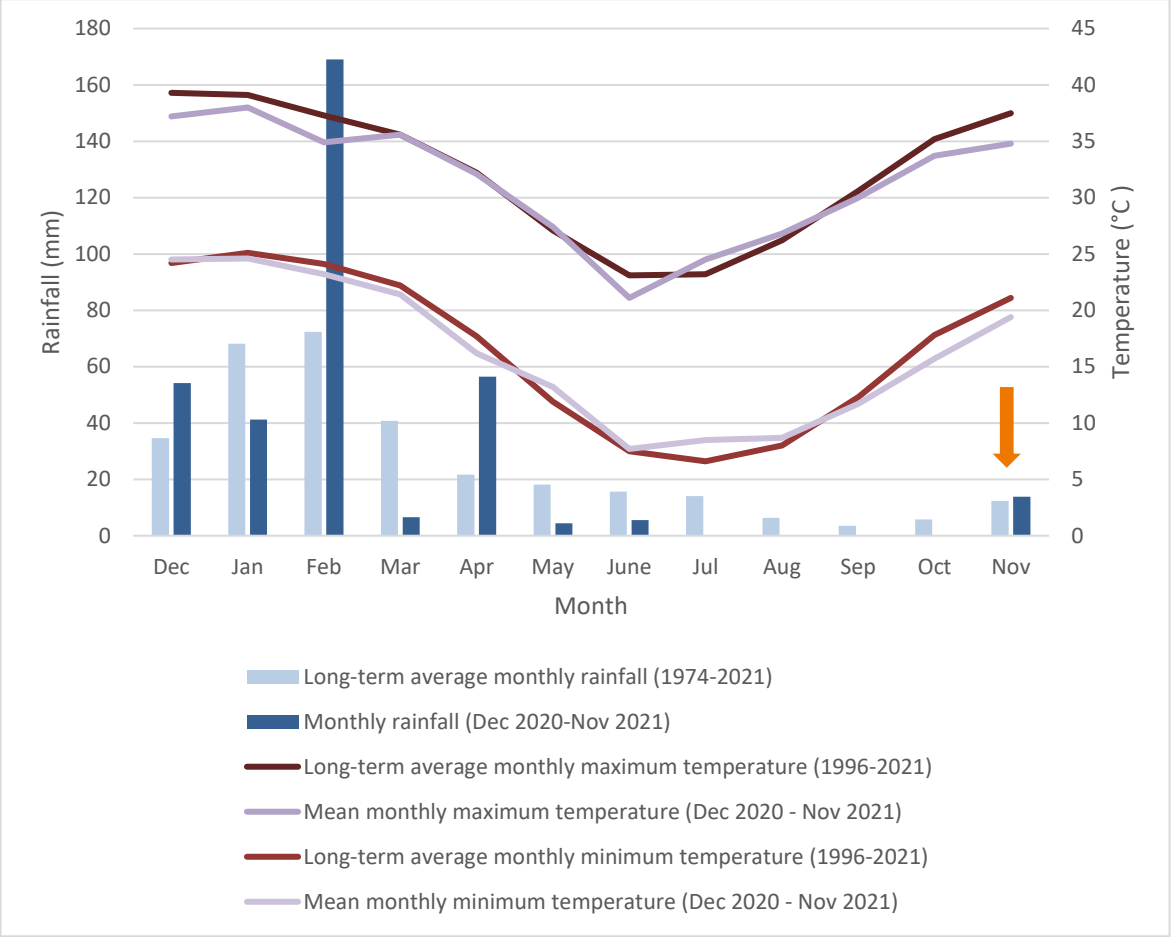

Figure 1: Climate statistics for Paraburdoo Aero (Station ID: 007185) 12 months prior to survey. Orange arrow indicates survey timing.

Survey personnel:

Rio Tinto Botanist Julijanna Hantzis and Rio Tinto Ethnobiologist Caroline Gill.

Methodology:

Field Survey

The study area was surveyed by Rio Tinto Botanist Julijanna Hantzis and Rio Tinto Ethnobiologist Caroline Gill on the 15-17th November 2021.

The study area was assessed in accordance with the *Technical Guidance – Flora and Vegetation Surveys for Environmental Impact Assessment* (EPA 2016a) and Environmental Factor Guideline – Flora and Vegetation (EPA 2016b). Fauna habitats were assessed in reference to *Technical Guidance – Terrestrial vertebrate fauna surveys for environmental impact assessment* (EPA 2020) and *Environmental Factor Guideline – Terrestrial Fauna* (EPA 2016c). Habitats with potential to support species of conservation significance, identified by the database searches and desktop assessment, were the focus of targeted searches.

Relevé (unpegged) survey sites, typically 50 x 50 m in size (to represent an approximate 2,500m^2), were established in representative areas of vegetation associations within the study area. A botanical relevé is described as a vegetation sample that describes the structure and floristics and associated physical attributes, flora, and opportunistic fauna sightings. A total of eight relevés were surveyed in representative vegetation associations. The layout and co-ordinates of each relevé sampled within the study area is presented in **Figure 2**. At each relevé site, a location was recorded with a handheld GPS (GDA94, Z50)

and photographs were taken. Data was collected on the flora species present including percentage cover, average height of each vegetation stratum, site slope, aspect, topography, soil texture and colour, landform type, and habitat features.

Recent orthorectified aerial photography covering the study area was reviewed whilst in the field to confirm boundaries of vegetation communities previously mapped by Biologic (2021c). The location of each site where a relevé was installed was largely determined by the previously mapped vegetation communities. Determination of boundaries between vegetation associations was also undertaken using aerial photography and ground truthing in the field.

Locations of flora of conservation significance, flora of special interest, unknown flora, weeds, and other observations including opportunistic fauna sightings were recorded using a hand-held GPS (GDA94, Z50). Where populations of conservation significant flora were encountered; estimates of density or numbers of individuals, habitats, and associated flora were recorded. Density or numbers of individuals of introduced flora species were also recorded.

Vegetation descriptions condition assessment and mapping

Vegetation descriptions for the survey area were based on Specht (1970) with modification by Aplin (1979). Where appropriate, vegetation descriptions within study area were kept consistent with those assigned by Biologic (2021c). Descriptions were taken at relevés and where changes in the vegetation structure were observed. Assessment of the overall condition of each vegetation association was made based on Trudgen (1988).

The mapping notes gathered in the field were used to prepare a draft map of vegetation, utilising rectified colour digital aerial photography as the background. The vegetation boundaries were digitised on-screen using ArcMap 10.7.1.

The resulting polygons were attributed with the relevant information including the vegetation association, description, and condition. Point locations of each relevé recorded were also uploaded into ArcMap, and together with visual photographs were used to assist with the finalising of vegetation boundaries.

Flora identification

Voucher samples of unknown and Priority flora were collected, pressed, and dried in the field and assigned a unique reference identification sample number.

Flora samples collected in the field were taken to the Western Australian Herbarium (WAH) to be formally identified using relevant taxonomic publications and comparisons to collections at the WAH. Sample identifications were conducted by taxonomist Steve Dillon. Voucher quality specimens will be lodged with the Western Australian Herbarium in the future. Nomenclature was cross-checked using the Parks and Wildlife's FloraBase (WAH 2021) website and updated where required.

Fauna habitat assessment

Habitat assessments are used to identify fauna habitat types and quantify their extents within the study area. Habitat assessments incorporate information obtained through the desktop assessment (i.e., vegetation and geological information) as well as information obtained through the field survey (i.e., physical characteristics). Unique habitats can be identified based on their combinations of landforms, soil, and vegetation which determine their ability to support specific fauna assemblages or significant fauna.

Significant habitats include rare or isolated habitats and habitat features, such as rock piles, caves, gullies, significant trees, drainage lines or waterholes, damplands and springs as well as those that are likely to provide special resources to fauna. Other important habitats include ecological linkages and migration pathways,

refugia, islands, areas that support large or seasonal aggregations of fauna and areas that are important to significant fauna (e.g., for breeding, roosting, or foraging).

Where appropriate broad fauna habitats were identified and mapped based on previous mapping completed within the study area by Biologic (2021b). Habitats were assessed for their potential to support species of conservation significance, in accordance with relevant State and Commonwealth Guidelines. Supporting evidence such as sightings, the presence of microhabitats (i.e., caves, water holes, tree hollows, and burrows) were recorded throughout the study area. Representative traverses were also completed throughout all habitats present within the study area.

Fauna habitats were assessed and mapped as per *Technical Guidance: Terrestrial vertebrate fauna surveys for environmental impact assessment* (EPA 2020) which was current at the time of the survey.

Results:

Vegetation of the study area

Eleven vegetation types were identified across four major landforms within the study area. The vegetation types are summarised in **Table 2-1** and are described in detail on the following pages, accompanied by vegetation mapping (**Figure 3**).

Five vegetation types were described from stony hillslopes, hillcrests and foothills; three vegetations types from clay plains and stony plains; one vegetation type from gorges and gullies and two vegetation types from minor-moderate drainage.

All vegetation types within the study area are representatives of Vegetation types described by Biologic (2021c).

Four vegetation types did not have relevés installed within their mapped extent in the study area. This was due to their small area of coverage. Vegetation types EtTp, AanAayElERfoERlaTpTw, AanAayApTvTp, and AanApAayTp were all on the periphery of the study area and cumulatively covered 1.95 ha of the study area (0.54%). These four vegetation types were previously described by Biota (2020) and were broadly distributed across the Biota (2020) and Biologic (2021c) study areas.

The most widespread vegetation type was EtErEsTspp (145.53 ha covering 40.68% of the study area). The least widespread units were AanAayElERfoERlaTpTw (0.14 ha covering 0.04% of the study area) and AanApAayTp (0.19 ha covering 0.05% of the study area).

Table 2-1: Vegetation type summary Unit

Vegetation Description		Extent within the study area (ha)	Proportion of study area
Unit	**Vegetation Description**		
ChAmoTHtTp	*Corymbia hamersleyana* low open woodland over *Acacia monticola* tall shrubland over *Themeda triandra* very open tussock grassland over *Triodia pungens* very open hummock grassland.	15.08	4.22
EtTp*	*Eucalyptus trivalva* low mallee woodland over *Triodia vanleeuwenii, T. pungens* open hummock grassland.	0.89	0.25
CfAmoTHtTp	*Corymbia ferriticola* low open woodland over *Acacia monticola* tall open shrubland over *Themeda triandra* very open tussock grassland over *Triodia pungens* scattered hummock grasses.	0.67	0.19
AanAayElERfoERlaTpTw*	*Acacia 'aneura'* and/or *A. ayersiana, (Eucalyptus leucophloia subsp. leucophloia)* low woodland over *Eremophila forrestii* subsp. *forrestii*, *E. latrobei* subsp. *latrobei* scattered shrubs over *Triodia pungens, T. wiseana* very open hummock grassland.	0.14	0.04
ElEgAmPlTvTw	*Eucalyptus leucophloia subsp. leucophloia* scattered low trees over *E. gamophylla* low open mallee woodland over *Acacia maitlandii, Petalostylis labicheoides* open shrubland over *Triodia vanleeuwenii, T. wiseana* open hummock grassland.	15.08	4.22
AiTw	*Acacia inaequilatera* scattered tall shrubs over *Triodia wiseana* open hummock grassland.	62.57	17.49
ElAmTvTp	*Eucalyptus leucophloia subsp. leucophloia* scattered low trees over *Acacia maitlandii* scattered shrubs over *Triodia vanleeuwenii, T. pungens* open hummock grassland.	80.25	22.43
ElCdEgTv	*Eucalyptus leucophloia subsp. leucophloia* and/or *Corymbia deserticola subsp. deserticola* low open woodland over *E. gamophylla* low open mallee woodland *Triodia vanleeuwenii* open hummock grassland.	34.77	9.72
AanAayApTvTp*	*Acacia 'aneura', A. ayersiana, A. pruinocarpa* low open woodland over *Triodia vanleeuwenii, T. pungens* open hummock grassland.	0.73	0.2
EtErEsTspp	*Eucalyptus trivalva, E. repullulans, E. socialis subsp. eucentrica* low open mallee woodland over *Triodia wiseana,* (*T. angusta, T. pungens, T. longiceps*) open hummock grassland.	145.53	40.68
AanApAayTp*	*Acacia 'aneura', A. pruinocarpa, A. ayersiana* woodland over *Triodia pungens* open hummock grassland.	0.19	0.05
Disturbed		1.83	0.51
Total		357.7	100

*Denotes vegetation types missing relevé representation within extent of study area

Vegetation of minor-moderate drainage

ChAmoTHtTp (from Biologic 2021c)	***Corymbia hamersleyana* low open woodland over *Acacia monticola* tall shrubland over *Themeda triandra* very open tussock grassland over *Triodia pungens* very open hummock grassland.**
Landform and soils	This vegetation type occurs within minor drainage lines on sandy clay loam soils on banks and sandy soils in creek bed
Distribution	This vegetation type was recorded from the Deposit F study area, representing the minor drainage lines supporting riparian vegetation.
Associated species	Trees: ***Eucalyptus xerothermica, Eucalyptus gamophylla*** Shrubs: ***Acacia bivenosa,*** *A. maitlandii, A. pyrifolia var. pyrifolia,* ***A. dictyophleba, Androcalva luteiflora,*** *Indigofera monophylla,* ***Petalostylis labicheoides, Santalum lanceolatum,*** *Senna artemisioides subsp, oligophylla,* ***Gossypium robinsonii*** Low shrubs: - Grasses: *Eulalia aurea, Paraneurachne muelleri,* ***Triodia wiseana, Triodia angusta*** Herbs: -
Conservation listed flora	**None recorded**
Weeds	***Bidens bipinnata***
Condition	**(Very Good)**
Sampling sites	Relevés: **(DEP F MD)**
Fire and disturbance	Partial recent fire between four to eight years.
Photo	Plate 1

Note: **bold text** indicates information from the current survey.

Plate 1: **Representative photo of vegetation type ChAmoTHtTp (from DEP F MD: 692663 E, 7436348 N)**

EtTp (from Biologic 2021c)	***Eucalyptus trivalva* low mallee woodland over *Triodia pungens* very open hummock grassland.**
Landform and soils	This vegetation type occurs in minor drainage lines with sandy-clay-loam soils on banks and sandy soils in creek beds.
Distribution	This vegetation type is restricted to a small drainage line within the centre of the Deposit F study area.
Associated species	Trees: *Corymbia hamersleyana, Euclayptus socialis subsp. excentrica, E. xerothermica* Shrubs: *Acacia monticola, Androcalva luteiflora, Gastrolobium grandiflorum, Santalum lanceolatum* Grasses: *Paraneurachne muelleri, Themeda triandra, Triodia wiseana.*
Conservation listed flora	None recorded
Weeds	None recorded
Condition	(Excellent)
Sampling sites	Relevés: No sites from this survey
Fire and disturbance	Moderate fire age between four to eight years.
Photo	Not Available

Note: **bold text** indicates information from the current survey.

Vegetation of gorges and gullies

CfAmoTHtTp (from Biologic 2021c)	***Corymbia ferriticola* low open woodland over *Acacia monticola* tall open shrubland over *Themeda triandra* very open tussock grassland over *Triodia pungens* scattered hummock grasses.**
Landform and soils	This vegetation type occurs in minor gorges and gullies with massive ironstones and sandy soils in ephemeral beds.
Distribution	This vegetation type is restricted to a small gorge in the centre of the Deposit F study area.
Associated species	Trees: *Acacia aptaneura, A. catenulata subsp. occidentalis, Ficus brachypoda.* Shrubs: *Acacia hamersleyensis, A. maitlandii,* ***A. bivenosa, Androcalva luteiflora,*** *Capparis mitchellii, Clerodendrum floribundum var. angustifolium, Dodonaea pachyneura, D. viscosa subsp. mucronata,* ***Gastrolobium grandiflorum, Gossypium australe,*** *Gossypium robinsonii,* ***Grevillea wickhamii,*** *Harnieria kempeana subsp. muelleri, Indigofera gilesii, Olearia stuartii,* ***Petalostylis labicheoides****, Santalum lanceolatum.* Grasses: *Aristida burbidgeae, Cymbopogon ambiguus, Eriachne mucronata, Triodia sp. Mt Ella (M.E. Trudgen 12739).* Herbs *:* *Cheilanthes brownii.*
Conservation listed flora	None recorded
Weeds	***Malvastrum americanum, Setaria verticillata***
Condition	(Very Good)
Sampling sites	Relevés: **DEP F GOR**
Fire and disturbance	Old fire age between eight to twelve years.
Photo	Plate 2

Note: **bold text** indicates information from the current survey.

Plate 2: **Representative photo of vegetation type CfAmoTHtTp (from DEP F GOR: 688432 E, 7436290 N)**

Vegetation of Stony Hillslopes, Hillcrests and Foothills

AanAayElERfoERlaTpTw (from Biologic 2021c)	***Acacia 'aneura' and/or A. ayersiana, (Eucalyptus leucophloia subsp. leucophloia)* low woodland over *Eremophila forrestii* subsp. *forrestii, E. latrobei* subsp. *latrobei* scattered shrubs over *Triodia pungens, T. wiseana* very open hummock grassland.**
Landform and soils	This vegetation type occurs on hillslopes supporting Acacia 'aneura' on silty clay loam soils.
Distribution	This vegetation type is restricted to a small calcrete hill in the Deposit H study area.
Associated species	Trees: *Acacia catenulata subsp. occidentalis, A. rhodophloia, Grevillea berryana.* Shrubs: *Abutilon cryptopetalum, Psydrax suaveolens, Ptilotus obovatus, Senna glaucifolia, Teucrium teucriiflorum.* Grasses: *Chrysopogon fallax, Enneapogon lindleyanus, Eriachne mucronata, Themeda triandra, Triodia vanleeuwenii.* Herbs *:* *Cheilanthes sieberi subsp. sieberi, *Malvastrum americanum, Ptilotus gomphrenoides, Streptoglossa bubakii, Vigna lanceolata var. lanceolata.*
Conservation listed flora	None recorded
Weeds	*Malvastrum americanum*
Condition	(Excellent)
Sampling sites	Relevés: **No sites**
Fire and disturbance	Old fire age over twelve years.
Photo	No photo

Note: **bold text** indicates information from the current survey.

ElEgAmPlTvTw (from Biologic 2021c)	***Eucalyptus leucophloia subsp. leucophloia* scattered low trees over *E. gamophylla* low open mallee woodland over *Acacia maitlandii, Petalostylis labicheoides* open shrubland over *Triodia vanleeuwenii, T. wiseana* open hummock grassland.**
Landform and soils	This vegetation type occurs on hillcrests on sandy clay loam soils.
Distribution	This vegetation type is restricted to hillslopes in the south of Deposit H study area.
Associated species	Trees: ***Corymbia hamersleyana*** Shrubs: *Acacia hamersleyensis, A. hilliana,* ***A. monticola****, A. pyrifolia* var. *pyrifolia, A. tenuissima, Hakea chordophylla, Corchorus lasiocarpus* subsp. *parvus, Gompholobium oreophilum, Halgania gustafsenii* var. Mid West (G. Perry 370)*, Hibiscus sturtii* var. *campylochlamys,* ***Mirbelia viminalis,*** *Ptilotus rotundifolius, Senna ferraria, S. glutinosa* subsp*. glutinosa, Seringia elliptica, Sida* sp. Excedentifolia (J.L. Egan 1925). Grasses: ***Eriachne lanata,*** *Eriachne mucronata,* ***Triodia pungens.***
Conservation listed flora	None recorded
Weeds	None recorded
Condition	(Excellent)
Sampling sites	Relevés: **Dep H HS**
Fire and disturbance	Old fire age over twelve years.
Photo	Plate 3

Note: **bold text** indicates information from the current survey.

Plate 3: **Representative photo of vegetation type ElEgAmPlTvTw (from DEP H HS: 697620 E, 7441313 N)**

AiTw (from Biologic 2021c)	***Acacia inaequilatera scattered tall shrubs over Triodia wiseana open hummock grassland.***
Landform and soils	This vegetation type occurs on undulating basalt hills on sandy clay loam soils.
Distribution	This vegetation type is restricted to stony undulating plains in the north of the Deposit F study area and centre of Deposit H study area.
Associated species	Trees: *Eucalyptus leucophloia subsp. leucophloia, Corymbia hamersleyana.* Shrubs: ***Acacia bivenosa**, Gossypium australe, Indigofera rugosa, Ptilotus rotundifolius, Senna glutinosa subsp. glutinosa, S. glutinosa subsp. pruinosa, Sida echinocarpa.* Grasses: *Cymbopogon ambiguus, Enneapogon caerulescens, Themeda sp. Mt Barricade (M.E. Trudgen 2471)* ***Themeda triandra.*** Herbs : *Boerhavia gardneri, Euphorbia careyi, Swainsona maccullochiana.*
Conservation listed flora	None recorded
Weeds	None recorded
Condition	(Excellent)
Sampling sites	Relevés: **Dep F HS1**
Fire and disturbance	Young fire age between two to four years.
Photo	Plate 4

Note: **bold text** indicates information from the current survey.

Plate 4: **Representative photo of vegetation type AiTw (from DEP F HS1: 692439 E, 7436508 N)**

ElAmTvTp (from Biologic 2021c)	***Eucalyptus leucophloia* subsp. *leucophloia* scattered low trees over *Acacia maitlandii* scattered shrubs over *Triodia vanleeuwenii, T. pungens* open hummock grassland.**
Landform and soils	This vegetation type occurs on hillcrests on sandy clay loam soils.
Distribution	This vegetation type is restricted to a hillslopes, majority in the western portion of the Deposit F study area.
Associated species	Trees: *Eucalyptus gamophylla,* ***Hakea chordophylla.*** Shrubs: ***Acacia tenuissima, Gompholobium oreophilum****,* ***Halgania gustafsenii var. Mid West (G. Perry 370****),* ***Senna spp.,*** *Seringia elliptica.* Grasses: *Eriachne lanata,* ***Triodia wiseana****.*
Conservation listed flora	None recorded
Weeds	None recorded
Condition	(Excellent)
Sampling sites	Relevés: **Dep F SP2**
Fire and disturbance	Young fire age between two to four years.
Photo	Plate 5

Note: **bold text** indicates information from the current survey.

Plate 5: **Representative photo of vegetation type ElAmTvTp (from DEP F SP2: 687817 E, 7436420 N)**

ElCdEgTv (from Biologic 2021c)	***Eucalyptus leucophloia* subsp. *leucophloia* and/or *Corymbia deserticola* subsp. *deserticola* low open woodland over *E. gamophylla* low open mallee woodland over *Triodia vanleeuwenii* open hummock grassland.**
Landform and soils	This vegetation type occurs on low undulating ironstone hills and foothills on sandy clay loam soils.
Distribution	This vegetation type is restricted to stony hills in the centre of the Deposit F study area.
Associated species	Trees: *Acacia pruinocarpa, Corymbia hamersleyana, Hakea chordophylla.* Shrubs: *Acacia adoxa* var. *adoxa,* ***A. catenulata,*** *A. cowleana, A. dictyophleba,* ***A. pruinocarpa,*** *Gompholobium oreophilum, Halgania gustafsenii* var. Mid West (G. Perry 370), *Sida cardiophylla.* Grasses: *Amphipogon sericeus, Themeda triandra,* ***Triodia melvillei***
Conservation listed flora	*Aristida jerichoensis* var. *subspinulifera* (P3)
Weeds	None recorded
Condition	(Excellent)
Sampling sites	Relevés: **Dep F FS**
Fire and disturbance	Old fire age between eight to twelve years.
Photo	Plate 6

Note: **bold text** indicates information from the current survey.

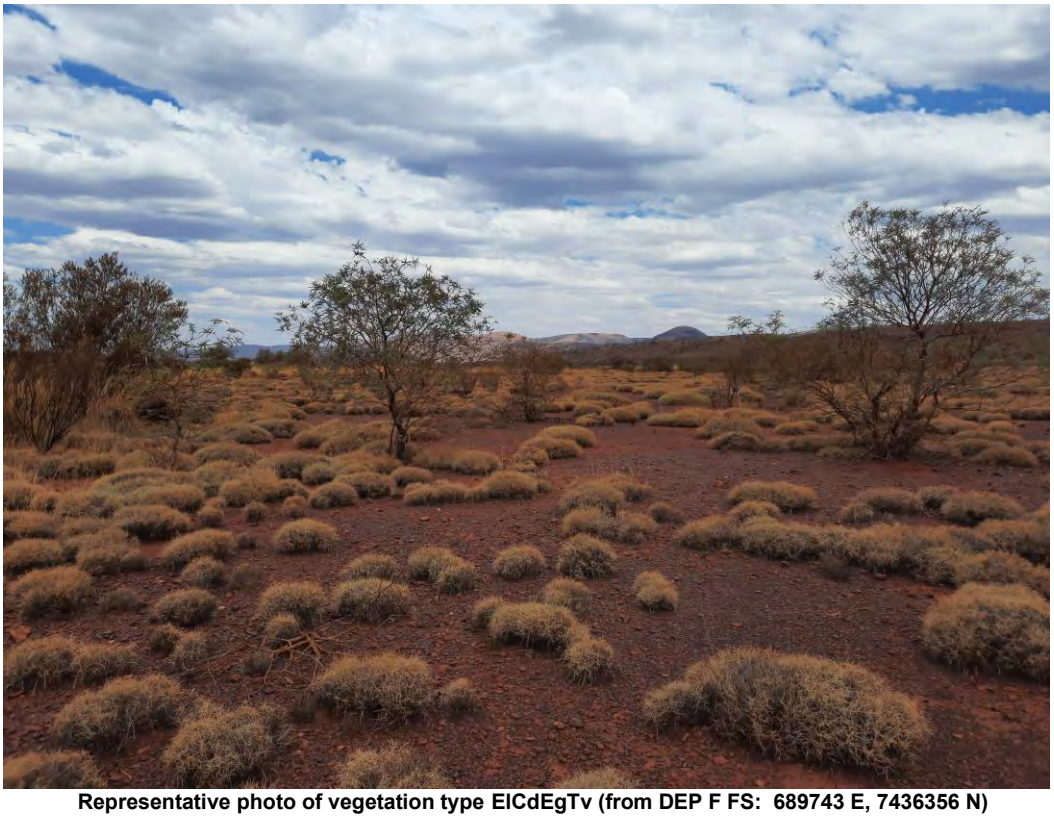

Plate 6: **Representative photo of vegetation type ElCdEgTv (from DEP F FS: 689743 E, 7436356 N)**

Vegetation of Clay plains and Stony Plains

AanAayApTvTp (from Biologic 2021c)	***Acacia 'aneura', A. ayersiana, A. pruinocarpa* low open woodland over *Triodia vanleeuwenii, T. pungens* open hummock grassland.**
Landform and soils	This vegetation type occurs on low undulating ironstone hills and foothills on sandy clay loam soils.
Distribution	This vegetation type is restricted low foothills in the centre of the Deposit F study area.
Associated species	Trees: *Acacia catenulata subsp. occidentalis.* Shrubs: *Acacia bivenosa, A. maitlandii, Anthobolus leptomerioides, Eremophila forrestii* subsp*. forrestii, Hibiscus burtonii, H. coatesii, Maireana villosa, Psydrax suaveolens, Sida* sp. L (A.M. Ashby 4202)*, Solanum lasiophyllum.* Grasses: *Aristida contorta, A. inaequiglumis, Cymbopogon obtectus, Panicum effusum.* Herbs: *Cheilanthes sieberi* subsp*. sieberi.*
Conservation listed flora	None recorded
Weeds	None recorded
Condition	(Excellent)
Sampling sites	Relevés: **No Site**
Fire and disturbance	Young fire age between two to four years.
Photo	No photo

AanApAayTp (from Biologic 2021c)	***Acacia 'aneura', A. pruinocarpa, A. ayersiana* woodland over *Triodia pungens* open hummock grassland.**
Landform and soils	This vegetation type occurs on low plains on sandy clay loam soils.
Distribution	This vegetation type is restricted low foothills in the southeast of the Deposit F study area.
Associated species	Trees: *Corymbia deserticola* subsp. *deserticola.* Shrubs*: Androcalva luteiflora, Eremophila fraseri* subsp. *fraseri, Maireana planifolia, Seringia elliptica, Sida* sp. dark green fruit (S. van Leeuwen 2260)*, S.* sp. L (A.M. Ashby 4202). Herbs: *Ptilotus helipteroides.* Grasses*: Amphipogon sericeus, Aristida contorta, A. holathera* var. *holathera, Cymbopogon obtectus, Enneapogon robustissimus, Panicum effusum.*
Conservation listed flora	None recorded
Weeds	None recorded
Condition	(Excellent)
Sampling sites	Relevés: **No Site**
Fire and disturbance	Young fire age between two to four years.
Photo	No photo

EtErEsTspp (from Biologic 2021c)	***Eucalyptus trivalva, E. repullulans, E. socialis* subsp. *eucentrica* low open mallee woodland over *Triodia wiseana, (T. angusta, T. pungens, T. longiceps)* open hummock grassland.**
Landform and soils	This vegetation type occurs on low undulating ironstone hills and foothills on sandy clay loam soils.
Distribution	This vegetation type is restricted to a undulating hills in the east of the Deposit F study area, and the north of the Deposit H study area.
Associated species	Trees: ***Eucalyptus leucophloia subsp. leucophloia.*** Shrubs: *Acacia adsurgens,* ***A. pruinocarpa,*** *A. synchronicia, A. tenuissima, Dodonaea lanceolata var. lanceolata, Gossypium robinsonii,* ***Maireana georgei,*** *Sida echinocarpa.* Grasses: *Enneapogon caerulescens,* ***Triodia vanleeuwenii****.*
Conservation listed flora	None recorded
Weeds	None recorded
Condition	(Excellent)
Sampling sites	Relevés: **Dep F SP, Dep H SP**
Fire and disturbance	Young fire age between two to four years.
Photo	Plate 7

Note: **bold text** indicates information from the current survey.

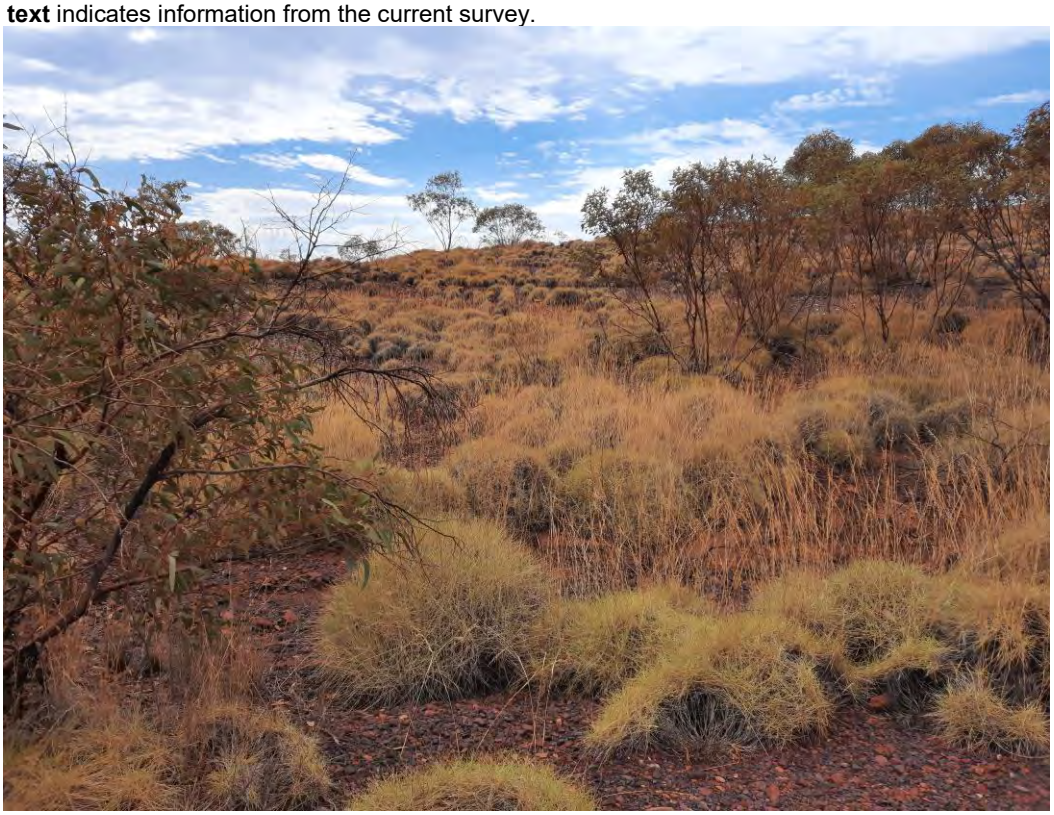

Plate 7: **Representative photo of vegetation type EtErEsTspp (from DEP F SP: 692890 E, 7436116 N)**

Vegetation condition

The majority of vegetation within the study area was rated as being in Excellent condition (355.24 ha) (Trudgen 1988), followed by Completely Degraded (1.82 ha), in the form of previously cleared tracks and drilling.

Vegetation condition mapping is presented in (**Figure 4**), whilst **Table 2-2** presents the extent of vegetation condition mapped within the study area.

Table 2-2: Vegetation condition of the study area

	Area (ha)	Proportion (%) of study area
Excellent	355.24	99.30
Very Good	0.67	0.18
Completely Degraded	1.82	0.51
Total	357.72	100

Vegetation of conservation significance

None of the vegetation associations occurring within the study area correspond to any ecosystems listed as Threatened under the EPBC Act and none are consistent with ecosystems listed as TECs or PECs by the Department of Biodiversity, Conservation and Attractions (DBCA) (2021).

Other vegetation of significance

None of the vegetation associations occurring within the study area correspond to other vegetation of significance.

Native flora recorded during survey

A total of 116 taxa from 66 genera representing 27 families were recorded during the current survey (**Table 2-3, Appendix A**). An additional four specimens could not be confidently identified to species level due to poor collection material and/or lack of diagnostic characteristics. Two are considered not to be represented in the current inventory and have been included in the taxa count as there are no other species represented from this genus within the study area.

The most specious families were Fabaceae (n = 29), Poaceae (n = 24) and Malvaceae (n =10).

Table 2-3: Total recorded numbers of families, genera, species, taxa, priority species and weeds recorded during survey

Flora group	Taxa within study area
Families	27
Genera	66
Taxa	116
Priority species	1
Weeds	3

Conservation listed flora recorded during survey

One Priority 3 flora species, *Aristida jerichoensis* var. *subspinulifera* was recorded within the study area (**Figure 4**).

Aristida jerichoensis var. *subspinulifera*

Aristida jerichoensis var. *subspinulifera* (P3) is described as a compactly tufted perennial, grass-like or herb growing from 0.3m to 0.8m in height (WAH 2022). This species generally grows on hardpan plains and has been recorded in the Hamersley IBRA sub-region of the Pilbara.

This species was detected in on a stony hillslope within the ElCdEgTv vegetation type, in the centre of the Deposit F study area.

Fauna and Fauna habitats of the study area

Fauna habitats of the study area

Four broad fauna habitat types were identified during the field survey aligning with previous mapping undertaken by Biologic (2021b). These comprise; Drainage Line (10.04 ha); Footslopes and Plain (196.45 ha); Gorge/Gully (0.65 ha); and Hillcrest and Hillslope (148.76 ha) (**Figure 5**).

The Drainage Line is described as densely vegetated plains occurring on low-lying alluvial plains, with a moderate-high amount of leaf litter and woody debris (Biologic 2021a). The Footslopes and Plain are described as the low-lying open plains and rolling hills below upland areas (Biologic 2021a). Gorge/Gully habitats are described as rugged, steep-sided valleys incised into the surrounding landscape. Gorges tend to be deeply incised, with vertical cliff faces, while gullies are more open (but not as open as Drainage Area or Valleys). Hillcrest and hillslopes are described as hills and undulating stony plains of higher elevation, often supporting hard spinifex with a mantle of gravel and larger rocks. Scattered areas of minor outcropping and breakaway, particularly atop hillcrests.

Habitat connectivity was generally good over the study area with vehicle tracks throughout the study area providing some form of barrier to smaller ground dwelling fauna. However, barrier effects are considered minimal. The survey area does not contain permanent water or core habitat for Threatened Fauna.

Habitat types identified within the study area are further described below in **Table 2-4**.

Table 2-4:List of habitat types within the study area

Habitat	Fauna habitat description	Associated vegetation units	Extent (ha) within study area	Proportion (%) within study area	Habitat significance for conservation significant species
Drainage Lines	Vegetation within this habitat is generally dominated by *Eucalyptus* or *Melaleuca* species over a variable understory of mixed small to medium shrubs (*Acacia* sp.) and tussock grasses over sandy creek beds (Biologic 2021b). The Structure and condition of the vegetation varies seasonally, particularly following significant rainfall events (Biologic 2021b). Drainage lines Drainage lines comprise a moderate to high amount of leaf litter and woody debris (Biologic 2021b).	ChAmoTHtTp EtTp	10.04	2.8	Northern quoll – Moderate Pilbara leaf-nosed bat – Moderate Ghost bat – Moderate Pilbara olive python - High
Footslopes and Plain	Footslopes and Plain comprises low-lying open plains and the rolling hills below upland areas. Vegetation within this habitat varies in composition; however, is generally dominated by scattered mulga and *Acacia pruinocarpa overstorey, Eremophila* and *Ptilotus* spp midstorey over low hummock grasslands of *Triodia wiseana*, *basedowii, T. longifolia* and *T. pungens.* Scattered *Corymbia hamersleyana, Eucalyptus leucophloia* and *E. gamophylla* also present (Biologic 2021b).	AanApAayTp AanAayElERfoERlaTpTw AanApAayTp AiTw ElAmTvTp ElCdEgTv EtErEsTspp	196.45	54.92	Northern quoll – low Greater bilby – low Pilbara leaf-nosed bat – Moderate Ghost bat – Moderate Night parrot – Low Pilbara olive python - Low
Gorge/Gully	Gorges and gullies area rugged, steep-sided valleys incised into the surrounding landscape. Gorges tend to be deeply incised, with vertical cliff faces, while gullies are more open. Caves and deep rocky cervices are most often encountered in this habitat type, along with water pools. Vegetation can vary, and be dense and complex in areas of soil deposition, or sparse and simple where exposed to outcropping or in areas that are eroded (Biologic 2021b).	CfAmpTHtTp	0.65	0.18	Northern quoll – High Pilbara leaf-nosed bat – High Ghost bat – High Pilbara olive python - High

Habitat	Fauna habitat description	Associated vegetation units	Extent (ha) within study area	Proportion (%) within study area	Habitat significance for conservation significant species
Hillcrest and Hillslope	Hillcrest and Hillslope habitat tends to be more open and structurally simple than other fauna habitats. A common feature of this habitat is a rocky substrate, often with exposed bedrock, and skeletal red soils. These can contain cracks and crevices, but not to the same extent as within rocky upland areas of Gorge/Gully habitat. This habitat is usually dominated by open Eucalyptus woodlands, Acacia and Grevillea scrublands and Triodia low hummock grasslands (Biologic 2021b).	AiTw ElAmTvTp ElEgAmPlTvTw EtErEsTspp	148.76	41.59	Northern quoll – Moderate Pilbara leaf-nosed bat – Low Ghost bat – Low Pilbara olive python - Low

Conservation listed fauna recorded during survey

No threatened fauna were observed during the survey. No Priority fauna were observed during the survey.

Fauna habitat of significance

Of the five fauna habitats present within the study area, Gorge/Gully habitat is considered the most significant as it potentially supports the presence of six conservation significant species. Gorge/gully habitat was present, covering an extent of 0.65ha (0.18%) of the study area. Gorge/gully habitat is significant for generally providing caves and deep rocky crevices used by conservation significant species, however this habitat within the study area provided no caves or deep crevices, nor any standing water. No microhabitats (i.e., caves, water holes, tree hollows, and burrows) were observed within the study area.

Limitations

Limitations of the current survey of the study area are summarised in **Table 3-1**.

Table 3-1 Constraints and limitations of the current study

Constraint	Limitation
Sources of information	The Pilbara bioregion has been relatively well surveyed, with increasing biological survey work occurring due to the resource expansion in the region. One detailed flora and vegetation survey (Biota 2019) and one detailed fauna survey (Biologic 2021a) have previously been completed directly adjacent to the study area, as well as a desktop consolidation vegetation mapping assessment (Biologic 2021c) and desktop fauna habitat mapping assessment (Biologic 2021b), along with numerous flora and fauna surveys within the wider locality; therefore, a suitable number of survey reports are available. Source of information was not considered a limitation for the study area.
Scope of works	The survey requirements of a reconnaissance flora and vegetation survey and targeted terrestrial fauna survey were met. No quadrat sampling or fauna trapping was undertaken, however, relevés were undertaken to confirm vegetation associations in addition to foot traverses of the study area, fauna habitat assessments and targeted flora and fauna searches.
Completeness of survey	The study area was fully surveyed to the satisfaction of an equivalent Reconnaissance survey. No additional surveys were deemed necessary for the purpose of this assessment. Fungi and non-vascular flora (algae, mosses and liverworts) were not sampled.
Intensity of survey	The study area was surveyed by targeted traverses on foot. Habitats with potential to support conservation significant species were searched.
Timing, weather, season, cycle	The survey was conducted during November 2021. Conditions encountered during the survey were regarded as less than ideal for annuals, with 0 mm rainfall in the preceding three months.
Disturbances	Minor parts of the survey area had been disturbed by vehicle tracks and drill pads. 0.5% of the survey area has been mapped as disturbed. There have been no recent fires (< 2 years) within the study area.
Resources	The biologists undertaking the surveys and subsequent reports as part of the studies were suitably qualified to identify flora and fauna. Julijanna Hantzis (field survey and report writing) has more than four years of experience as a botanist in Western Australia, with significant experience working in the Pilbara. Caroline Gill (field survey) has more than 14 years as a botanist and biologist in Western Australia and the Pilbara. Steven Dillon, from the Western Australian Herbarium, completed the plant specimen identifications. There were no limitations noted due to resourcing.
Accessibility / remoteness	The study area was accessed by vehicle and on foot. The study area was adequately traversed on foot. No parts of the study area were inaccessible. Accessibility/remoteness was not considered a limitation to this survey.

References:

Biota (2020). West Angelas Beyond 2020 Detailed Flora and Vegetation Survey: Phases 1 and 2. Unpublished report Prepared for Rio Tinto, March 2020, Biota Environmental Sciences, Western Australia.

Biologic (2021a) West Angelas Beyond 2020: Level 2 Vertebrate and SRE Invertebrate Fauna Assessment Phase 1 & 2. Unpublished report prepared for Rio Tinto, January 2021, Biologic Environmental Survey, Western Australia.

Biologic (2021b). West Angelas Development Envelope Fauna Habitat Mapping Memo. Unpublished report prepared for Rio Tinto, August 2021, Biologic Environmental Survey, Western Australia.

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Western Australian Herbarium (WAH) (2021). FloraBase—the Western Australian Flora. Department of Biodiversity, Conservations and Attractions. http://florabase.dpaw.wa.gov.au/.

Lineage:

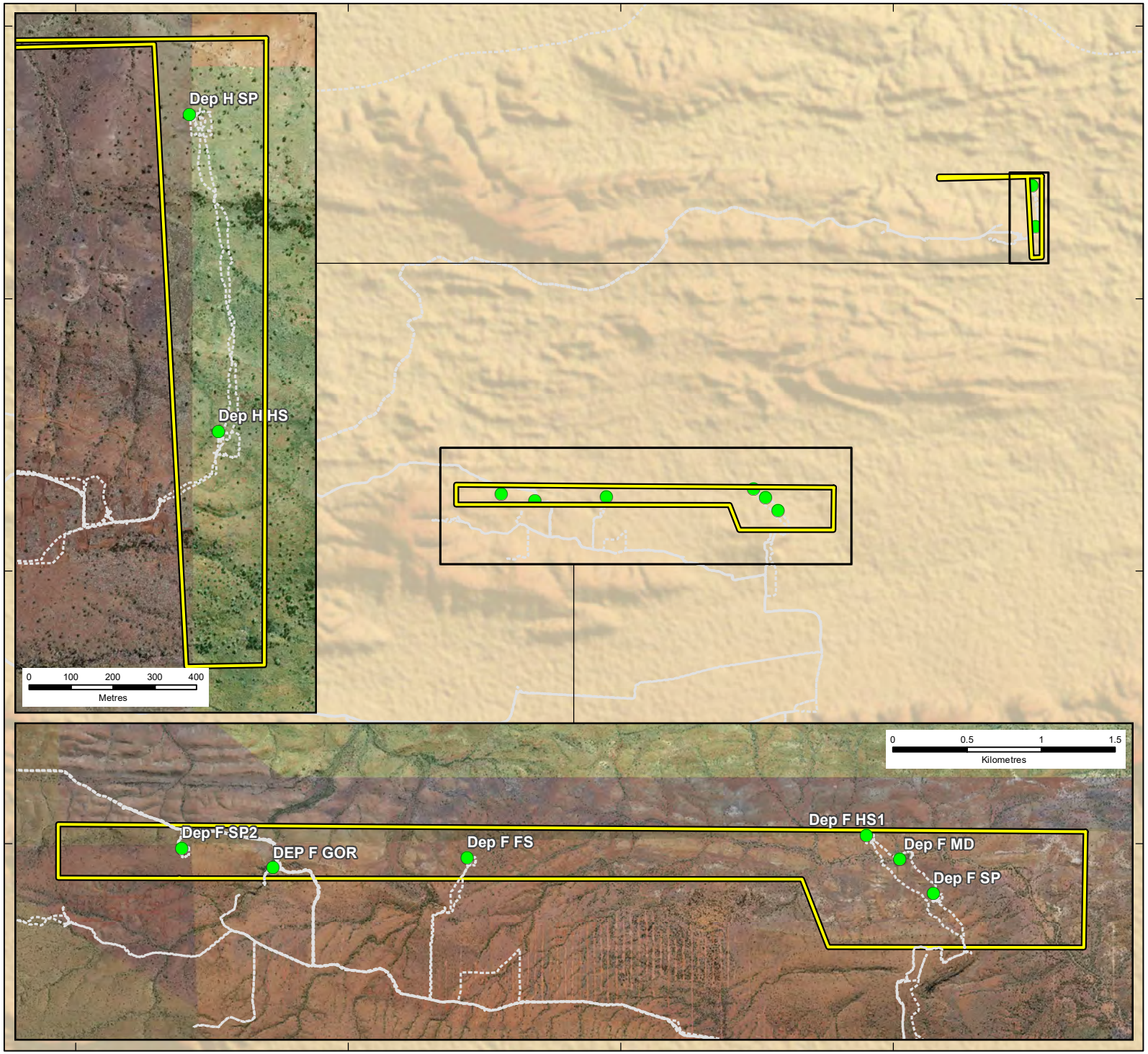
Biological datasets are created manually for Rio Tinto by internal botanists or external consultants undertaking biological surveys. These datasets define the locations of flora or fauna species, or variations of vegetation or fauna habitat types, which are observed in the field and through interpretation of ortho-rectified aerial photography of an area. Features of conservation significance are assigned a protection value in accordance with relevant State and Federal legislative requirements.

Associated Files:

The complete list of biological data standards can be found on HSEQ: Sites & Divisions / Expansion Projects / Approvals. These standards provide details of each attribute in the dataset as well as information on the supply of data.

Data Owner:

Julijanna Hantzis
Botanist – Biological Assessments, State Agreements and Approvals
Rio Tinto Iron Ore
Julijanna.Hantzis@riotinto.com



RioTinto

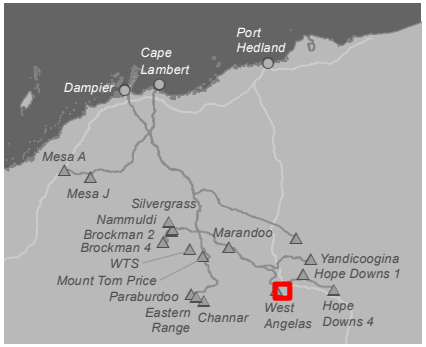
Figure 2: Relevés within the study area and tracklogs from current survey

Drawn: A.Coulson
Plan: PDE0191341v1
Date: October 2022

Proj: GDA 1994 MGA Zone 50
Scale: 1:100,000 @A4
GIS.Team@riotinto.com

Legend

- Rio Tinto Relevé
- Study Area
- Rio Tinto Tracklog



N

0 1 2 3 4 5
Kilometres

Map units in metres

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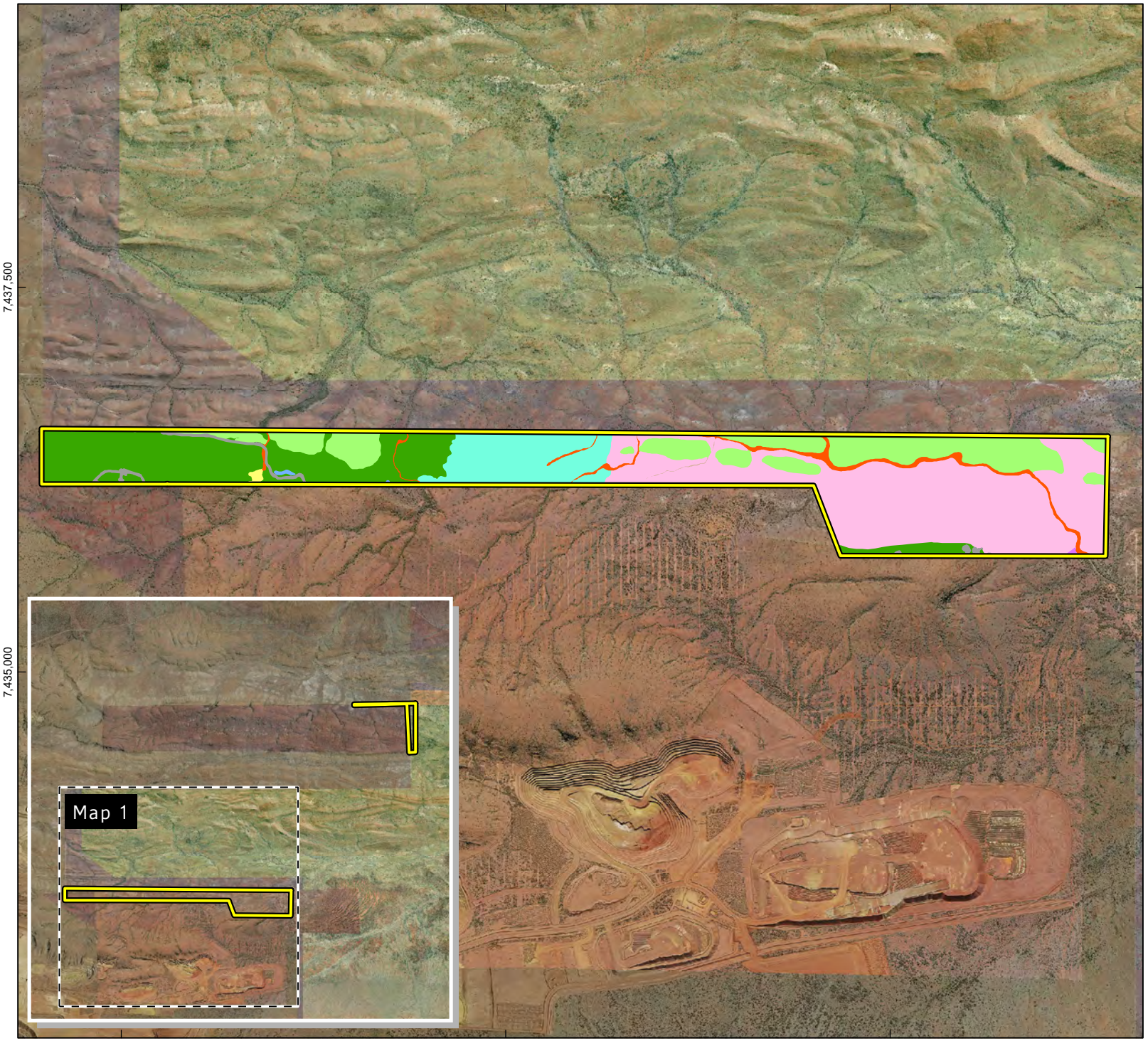


RioTinto

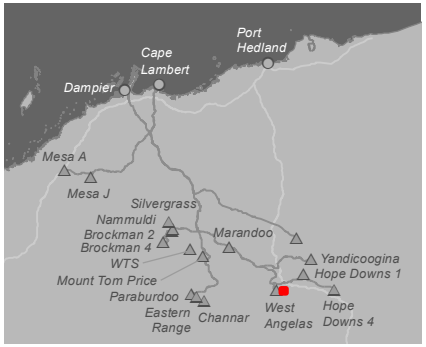
Figure 3: Vegetation types of the study area - Map 1

Drawn: A.Coulson
Plan: PDE0191342v1
Date: October 2022

Proj: GDA 1994 MGA Zone 50
Scale: 1:35,000 @A4
GIS.Team@riotinto.com

Legend

- Study Area
- *Vegetation*
- Disturbed
- D7
- D9
- G3
- H4
- H7
- H9
- P1
- P4
- P14



N

0 0.25 0.5 0.75 1 1.25

Kilometres

Map units in metres

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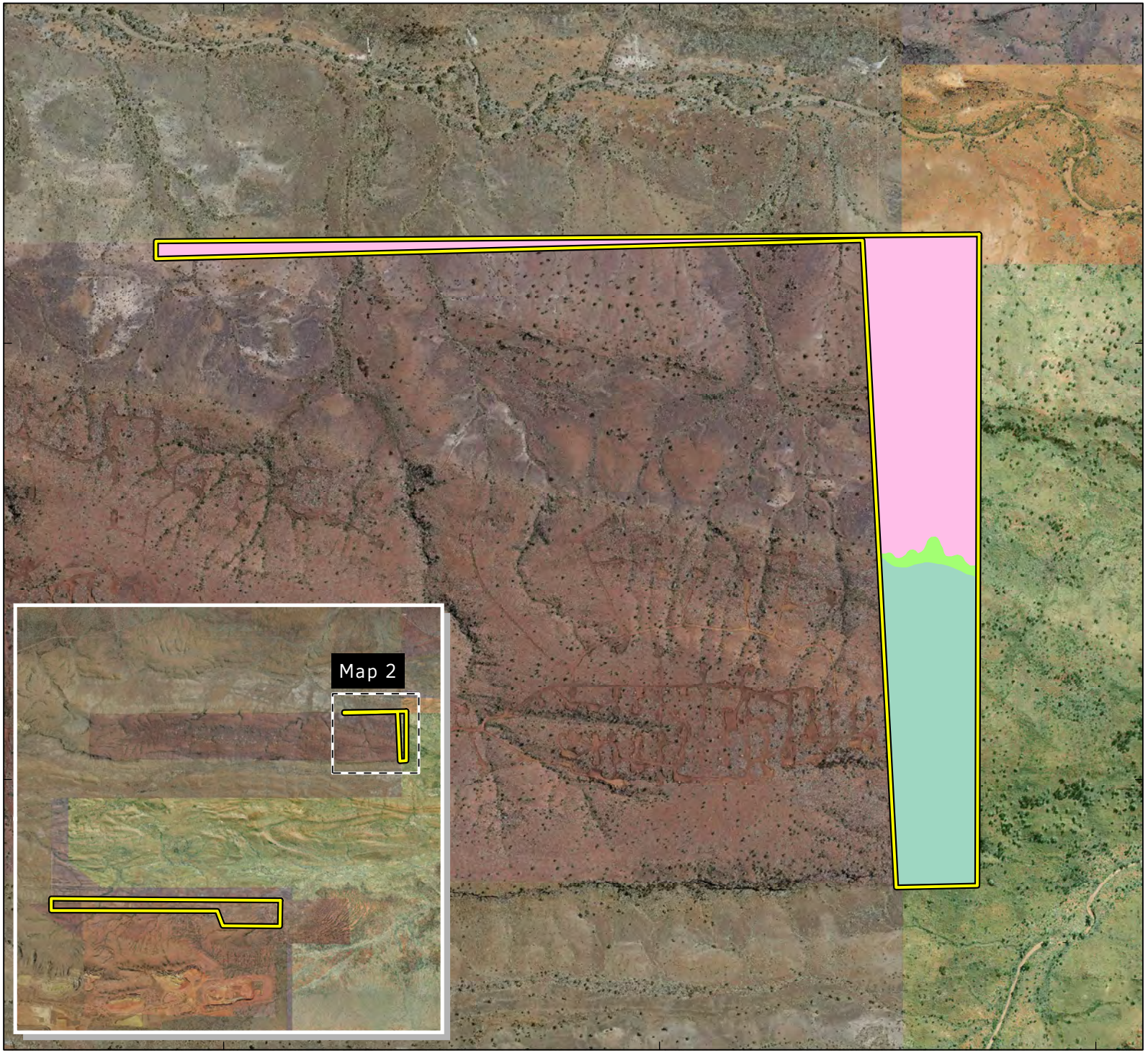


RioTinto

Figure 3: Vegetation types of the study area - Map 2

Drawn: A.Coulson
Plan: PDE0191342v1
Date: October 2022

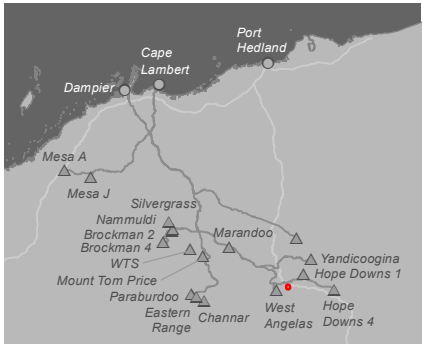
Proj: GDA 1994 MGA Zone 50
Scale: 1:12,500 @A4
GIS.Team@riotinto.com

Legend

- Study Area

Vegetation

- H1
- H4
- H10
- P14



N

0 100 200 300 400 500

Metres

Map units in metres

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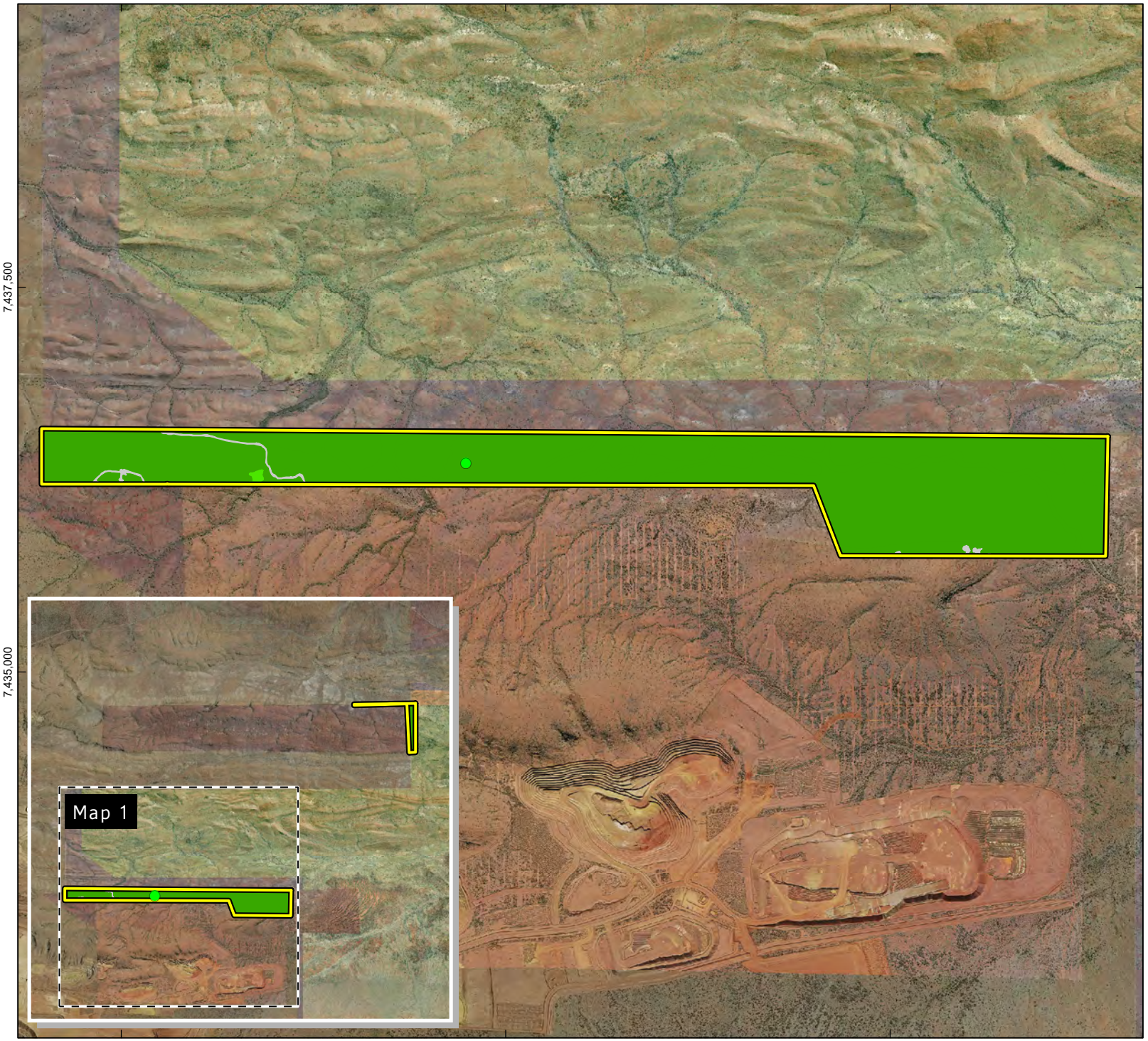


RioTinto

Figure 4: Vegetation condition within the study area and conservation significant flora detected during the survey - Map 1

Drawn: A.Coulson
Plan: PDE0191343v1
Date: October 2022

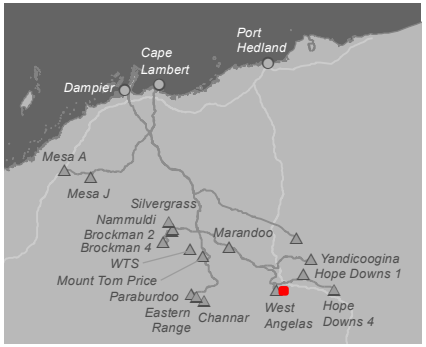
Proj: GDA 1994 MGA Zone 50
Scale: 1:35,000 @A4
GIS.Team@riotinto.com

Legend

- *Aristida jerichoensis* var. *subspinulifera* P3
- Study Area

Vegetation Condition

- Disturbed
- Very Good
- Excellent



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0 0.25 0.5 0.75 1 1.25

Kilometres

Map units in metres

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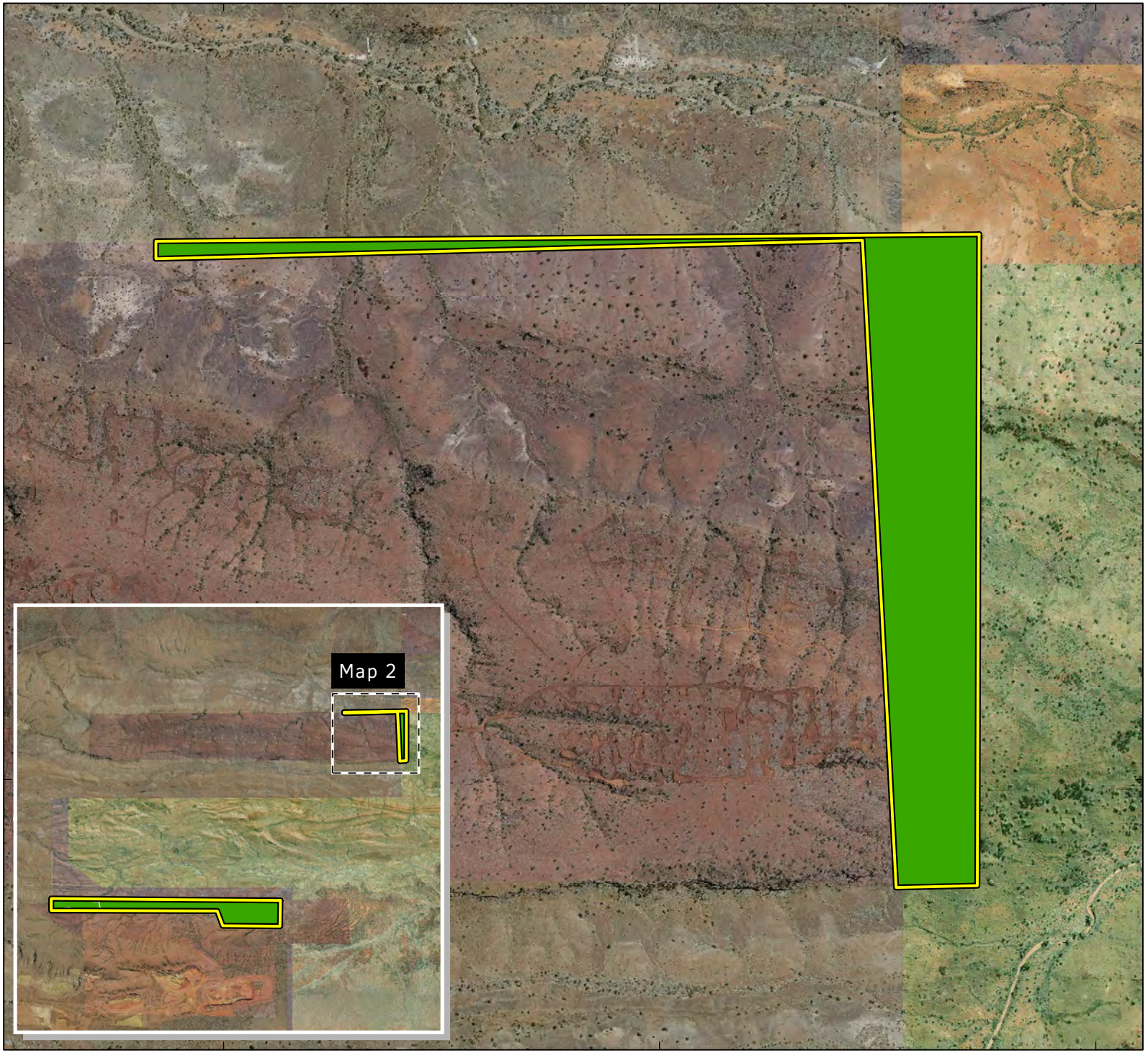


RioTinto

Figure 4: Vegetation condition within the study area and conservation significant flora detected during the survey - Map 2

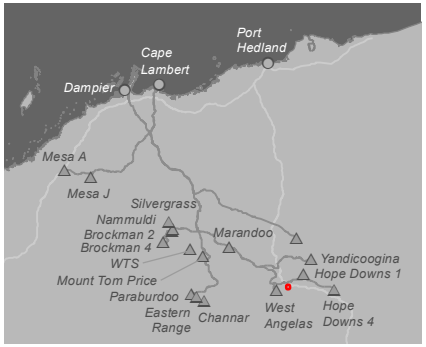
Drawn: A.Coulson
Plan: PDE0191343v1
Date: October 2022
Proj: GDA 1994 MGA Zone 50
Scale: 1:12,500 @A4
GIS.Team@riotinto.com

Legend

Study Area

Vegetation Condition

Excellent



N

0 100 200 300 400 500

Metres

Map units in metres

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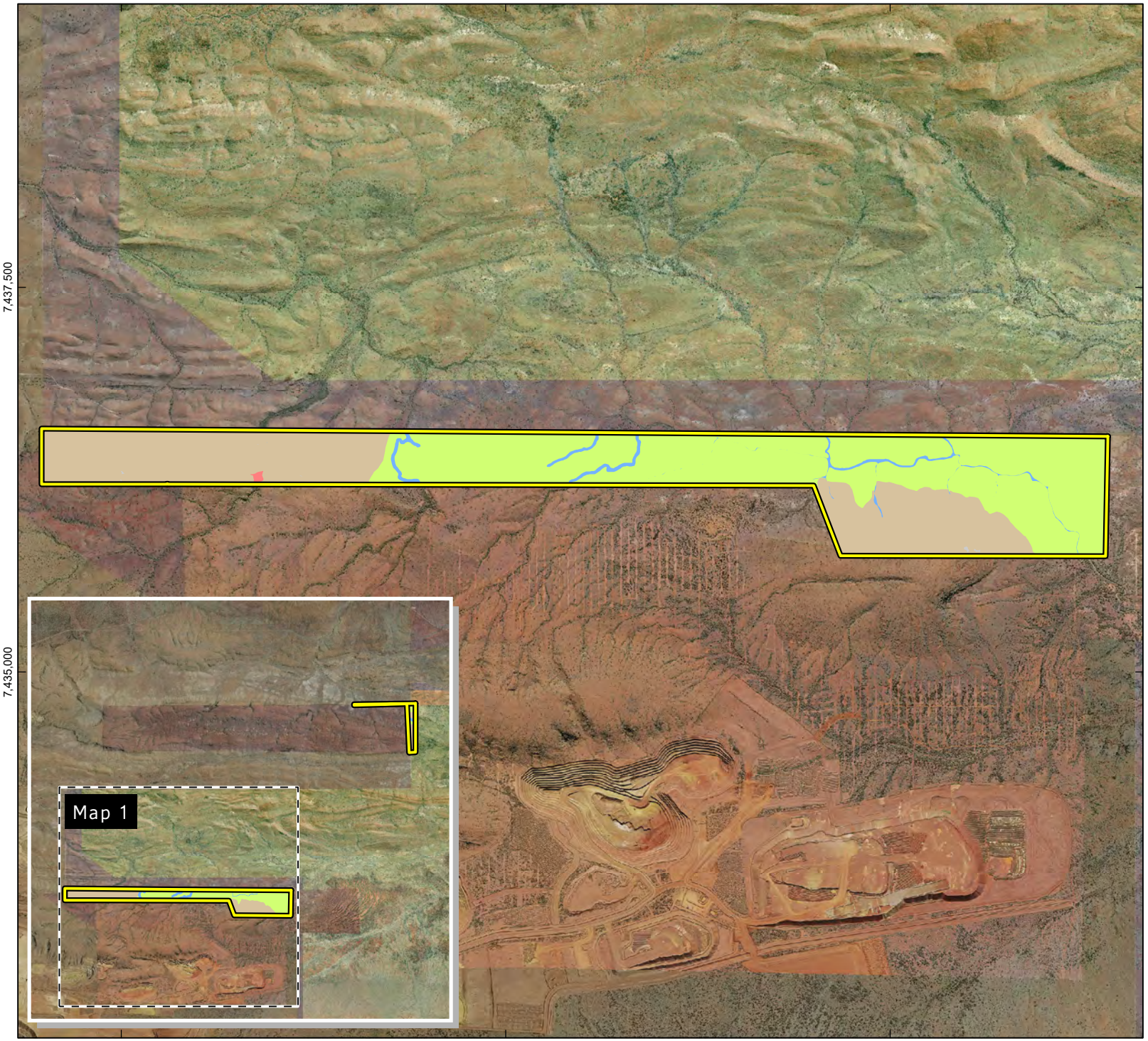


RioTinto

Figure 5: Fauna habitats within the study area - Map 1

Drawn: A.Coulson
Plan: PDE0191344v1
Date: October 2022

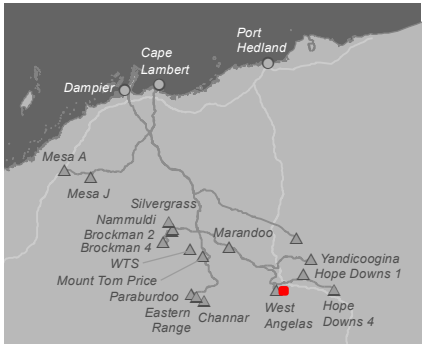
Proj: GDA 1994 MGA Zone 50
Scale: 1:35,000 @A4
GIS.Team@riotinto.com

Legend

- Study Area

Fauna Habitat

- Disturbed
- Drainage Line
- Footslopes and Plains
- Gorge/Gully
- Hillcrest and Hillslope



N

0 0.25 0.5 0.75 1 1.25

Kilometres

Map units in metres

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Figure 5: Fauna habitats within the study area - Map 2

Drawn: A.Coulson
Plan: PDE0191344v1
Date: October 2022

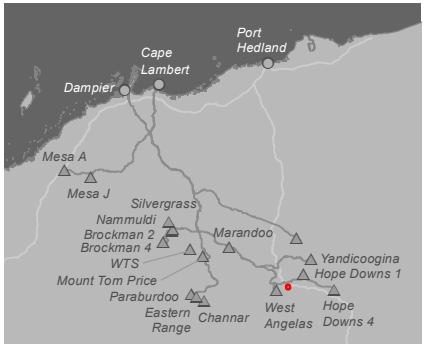
Proj: GDA 1994 MGA Zone 50
Scale: 1:12,500 @A4
GIS.Team@riotinto.com

Legend

- Study Area

Fauna Habitat

- Drainage Line
- Footslopes and Plains
- Hillcrest and Hillslope



N

0 100 200 300 400 500

Metres

Map units in metres

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Appendix A
Site by Species Matrix

	DEP F FS	DEP F GOR	DEP F HS1	DEP F MD	DEP F SP	DEP F SP2	DEP H HS	DEP H SP
Abutilon sp.					X			
Acacia catenulata subsp. *occidentalis*	X							
Acacia adoxa						X		
Acacia adsurgens					X			
Acacia aneura/aptaneura			X					
Acacia bivenosa		X	X	X	X			X
Acacia cowleana		X						
Acacia dictyophleba			X	X				
Acacia hamersleyensis						X		
Acacia inaequilatera			X			X		
Acacia kempeana	X							
Acacia maitlandii		X			X	X	X	
Acacia monticola		X					X	
Acacia pruinocarpa	X						X	
Acacia tenuissima			X	X	X	X	X	
Acacia tetragonophylla				X				
Achyranthes aspera		X						
Acrachne racemosa		X						
Amphipogon sericeus						X		
Androcalva luteiflora		X		X	X			
Anthobolus leptomerioides	X		X	X				
Aristida contorta	X				X			
Aristida holathera		X	X	X				
Aristida jerichoensis var. *subspinulifera*	X							
Astrotricha hamptonii		X						
Bidens bipinnata				X				
Capparis lasiantha		X			X		X	X
Capparis mitchellii		X						
Chenopodium gaudichaudianum		X						
Chrysopogon fallax				X				
Codonocarpus cotinifolius	X						X	

Corchorus lasiocarpus	x						x		
Corchorus lasiocarpus subsp. *parvus*						x			
Corymbia ferreticola		x							
Corymbia hamersleyana		x	x	x			x		
Cucumis variabilis				x					
Cymbopogon ambiguus		x		x					
Dampiera candicans							x		
Dodonaea coriacea						x			
Dodonaea lanceolata var. *lanceolata*					x				
Dodonaea viscosa subsp. *mucronata*		x							
Duperreya commixta		x		x					
Enchylaena tomentosa x *maireana georgei*								x	
Enneapogon caerulescens					x				
Enneapogon polyphyllus	x	x		x					
Eragrostis setifolia	x								
Eremophila latrobei subsp. *latrobei*						x			
Eremophila longifolia		x		x					
Eriachne lanata							x		
Eriachne mucronata		x				x	x	x	
Eriachne pulchella					x			x	
Eucalyptus gamophylla	x			x			x		
Eucalyptus leucophloia					x	x	x	x	
Eucalyptus trivalva					x				
Eucalyptus xerothermica				x					
Evolvulus alsinoides subsp. *villosicalyx*	x			x					
Exocarpos sparteus								x	
Ficus brachypoda		x							
Fimbristylis dichotoma						x			
Gastrolobium grandiflorum		x							
Gompholobium oreophilum						x			
Goodenia microptera	x								
Goodenia stobbsiana						x	x		
Gossypium australe		x							
Gossypium robinsonii				x					

Grevillea wickhamii		x	x						
Hakea chordophylla			x		x	x	x		
Hakea lorea				x					
Halgania gustafsenii						x			
Jasminum didymum				x	x				
Lepidium pedicellosum								x	
Malvastrum americanum		x							
Melhania oblongifolia		x		x					
Mirbelia viminalis						x	x		
Paraneurachne muelleri	x	x		x	x				
Peripleura arida		x							
Petalostylis labicheoides		x		x			x		
Pluchea sp.			x						
Plumbago zeylanica		x							
Psydrax rigidula					x				
Psydrax suaveolens	x								
Pterocaulon sphacelatum		x		x					
Ptilotus calostachyus	x		x			x	x		
Ptilotus exaltatus	x		x	x	x			x	
Ptilotus obovatus		x	x						
Ptilotus rotundifolius			x			x			
Rhagodia eremaea		x							
Rhynchosia minima				x					
Salsola australis		x						x	
Santalum lanceolatum		x	x	x					
Scaevola browniana						x	x		
Scaevola parvifolia subsp. *pilbarae*							x		
Senna artemisioides subsp. *filifolia*				x					
Senna artemisioides subsp. *oligophylla*		x	x		x	x		x	
Senna artemisioides subsp. *oligophylla x helmsii*			x						
Senna glaucifolia	x								
Senna glutinosa subsp. *glutinosa*						x		x	
Senna glutinosa subsp. *pruinosa*					x	x	x	x	

Senna glutinosa subsp. *xluerssenii*	x							
Senna pleurocarpa var. *angustifolia*				x				
Senna sericea					x			
Setaria dielsii				x				
Setaria verticillata		x						
Sida arenicola			x				x	
Sida sp.				x			x	
Solanum horridum			x					
Solanum sp.								x
Sporobolus australasicus		x						x
Themeda triandra		x	x	x	x	x	x	
Tribulus suberosus							x	x
Trichodesma zeylanicum				x				
Tricoryne sp. *Hamersley Range*							x	
Triodia angusta				x	x			
Triodia longiceps					x			
Triodia melvillei	x							
Triodia pungens		x		x		x	x	x
Triodia vanleeuwenii	x				x	x	x	x
Triodia wiseana			x	x	x	x	x	x

D.4: Targeted Flora and Fauna Survey Mt Ella East and Deposit J Pit and Waste Dump Footprints

Biologic Environmental Survey Pty Ltd
PO Box 179
Floreat, WA, 6014

7 April 2022

Attn: Elizabeth Mason

Rio Tinto Iron Ore

Dear Elizabeth,

Please find below a memo summarising the Targeted Flora and Vertebrate Fauna Survey completed for previously unsurveyed areas of the Mount Ella East and Deposit J areas proposed within West Angelas Project Envelope by Biologic Environmental Survey (Biologic).

1. Introduction and Objectives

Biologic was commissioned to undertake a targeted flora and vertebrate fauna survey of previously unsurveyed areas of the Mount Ella East and Deposit J areas proposed for development within the West Angelas Project Envelope (the Study Area) (Figure 1.1).

The Study Area is located south of the West Angelas Development Envelope and comprises a total 237.84 hectares (ha). The Study Area includes two proposed pits and two proposed waste dumps within the Mount Ella East area totalling 221.81 (ha) (herein the Mt Ella East Survey Area) and a single proposed pit within the Deposit J area totalling 16.03 ha (herein the Deposit J Survey Area) (Figure 1.1).

The overarching objective of this assessment was to undertake a single season targeted flora and vertebrate fauna survey of the Study Area, to identify the occurrence of flora and vertebrate fauna of conservation significance (herein referred to as significant species), as per the Environmental Protection Authority (EPA) guidelines (EPA (2016b, 2020). Significant species were based on those identified in previous desktop assessments for the broader West Angelas Revised Proposal Development Envelope, which encompasses the Study Area (Biologic, 2020b; Biota, 2020), to inform future development and environmental approvals within the area.

660000
670000
680000
690000
7440000
7430000
Great Northern Hwy
West Angelas

Legend

- Development Envelope
- Operating Mine
- **Study Area**
  - Deposit J
  - Mt Ella East
- State Road

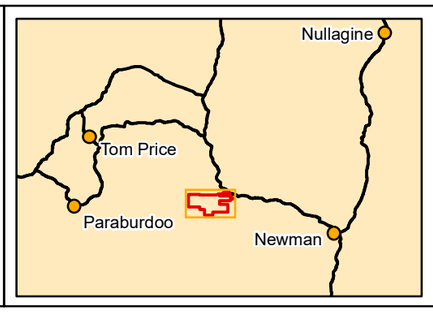
N

biologic Environmental Survey

Scale: 1:100,000

0 2 4 6 Km

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994 Created 04/03/2022



RIO TINTO IRON ORE

Mt Ella East and Deposit J Targeted Flora and Fauna Survey

Figure 1.1: Study Area and regional context

1.1. Background to Protection of Flora and Fauna

Within Western Australia, native flora and fauna are protected under the *Biodiversity Conservation Act 2016* (BC Act) and at a national level under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Any action that has the potential to impact on native fauna or flora needs to be approved by relevant state and/or federal departments as dictated by the state *Environmental Protection Act 1986* (EP Act) and the EPBC Act.

While all native flora and fauna are protected under these Acts, some species of flora and fauna that are determined to be at risk of extinction or decline are afforded extra protection under these Acts. These include species that are considered Threatened (Critically Endangered, Endangered and Vulnerable) under the EPBC Act and/or BC Act, or; migratory bird species that are protected under international agreements and subsequently listed as Migratory under the EPBC Act and/or BC Act. Furthermore, any species that may be threatened but for which there is insufficient information available to allocate a threatened status under the BC Act, can also be listed as Priority (Priority 1–4) species by the Western Australian Department of Biodiversity, Conservation and Attractions (DBCA). For the purposes of this memo, these species are deemed to be significant species. A summary of applicable legislation and status codes is provided in Table 1.1.

Table 1.1: Conservation significance assessment guidelines

Agreement, Act or List	Status Codes
FEDERAL	
Environment Protection and Biodiversity Conservation Act 1999 The Department of Agriculture, Water and the Environment (DAWE) lists threatened flora and vertebrate fauna, which are decided by the Threatened Species Scientific Committee (TSSC) according to criteria set out in the Act. Extinct or Threatened flora and vertebrate fauna are listed under one of six categories, depending on their specific conservation status (listed under 'Status Codes'). Additionally, Migratory species are those listed under international agreements and protected under the EPBC Act as a MNES. Relevant international agreements include the Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention), China-Australia Migratory Bird Agreement (CAMBA), Japan-Australia Migratory Bird Agreement (JAMBA), and Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA).	*Extinct* • Extinct (EX) • Extinct in the Wild (EW) *Threatened* • Critically Endangered (CR) • Endangered (EN) • Vulnerable (VU) • Conservation Dependent (CD) *Other* • Migratory (MI)
STATE	
Biodiversity Conservation Act 2016 The BC Act provides for the listing of threatened native flora and vertebrate fauna that need protection as critically endangered, endangered or vulnerable species because they are under identifiable threat of extinction. Under the BC Act, species are listed as being Extinct, Threatened or Specially Protected. Within these groups, species are listed under one of seven categories, depending on their specific conservation status. Migratory species are those listed under the Bonn Convention and/or CAMBA, JAMBA and ROKAMBA agreements.	*Threatened* • Schedule 1 (Critically Endangered) (S1 or CR) • Schedule 2 (Endangered) (S2 or EN) • Schedule 3 (Vulnerable) (S3 or VU) *Extinct* • Schedule 4 (Extinct) (S4 or EX) *Specially Protected* • Schedule 5 (Migratory) (S5 or MI) • Schedule 6 (Conservation Dependent) (26 or CD) • Schedule 7 (Other Specially Protected) (S7 or OS)
DBCA Priority list DBCA produces a list of Priority species and ecological communities (e.g., PECs) that have not been assigned statutory protection under the BC Act. This system gives a ranking from Priority 1 to Priority 4 for flora and fauna and Priority 1 to Priority 5 for PECs.	• Priority 1 (P1) • Priority 2 (P2) • Priority 3 (P3) • Priority 4 (P4) • Priority 5 (PECs) (P5)

2. Flora Species of Significance

2.1. Methods

2.1.1. Conformance

The survey was carried out in accordance with the Western Australian EPA guidelines for the environmental surveying and reporting of flora and vegetation. The following guidelines, procedures and documents were utilised prior to, during and after completion of the field survey:

- EPA (2018) Statement of Environmental Principles, Factors and Objectives;
- EPA (2016a) Environmental Factor Guideline: Flora and Vegetation;
- EPA (2016b) Technical Guidance – Flora and Vegetation Surveys for Environmental Impact Assessment; and
- Targeted conservation significant flora searches to meet the requirements of Rio Tinto (track logs provided)

2.1.2. Survey Type, Timing and Weather

A targeted single season flora survey was completed from the 2nd to the 6th of August 2021, equivalent to 86-person hours.

The climatic conditions experienced for the duration of the survey were clear skies (no rain received) with cool to mild day-time temperatures. The daily maximum temperatures at the time of the survey ranged from 19.7 °C to 23.4 °C which is below the long term average for August (37.4 °C; BoM, 2021).

Within the six months preceding the survey (February to July), above average rainfall was received (242 mm compared to the long-term average (LTA) of 72.3 mm) (Figure 2.1). However, a substantial amount of this rain (169.0 mm) fell in February, with average or below average rainfall for the three months (May to July 2021) leading into the field survey (BoM, 2021) (Figure 2.1).

The weather conditions experienced preceding and during the survey were considered suitable for completing a targeted survey.

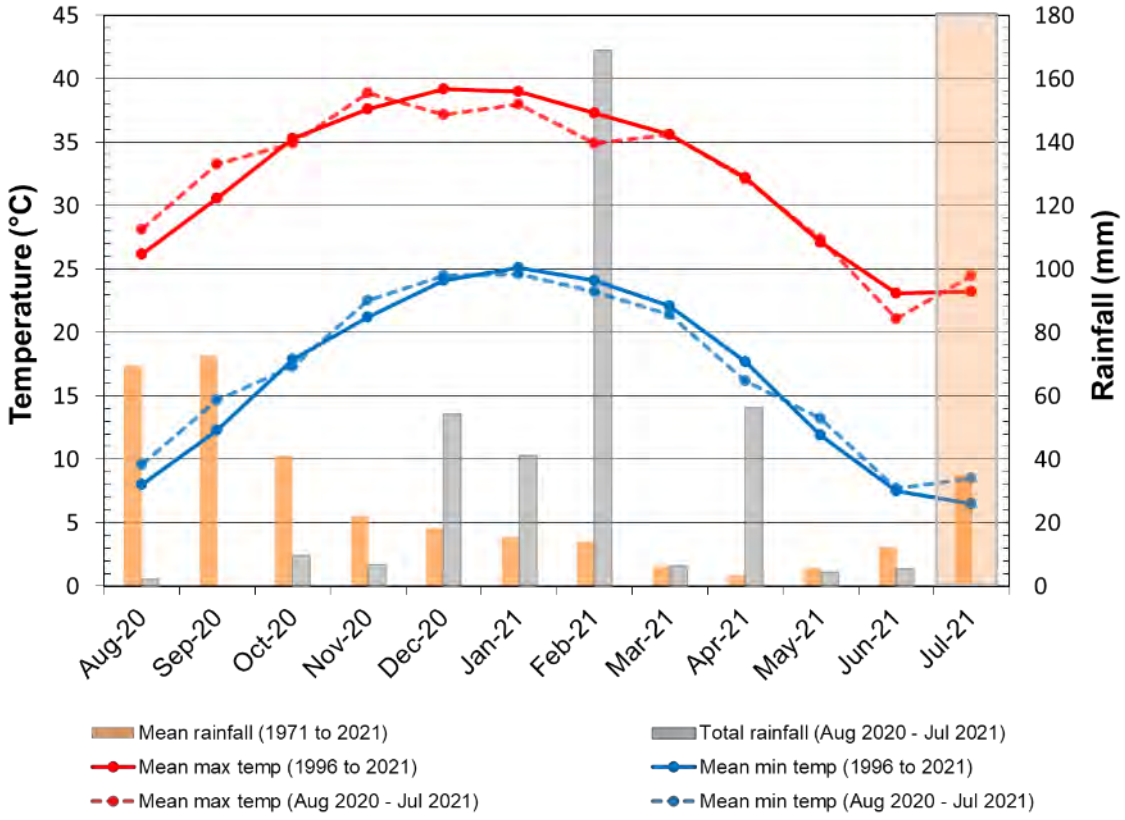


Figure 2.1: Monthly rainfall and long-term average rainfall for Newman Aero (Station ID 007176) (BoM, 2021). Survey period indicated by orange bar

2.1.3. Survey Team and Licensing

The targeted flora survey was undertaken by Biologic's Principal Botanist Clinton van den Bergh and Senior Botanist Carmel Winton (Table 2.1). Collectively, Clinton and Carmel have over 20 years' experience, with direct and relevant experience in the West Angelas region. Clinton and Carmel both meet the minimum 5 years' experience to lead a flora survey in the Pilbara bioregion as detailed by the EPA (2016b).

Table 2.1: Survey team and licensing

Team member	Role	Experience	Flora Licence	Threatened Flora Licence
Clinton van den Bergh	Principal Botanist	≈ 14 years	FB62000105	59-1819
Carmel Winton	Senior botanist	≈ 8 years	FB62000134	134B-2021

2.1.4. Desktop Assessment and Likelihood of Flora Occurrence

A desktop assessment was undertaken utilising information collated from the desktop assessment and field survey conducted by Biota (2020) for the broader West Angelas Beyond 2020 Development Envelope, which encompasses the Study Area. This assessment also reviewed aerial photography (Scale 1:30,000) of the Study Area and Google Earth Pro© imagery, along with data provided by Rio Tinto from their internal database (Rio Tinto, 2021b).

The desktop assessment was used to further refine sampling methods to ensure appropriate sampling was undertaken for all target species and to allow an accurate assessment of their occurrence or likelihood of occurrence within the Study Area.

The significant flora taxa identified from the database searches and literature review were assessed and ranked on the likelihood of occurring within the Study Area (Appendix A). The rankings were assigned using the following definitions presented in Table 2.2 and are intended to be an indicative guide only.

Table 2.2: Flora likelihood of occurrence decision matrix

Occurrence categories	Habitat categories (within the Study Area)			
	Core/ critical habitat present	Suitable habitat present/ within known distribution	Marginal habitat present/ adjacent to known distribution	No suitable habitat present/ outside of known distribution
Recorded in the Study Area	Confirmed	Confirmed	Confirmed	Confirmed
Recorded within <5 km	Highly Likely	Likely	Possible	Possible
Recorded within 5-15 km	Likely	Possible	Possible	Unlikely
Recorded within 15 - 50 km	Possible	Possible	Unlikely	Unlikely
Recorded >50 km	Possible	Unlikely	Unlikely	Highly Unlikely
Species considered locally/ regionally extinct	Unlikely	Unlikely	Highly Unlikely	Highly Unlikely

2.1.5. Field Survey: Targeted Searching

Following the desktop assessment, survey plans were designed to ensure the Study Area was appropriately traversed and targeted, particularly key habitat for significant flora, to capture the data required for a targeted survey. Due to constraints associated with steep slopes, breakaways and free faces, the entirety of the Study Area was not intensively traversed. However, search effort was concentrated on habitats (i.e., summits, gorges, gullies) that were likely to support significant flora, where safe to do so, thus the survey is considered sufficient to meet EPA requirements (EPA, 2016b).

Prior to the survey, a list of significant flora previously recorded, or with the potential to occur within the Study Area was compiled (refer to Section 2.1.4). Field personnel familiarised themselves with photographs, reference samples and descriptions of these taxa prior to mobilisation. An understanding of which significant flora were expected to occur in which locations was established based on aerial photography, location of known records, potential habitat and knowledge of the area and plants. This was reviewed each day in the field or when commencing searches in a new area. Aerial imagery, known locations and botanical references were available and utilised during the field assessment.

Comprehensive parallel targeted traverses of 30–50 m spacing were conducted where terrain permitted (Figure 2.2). Two of the areas within the Mt Ella East Survey Area were on steep terrain / free faces / breakaways where parallel traverses were unsuitable due to safety concerns. In this instance, meandering traverses following potential habitat was targeted.

Where habitat was deemed unsuitable for the target species, searching intensity was reduced to maximise field survey efficiency in suitable habitat.

Upon encountering significant taxa, a GPS coordinate of the individual was taken when occurring in isolation, or a central GPS coordinate was taken for a small population (central coordinate with an approximate 20 m radius). Once an individual / population was located, the surrounding area was searched to define the population extent.

Information collected at each location comprised:

- Number of individuals, for a small population, or an estimate of individuals for large populations;
- Notes on reproductive status and condition/ health of individuals/ populations;
- Notes of vegetation habitat; and
- Coordinates of either each plant (if few) or the extent of the population (if many) using a GPS.

Threatened and Priority Flora Report Forms (TPRFs) will be provided to the Parks and Wildlife Division (Parks and Wildlife) of DBCA, as required under the flora collecting permits. Significant flora specimens were vouchered with the Western Australian Herbarium (WAH), where required and appropriate.

2.1.6. Nomenclature & Specimen Identification

Flora nomenclature used in this *memo* is consistent with the WAH's plant census, provided on Florabase© (WAH, 1998-). All species are current at the time of report preparation.

Plant taxa that could not be identified during the field survey were collected, assigned a unique number for tracking purposes, and pressed for subsequent identification. Identifications were carried out by Biologic's taxonomists, Mr Samuel Coultas and Dr Rachel Meissner, utilising Western Australian Herbarium's reference collection, taxonomic keys, and reference material. All taxa were checked against FloraBase© (WAH, 1998-) to ensure their currency and validity.

A representative specimen of all significant flora observed in the Survey Area was collected and submitted to the Rio Tinto sponsored botanist, Steve Dillon, for confirmation, in accordance with Rio Tinto's chain of custody requirements. The submitted specimens list and their confirmed identification is included in Appendix B.

664000 676000 688000 700000 712000

7452000

7440000

7428000

Great Northern Hwy

West Angelas

Legend

- Development Envelope
- Operating Mine
- Local Road
- State Road

Study Area

- Deposit J
- Mt Ella East

- Targeted Search and Transect

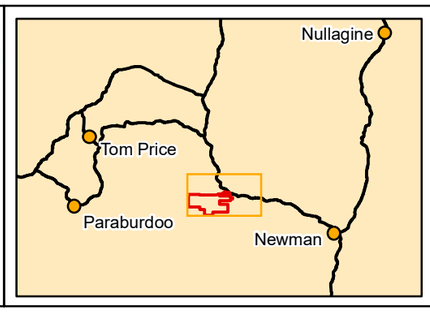
N

biologic Environmental Survey

Scale: 1:150,000

0 2 4 6 8 Km

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994 Created 04/03/2022



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Mt Ella East and Deposit J Targeted Flora and Fauna Survey

Figure 2.2: Targeted flora searches and traverses

2.2. Limitations

Some portions of the Mt Ella East Survey Area were not traversed because of the safety risk of steep terrain, breakaways and free faces. At each location of terrain considered to be a risk, Take 5s and Critical Control Checklists (CCCs) were completed to assess the risk and identify controls. In some situations, controls were easily implemented (e.g., utilising gloves and keeping hands free), while in other situations the controls could not be implemented to ensure safe access, so alternate routes were sought.

There were also late daily starting times due to additional paperwork and pre-starts with the inclusion of Traditional Owners on the survey team. This did not substantially impact the results of the survey and/or the determined likelihood of occurrence assessments for species of significance.

Goodenia nuda (P4) and *Oxalis* sp. Pilbara (M.E. Trudgen 12725) (P2) were not found during the survey, despite the Study Area being within their distributional range and having potential habitat for these taxa. The lack of observation may suggest that survey timing was a minor limitation for these taxa.

The vegetation types of the Study Area and the greater West Angelas Project Envelope has been consolidated by (Biologic, 2021c). The vegetation type determinations completed in field during the survey are considered to be at a finer scale than what is presented in the consolidated mapping. As such, there will be differences in the species assemblage and descriptions for the strata, mostly in the shrub strata which can vary due to fire, floods and other disturbances which may result in mass germination of coloniser species (i.e., *Acacia* spp.).

2.3. Results and Discussion

2.3.1. Desktop Assessment and Likelihood of Flora Occurrence

A total of 61 significant vascular flora species were identified by the desktop assessment completed for the West Angelas Beyond 2020 Detailed Flora and Vegetation Survey (Biota, 2020). Two significant flora taxa have previously been recorded within the Survey Area according to data provided by Rio Tinto (Rio Tinto, 2021b) (Figure 2.3):

- *Rhagodia* sp. Hamersley (M. Trudgen 17794) (P3)
- *Triodia* sp. Mt Ella (M.E. Trudgen 12739) (P3)

The spatial data on significant flora held by Rio Tinto indicates that there are six records of *Rhagodia* sp. Hamersley (M. Trudgen 17794) (P3) within the Mt Ella East Survey Area (within the conceptual waste dump areas). The spatial data also indicates that there are eight known records of *Triodia* sp. Mt Ella (M.E. Trudgen 12739) (P3) within the proposed pit locations in the Mt Ella East Survey Area. There are no known records of significant flora within the Deposit J Survey Area.

The flora taxa of significance identified by the desktop assessment were assessed and ranked on the likelihood of occurring within the Study Area. The full list is presented in Appendix A. The two taxa mentioned above have been previously recorded within the Study Area and are therefore considered

confirmed. Of the remaining taxa, three are considered Highly Likely to occur, 13 Likely, and 13 Possible (Table 2.3). The remaining 30 taxa were considered Unlikely (16) or Highly Unlikely (14) to occur within the Study Area (Appendix A).

Table 2.3: Significant flora likelihood of assessment results (confirmed to possible)

Taxon	Description (WAH, 1998-)	Location
Confirmed		
Rhagodia sp. Hamersley (M. Trudgen 17794) (P3)	Mulga (*Acacia aneura*) and Snakewood (*A. xiphophylla*) vegetation on clay plains.	Within Study Area
Triodia sp. Mt Ella (M.E. Trudgen 12739) (P3)	Light orange-brown to red-brown pebbly loam on hill slopes and in gullies.	Within Study Area
Highly Likely		
Eremophila sp. Hamersley Range (K. Walker KW 136) (P3)	Skeletal red-brown silty loam on hill crests, cliff tops, gorges.	< 10 Km
Indigofera gilesii (P3)	Skeletal red-brown loam on rocky slopes, gorges, and creeklines.	< 1 Km
Acacia bromilowiana (P4)	Skeletal loam soils on rocky hills, breakaways, scree slopes, gorges and rocky creek beds.	< 5 Km
Likely		
Vittadinia sp. Coondewanna Flats (S. van Leeuwen 4684) (P1)	Mainly on red clay on plains, low in the landscape.	< 5 Km
Aristida lazaridis (P2)	Major drainage areas through clayey flats.	< 1 Km
Hibiscus sp. Gurinbiddy Range (M.E. Trudgen MET 15708) (P2)	Hilltops, upper hillslopes.	< 5 Km
Oxalis sp. Pilbara (M.E. Trudgen 12725) (P2)	Red-brown loam on rocky hillslopes and in gorges.	< 5 Km
Acacia effusa (P3)	Stony red loam; scree	< 5 Km
Aristida jerichoensis var. *subspinulifera* (P3)	Hardpan clay plains.	< 1 Km
Olearia mucronata (P3)	Hills and rocky drainage channels.	< 5 Km
Pilbara trudgenii (P3)	Skeletal red stony soil over ironstone; hill summits, steep slopes, screes, cliff faces.	< 5 Km
Rostellularia adscendens var. *latifolia* (P3)	Various; creeks, plains, low hills.	< 5 Km
Sida sp. Hamersley Range (K. Newbey 10692) (P3)	Base of rocky cliff habitats in red skeletal stony soils or ironstone.	< 5 Km
Solanum kentrocaule (P3)	Hillsides and mountain crests, creek beds; skeletal red-brown soil over ironstone on basalt or scree.	< 5 Km
Eremophila magnifica subsp. *magnifica* (P4)	Rocky hillslopes, breakaways.	< 5 Km
Goodenia nuda (P4)	Alluvial plains, creeks.	< 5 Km
Possible		
Eremophila sp. West Angelas (S. van Leeuwen 4068) (P1)	Skeletal red-brown soil on hill summits high in the landscape.	< 20 Km
Eremophila pusilliflora (P2)	Alluvial plains.	< 20 Km
Isotropis parviflora (P2)	Undulating ironstone plains.	< 20 Km
Tetratheca fordiana (P2)	Shale pockets amongst ironstone on free rock faces.	< 10 Km

Taxon	Description (WAH, 1998-)	Location
Acacia daweana (P3)	Stony red loamy soils on low rocky rises and along drainage lines.	< 20 Km
Dolichocarpa sp. Hamersley Station (A.A. Mitchell PRP 1479) (P3)	Stony undulating clay plains.	< 20 Km
Euphorbia clementii (P3)	Gravelly hillsides, stony ground.	< 10 Km
Geijera salicifolia (P3)	Skeletal and stony soils in massive rock scree, rockpiles and gorges.	< 10 Km
Grevillea saxicola (P3)	Upper scree slopes on banded ironstone, usually with Mulga.	< 20 Km
Sida sp. Barlee Range (S. van Leeuwen 1642) (P3)	Steep slopes, rocky gullies and breakaways.	< 10 Km
Themeda sp. Hamersley Station (M.E. Trudgen 11431) (P3)	Clay plains.	< 5 Km
Xerochrysum boreale (P3)	Loamy, sandy or gravelly soils on plains.	>20 Km
Lepidium catapycnon (P4)	Skeletal soils on hill slopes.	< 10 Km

640000
680000
720000
7440000
7400000
Packsaddle Rd
West Angelas
West Angelas
Snowy Mount
Turee Creek Rd

Legend

- Development Envelope
- Operating Mine
- Local Road
- State Road

Study Area

- Deposit J
- Mt Ella East

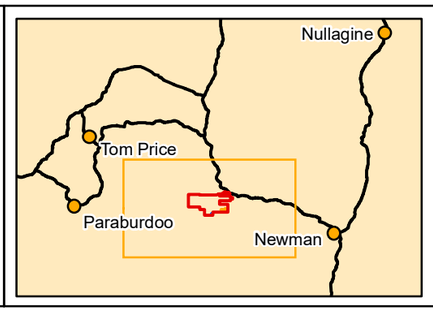
N

biologic Environmental Survey

Scale: 1:350,000

0 10 20 Km

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994 Created 04/03/2022



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Mt Ella East and Deposit J Targeted Flora and Fauna Survey

Figure 2.3: Conservation significant flora database search results

Legend

DBCA

T,VU

- *Thryptomene wittweri*

P1

- *Eragrostis* sp. Mt Robinson (S. van Leeuwen 4109)
- *Eremophila* sp. West Angelas (S. van Leeuwen 4068)
- *Rhodanthe ascendens*
- *Triodia* sp. Karijini (S. van Leeuwen 4111)
- *Vittadinia* sp. Coondewanna Flats (S. van Leeuwen 4684)

P2

- *Aristida lazaridis*
- *Eremophila pusilliflora*
- *Euphorbia inappendiculata* var. *queenslandica*
- *Hibiscus* sp. Gurinbiddy Range (M.E. Trudgen MET 15708)
- *Isotropis parviflora*
- *Oxalis* sp. Pilbara (M.E. Trudgen 12725)
- *Tetratheca fordiana*
- *Teucrium pilbaranum*

P3

- *Acacia daweana*
- *Acacia effusa*
- *Acacia subtiliformis*
- *Aristida jerichoensis* var. *subspinulifera*
- *Dampiera metallorum*
- *Eremophila magnifica* subsp. *velutina*
- *Eremophila rigida*
- *Eremophila* sp. Hamersley Range (K. Walker KW 136)
- *Euphorbia clementii*
- *Euphorbia stevenii*
- *Goodenia lyrata*
- *Goodenia* sp. East Pilbara (A.A. Mitchell PRP 727)
- *Grevillea saxicola*
- *Indigofera gilesii*
- *Oldenlandia* sp. Hamersley Station (A.A. Mitchell PRP 1479)
- *Olearia mucronata*
- *Pilbara trudgenii*
- *Rhagodia* sp. Hamersley (M. Trudgen 17794)
- *Rostellularia adscendens* var. *latifolia*
- *Sida* sp. Barlee Range (S. van Leeuwen 1642)
- *Sida* sp. Hamersley Range (K. Newbey 10692)
- *Solanum kentrocaule*
- *Stackhousia clementii*
- *Swainsona thompsoniana*
- *Themeda* sp. Hamersley Station (M.E. Trudgen 11431)
- *Triodia basitricha*
- *Triodia* sp. Mt Ella (M.E. Trudgen 12739)
- *Xerochrysum boreale*

P4

- *Acacia bromilowiana*
- *Eremophila magnifica* subsp. *magnifica*
- *Goodenia nuda*
- *Lepidium catapycnon*
- *Ptilotus mollis*

RTIO

P1

- *Hibiscus* sp. Mt Brockman (E. Thoma ET 1354)
- *Vittadinia* sp. Coondewanna Flats (S. van Leeuwen 4684)

P2

- *Aristida lazaridis*
- *Eremophila pusilliflora*
- *Hibiscus* sp. Gurinbiddy Range (M.E. Trudgen MET 15708)
- *Isotropis parviflora*
- *Oxalis* sp. Pilbara (M.E. Trudgen 12725)
- *Tetratheca fordiana*

P3

- *Acacia daweana*
- *Acacia effusa*
- *Acacia subtiliformis*
- *Aristida jerichoensis* var. *subspinulifera*
- *Dampiera metallorum*
- *Eremophila* sp. Hamersley Range (K. Walker KW 136)
- *Euphorbia clementii*
- *Geijera salicifolia*
- *Goodenia* sp. East Pilbara (A.A. Mitchell PRP 727)
- *Grevillea saxicola*
- *Indigofera gilesii*
- *Olearia mucronata*
- *Pilbara trudgenii*
- *Rhagodia* sp. Hamersley (M. Trudgen 17794)
- *Rostellularia adscendens* var. *latifolia*
- *Sida* sp. Barlee Range (S. van Leeuwen 1642)
- *Sida* sp. Hamersley Range (K. Newbey 10692)
- *Solanum kentrocaule*
- *Themeda* sp. Hamersley Station (M.E. Trudgen 11431)
- *Triodia* sp. Mt Ella (M.E. Trudgen 12739)

P4

- *Acacia bromilowiana*
- *Eremophila magnifica* subsp. *magnifica*
- *Goodenia nuda*
- *Lepidium catapycnon*
- *Ptilotus mollis*

biologic Environmental Survey

2.3.2. Field Survey: Targeted Searching for Significant Flora

Following the completion of the targeted flora survey, a total of seven significant flora taxa were recorded (Figure 2.4; Appendix C), inclusive of the two previously known taxa:

- *Hibiscus* sp. Gurinbiddy Range (M.E. Trudgen MET 15708) (P2) – three point locations totalling five individuals;
- *Indigofera gilesii* (P3) – 18 point locations totalling 34 individuals;
- *Rhagodia* sp. Hamersley (M. Trudgen 17794) (P3) – 27 point locations totalling 48 individuals;
- *Solanum kentrocaule* (P3) – 21 point locations totalling 28 individuals;
- *Triodia* sp. Mt Ella (M.E. Trudgen 12739) (P3) – 178 point locations totalling approximately 4,654 individuals;
- *Acacia bromilowiana* (P4) – recorded from one point location totalling 15 individuals; and
- *Eremophila magnifica* subsp. *magnifica* (P4) – 18 point locations totalling 88 individuals.

The seven significant flora taxa were all recorded from the Mt Ella East Survey Area (Figure 2.4), with no significant flora recorded from the Deposit J Survey Area. The seven significant flora taxa observed within the Survey Area have previously been recorded from the general West Angelas area (Rio Tinto, 2021b), while preliminary information available for the adjacent Angelo River Project suggests these seven individuals also occur to the south of the Survey Area (Biologic data).

Deposit J Survey Area

The Deposit J Survey Area was comprehensively traversed with no significant flora recorded. The vegetation was observed to be in very good to excellent condition, with no disturbances associated with mining exploration work. Consolidated vegetation mapping across the West Angelas Project Envelope completed by Biologic (Biologic, 2021b) described the Survey Area vegetation as *Eucalyptus leucophloia* subsp. *leucophloia* and/or *Corymbia deserticola* subsp. *deserticola* low open woodland over *E. gamophylla* low open mallee woodland over *Triodia vanleeuwenii* open hummock grassland (ElCdEgTv). The vegetation observed (which is at a finer scale than the consolidated mapping) during the current survey was described as:

- *Eucalyptus gamophylla* low open mallee woodland over *Triodia vanleeuwenii* low hummock grassland on low undulating foot slopes with brown clay loam (Plate 2.1a).
- *Eucalyptus leucophloia, Corymbia deserticola* subsp. *deserticola* and *Eucalyptus gamophylla* low open to scattered low trees over *Triodia vanleeuwenii* low hummock grassland with scattered low shrubs of *Seringia exastia* and *Gompholobium oreophilum* on low undulating foot slopes with brown clay loam (Plate 2.1b).

Overall, these two vegetation types are encompassed within the ElCdEgTv vegetation but have been listed separately due to the presence or absence of particular strata, such as small shrubs.

Plate 2.1: Broad vegetation units within the Deposit J Survey Area

664000 676000 688000 700000 712000

7452000

7440000

7428000

Great Northern Hwy

West Angelas

Legend

- Development Envelope
- Operating Mine
- Local Road
- State Road

Study Area

- Deposit J
- Mt Ella East

Taxon

- *Hibiscus* sp. Gurinbiddy Range (M.E. Trudgen MET 15708) - P2
- *Indigofera gilesii* - P3
- *Rhagodia* sp. Hamersley (M. Trudgen 17794) - P3
- *Solanum kentrocaule* - P3
- *Triodia* sp. Mt Ella (M.E. Trudgen 12739) - P3
- *Acacia bromilowiana* - P4
- *Eremophila magnifica* subsp. *magnifica* - P4

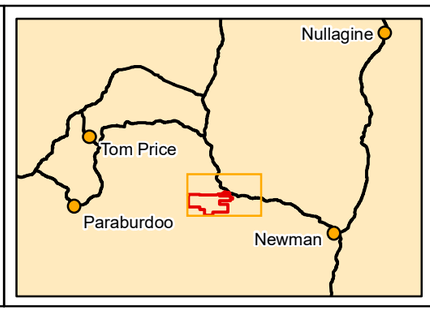
N

biologic Environmental Survey

Scale: 1:150,000

0 2 4 6 8 Km

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994 Created 04/03/2022



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Mt Ella East and Deposit J Targeted Flora and Fauna Survey

Figure 2.4: Significant flora recorded in the Study Area

Mt Ella East Survey Area

The Mt Ella East Survey Area was comprehensively traversed, excluding areas that were deemed a safety risk (i.e., steep terrain, free faces, falling objects risk; refer to Section 2.2), with a total of seven significant flora taxa recorded from the conceptual pits. One species only; *Rhagodia* sp. Hamersley (M. Trudgen 17794) was recorded from the conceptual waste dumps, (Figure 2.4). All seven significant flora taxa recorded within the Mt Ella East Survey Area were recorded from the proposed pits, with the western pit having a higher number of individuals and point locations (Table 2.4).

The vegetation within the Mt Ella East Survey Area was observed to be in very good to excellent condition with disturbances associated with mining exploration (i.e., drill lines). The broad vegetation types observed within the Mt Ella East Survey Area during the current survey are summarised in Table 2.5.

The vegetation observations within the waste dumps broadly match the following consolidated mapping (Biologic, 2021b) vegetation types:

- EgTpTv - *Eucalyptus gamophylla* low open mallee woodland *Triodia pungens* and/or *T. vanleeuwenii* open hummock grassland
- AanApAayTp: *Acacia 'aneura'*, *A. pruinocarpa, A. ayersiana* woodland *Triodia pungens* open hummock grassland

In the proposed pits, all vegetation observations were consistent with the broad vegetation type ElTpTw, *Eucalyptus leucophloia* subsp. *leucophloia* low open woodland over *Triodia pungens* and/or *T. wiseana* open hummock grassland (Biologic, 2021b).

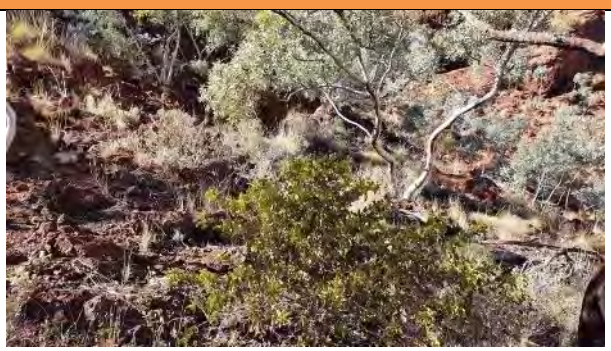
Table 2.4: Breakdown of significant flora records within Mt Ella East Survey Area

Taxon	Western Waste Dump		Eastern Waste Dump		Western Pit		Eastern Pit		Total	
	Locations	Individuals	Locations	Individuals	Locations	Individuals	Locations	Individuals	Locations	Individuals
Hibiscus sp. Gurinbiddy Range (M.E. Trudgen MET 15708) (P2)	0	0	0	0	3	5	0	0	3	5
Indigofera gilesii (P3)#	0	0	0	0	18	34	0	0	18	34
Rhagodia sp. Hamersley (M. Trudgen 17794) (P3)#	11	27	13	17	3	4	0	0	27	48
Solanum kentrocaule (P3)	0	0	0	0	20	27	1	1	21	28
Triodia sp. Mt Ella (M.E. Trudgen 12739) (P3)#	0	0	0	0	130	3,132	48	1,522	178	4,654
Acacia bromilowiana (P4)	0	0	0	0	0	0	1	15	1	15
Eremophila magnifica subsp. *magnifica* (P4)	0	0	0	0	18	88	0	0	18	88

- some point locations (and individuals) are located outside of the Survey Area

Table 2.5: Broad vegetation descriptions for the Mt Ella East Survey Area

Mt Ella East - Waste dumps	
Broad vegetation description	**Photo**
Eucalyptus gamophylla low open mallee woodland over *Acacia bivenosa, Acacia atkinsiana, Hakea lorea* mid to tall sparse shrubland over *Triodia vanleeuwenii* low hummock grassland on flat stony plains with brown clay loam. Broadly matches vegetation type EgTpTv.	
Eucalyptus leucophloia subsp. *leucophloia* low scattered trees over *Eucalyptus gamophylla* low open mallee woodland over *Triodia vanleeuwenii* with patches of *Triodia pungens* low open hummock grassland on lower stony slopes with brown clay loam. Broadly matches vegetation type EgTpTv.	
Acacia ayersiana low open woodland over *Acacia* spp. and *Eremophila* spp. over *Triodia pungens* low open hummock grassland on flat stony plains with brown clay loam Broadly matches vegetation type AanApAayTp.	
Eucalyptus gamophylla, *Corymbia deserticola* subsp. *deserticola* low scattered mallee trees over Mulga, *Acacia pruinocarpa* mid to tall sparse to scattered shrubs over *Triodia pungens* low open hummock grassland on flat stony plains with brown sandy loam. Broadly matches vegetation type EgTpTv.	

Mt Ella East - Proposed pits	
Broad vegetation description	**Photo**
Eucalyptus leucophloia subsp. *leucophloia* low open woodland over *Triodia pungens* low open hummock grassland with *Ptilotus obovatus* scattered low shrubs on upper hillslopes, crests and gullies with brown loam. Broadly matches vegetation type ElTpTw.	
Eucalyptus leucophloia subsp. *leucophloia* low scattered trees over *Triodia wiseana* mid to low hummock grassland with *Acacia* spp. mid scattered shrubs on hillslopes with brown loam. Broadly matches vegetation type ElTpTw.	
Eucalyptus leucophloia subsp. *leucophloia* low scattered trees over *Triodia wiseana* with patches of *Triodia pungens* and *Triodia* sp. Mt Ella (M.E. Trudgen 12739) low to mid hummock grassland on upper hillcrests and slopes with brown loam. Broadly matches vegetation type ElTpTw.	
Eucalyptus leucophloia subsp. *leucophloia* low scattered trees over *Triodia wiseana* mid open hummock grassland with mid to tall shrubs dominated by *Acacia* spp. over scattered tussock grasses including *Cymbopogon ambiguus*, *Eriachne mucronata* on gorges and gullies with brown skeletal loam. Broadly matches vegetation type ElTpTw.	

2.3.3. Review of Likelihood of Flora Occurrence

The post-survey significant flora likelihood of occurrence is presented in Appendix A. The two taxa confirmed pre-survey remain confirmed post-survey, while an additional five taxa considered highly likely and likely to occur pre-survey (Hibiscus sp. Gurinbiddy Range (M.E. Trudgen MET 15708) (P2), Indigofera gilesii (P3), Solanum kentrocaule (P3), Acacia bromilowiana (P4) and Eremophila magnifica subsp. magnifica (P4)) were confirmed by this survey to be present within the Study Area. The remaining 23 flora taxa considered highly likely, likely or possible pre-survey were downgraded to either possible, unlikely or highly unlikely, while all taxa considered unlikely pre-survey either remained so, or were further downgraded to highly unlikely. The downgrading of all remaining taxa not confirmed within the Study Area was based on the absence of preferred or key habitat within the Study Area, and the apparent absence of the target species despite extensive traverses across the Study Area. Given that sufficient searches were undertaken following favourable conditions in key suitable habitat during this survey, it is considered unlikely or highly unlikely that unrecorded target species would occur. However, small annual or ephemeral taxa such as Goodenia nuda and Oxalis sp. Pilbara (M.E. Trudgen 12725) are an exception, as these taxa may have been unidentifiable at the time of the survey or could have been overlooked due to their small size. The likelihood of occurrence for these two species post-survey was therefore only downgraded from likely to possible (Appendix A).

3. Vertebrate Fauna Species of Significance

3.1. Methods

3.1.1. Conformance and Licensing

This assessment was carried out in a manner consistent with the following guidelines and recommendations from the DBCA (formerly DPaW), the Department of Agriculture, Water and the Environment (DAWE; formerly DEHWA, DSEWPaC, DoE), the Environmental Protection Authority (EPA) and relevant survey-specific license conditions:

- DBCA (2017) Guidelines for surveys to detect the presence of bilbies, and assess the importance of habitat in Western Australia;
- DEWHA (2010a) Survey guidelines for Australia's threatened bats;
- DEWHA (2010b) Survey guidelines for Australia's threatened birds;
- DoE (2013) Matters of National Environmental Significance: Significant impact guidelines 1.1;
- DSEWPaC (2011a) Survey guidelines for Australia's threatened mammals;
- DSEWPaC (2011b) Survey guidelines for Australia's threatened reptiles; and
- EPA (2020) Technical Guidance: Terrestrial vertebrate fauna surveys for environmental impact assessment.

Fauna sampling was conducted under a DBCA Regulation 27 "Fauna Taking (Biological Assessment) License" (BA27000196-3) issued to A. Jenkins. In accordance with Section 40 of the BC Act, threatened species sampling was completed under a DBCA "Authorisation to Take or Disturbed Threatened Species" (authorisation number TFA 2019-0183-3) issued to A. Jenkins.

3.1.2. Taxonomy and Nomenclature

The latest checklist of mammal, reptile and amphibian names published by the Western Australian Museum (WAM, 2021) was used as a guide to the current taxonomy and nomenclature of these groups. For birds, the current checklist of Australian birds maintained by Birdlife Australia (based on Christidis & Boles, 2008) was used in conjunction with the Australian Biological Resources Study species list (ABRS, 2021). While compiling a list of vertebrate fauna potentially occurring in the Study Area, all records were checked to ensure the latest taxonomy, using recent papers and lists, was used.

3.1.3. Desktop Assessment

A desktop assessment was undertaken utilising information from a previous desktop assessment conducted by Biologic (2021a) for the broader West Angelas Beyond 2020 Development Envelope, which encompasses the Study Area. The desktop assessment was used to further refine sampling methods to ensure appropriate sampling was undertaken for all target species and to allow an accurate assessment of their occurrence or likelihood of occurrence within the Study Area.

3.1.4. Field Survey

Timing and Personnel

The survey was undertaken between the 2nd to the 6th of August 2021 by Principal Zoologist Ryan Ellis and Senior Zoologist Anton Mittra (Table 3.1). Collectively, Ryan and Anton have over 25 years of experience undertaking fauna surveys within the Pilbara region, including targeted surveys for the species of conservation significance that were the focus of this assessment.

Table 3.1: Project Team and experience

Personnel	Position and Role	Qualification	Experience
Ryan Ellis	Principal Zoologist • project management • field survey • reporting	BESc Wildlife and Conservation Biology Dip (Conservation and Land Management)	11 years' EIA (consulting) 15 years' field survey 15 years' vertebrate zoology/ ecology
Anton Mittra	Senior Zoologist • field survey	BSc Botany and Zoology (Hons)	10 years' EIA (consulting) 10 years' field survey 10 years' vertebrate zoology/ ecology

Habitat Assessments

Broad fauna habitats were previously defined and delineated by Biologic (2021b). Habitat assessments were undertaken in the field to ground truth and further define fauna habitats and their significance to vertebrate fauna. Following the field survey, broad fauna habitat mapping completed by Biologic (2021b) was amended and refined where necessary following ground truthing. Habitat assessments were undertaken at 24 locations across the Study Area, including 22 within the Mt Ella East Survey Area and two within the Deposit J Survey Area (Table 3.2; Figure 3.1; Appendix D). Habitat assessments were conducted using methodology and terminology modified from the *Australian Soil and Land Survey Field Handbook* (National Committee on Soil and Terrain, 2009). The characteristics recorded during the habitat assessments were:

- site information, photo and location;
- landform: slope, relative inclination of slope and landform type;
- vegetation: leaf litter %, wood litter, hollow bearing trees, broad floristic formation, vegetation structure (tall, mid and low), and dominant species;
- land surface: erosion, rock outcropping, water bodies;
- soil: texture, colour;
- substrate: bare ground, rock size, rock type, rock outcropping; and
- disturbance: time since last fire, evidence of weeds, grazing, or human disturbances.

Targeted Searches

Targeted searches were undertaken throughout the Study Area where habitats were considered to potentially support target species identified in the desktop assessment, including northern quoll, Pilbara leaf-nosed bat, ghost bat, Pilbara olive python and western pebble-mound mouse. Targeted searches comprised searching for occurrence of target species from direct observation, secondary evidence (i.e. tracks, scats, sloughs and foraging evidence) and/or habitat features of importance to the species (i.e. dens, roost caves and water features) which may be utilised by particular species. Specifically, targeted searches were undertaken at 14 locations for a total of 53.5 person hours (Table 3.2; Figure 3.1). Targeted searches comprised 28.5 person hours targeting northern quoll, Pilbara leaf-nosed bat, ghost bat and Pilbara olive python and 29 person hours for western pebble-mound mouse (inclusive of four person hours overlap between all target species) (Table 3.2).

Table 3.2: Fauna Sampling Effort

Site ID	Survey Area	Latitude	Longitude	Habitat assessment	Targeted searches[1] (person hrs)	Echolocation recording
VDJE-001	Deposit J	-23.2432	118.7666	•	4 hrs (WPMM)	4 nights
VDJE-002	Deposit J	-23.2407	118.7669	•		
VDJE-003	Mt Ella East	-23.2037	118.8820	•		
VDJE-004	Mt Ella East	-23.2049	118.8784	•	8 hrs (WPMM)	3 nights
VDJE-005	Mt Ella East	-23.2113	118.8800	•	7 hrs (NQ, PLNB, GB, POP)	3 nights
VDJE-006	Mt Ella East	-23.2147	118.8747	•	5.5 hrs (NQ, PLNB, GB, POP)	3 nights
VDJE-007	Mt Ella East	-23.2149	118.8565	•	4.5 hrs (NQ, PLNB, GB, POP)	3 nights
VDJE-008	Mt Ella East	-23.2086	118.8456	•	6 hrs (WPMM)	3 nights
VDJE-009	Mt Ella East	-23.2136	118.8572	•		
VDJE-010	Mt Ella East	-23.2165	118.8567	•		
VDJE-011	Mt Ella East	-23.2170	118.8554	•	4 hrs (NQ, PLNB, GB, WPMM, POP)	
VDJE-012	Mt Ella East	-23.2160	118.8522	•	1.5 hrs (WPMM)	
VDJE-013	Mt Ella East	-23.2166	118.8601	•		
VDJE-014	Mt Ella East	-23.2159	118.8608	•	2 hrs (NQ, PLNB, GB, POP)	

Site ID	Survey Area	Latitude	Longitude	Habitat assessment	Targeted searches[1] (person hrs)	Echolocation recording
VDJE-015	Mt Ella East	-23.2146	118.8657	•		
VDJE-016	Mt Ella East	-23.2171	118.8630	•	1.5 hrs (NQ, PLNB, GB, POP)	
VDJE-017	Mt Ella East	-23.2161	118.8622	•	1.5 hrs (NQ, PLNB, GB, POP)	
VDJE-018	Mt Ella East	-23.2140	118.8634	•	2.5 hrs (NQ, PLNB, GB, POP)	
VDJE-019	Mt Ella East	-23.2130	118.8785	•		
VDJE-020	Mt Ella East	-23.2111	118.8433	•	3 hrs (WPMM)	
VDJE-021	Mt Ella East	-23.2134	118.8757	•		
VDJE-022	Mt Ella East	-23.2044	118.8728	•	2.5 hrs (WPMM)	
VDJE-023	Mt Ella East	-23.2099	118.8488	•		
VDJE-024	Mt Ella East	-23.2069	118.8516	•		

[1] NQ = northern quoll, PLNB = Pilbara leaf-nosed bat, GB = ghost bat, POP = Pilbara olive python, WPMM = western pebble-mound mouse.

Water Feature and Cave Assessments

During the current survey, searches were undertaken for any water features or caves occurring within the Study Area, particularly those that had the potential to support species of conservation significance (i.e. roosting caves for Pilbara leaf-nosed bat or ghost bat or water features likely to support Pilbara olive python).

Ultrasonic Recorders for Pilbara Leaf-nosed Bat and Ghost Bat

SongMeter (SM; Wildlife Acoustics Inc.) ultrasonic bat recorders were deployed at six locations during the survey, comprising one in the Deposit J Survey Area and five within the Mt Ella East Survey Area (Table 3.2; Figure 3.1). At each location, recorders were placed in, or in the vicinity of, areas of prospective foraging and/or potential roosting habitats and features most likely to be utilised by bats, such as Gorge/ Gully habitat or potential movement corridors created by stands of trees. Recorders were deployed for three to four nights at each location for a total of 19 recording nights. The audio settings used for all the SM units followed the manufacturer's recommendations contained in the user manual (Wildlife Acoustics, 2011, 2017). Selectable filters and triggers were set to detect all species known to occur within the region (McKenzie & Bullen, 2009). Bat calls were analysed by Robert Bullen of Bat Call WA.

664000 676000 688000 700000 712000

7452000 7440000 7428000

VDJE-002
VDJE-001
VDJE-024
VDJE-008
VDJE-023
VDJE-020
VDJE-022
VDJE-003
VDJE-004
VDJE-005
VDJE-019
VDJE-021
VDJE-006
VDJE-009
VDJE-007
VDJE-018
VDJE-014
VDJE-015
VDJE-012
VDJE-011
VDJE-010
VDJE-017
VDJE-013
VDJE-016

Great Northern Hwy

West Angelas

Legend

- Development Envelope
- Operating Mine
- Local Road
- State Road

Study Area
- Deposit J
- Mt Ella East

Sampling Type
- Echolocation Recording
- Habitat Assessment
- Targeted Search and Transect

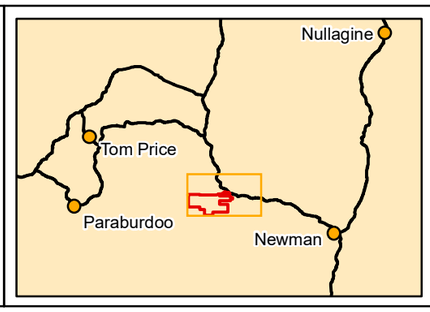
N

biologic Environmental Survey

Scale: 1:150,000

0 2 4 6 8 Km

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994 Created 04/03/2022



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Mt Ella East and Deposit J Targeted Flora and Fauna Survey

Figure 3.1: Fauna sample sites and traverses

Opportunistic observations

At all times while surveying, all records pertaining to species not previously recorded during the survey, particularly significant species, were documented. These records include those from primary (i.e. direct observation of species) or secondary (e.g. burrows, scratchings, diggings and scats) evidence.

3.1.5. Likelihood of Vertebrate Fauna Occurrence

Following completion of the field assessment, significant species identified by the desktop assessment were assessed for their likelihood of occurring within the Study Area using a decision matrix (Table 3.3). For this decision matrix, each species was assigned to one of six categories of likelihood: Confirmed, Highly Likely, Likely, Possible, Unlikely, or Highly Unlikely.

The decision matrix is intended to be an indicative guide only, and the way in which it is interpreted may vary between species, depending on a given species' habitat preferences and ability to disperse, as well as the reliability and availability of contextual information. For example, considering species which have been previously recorded close to the Study Area, a species with a limited dispersal capability will have a reduced likelihood of occurring in the Study Area compared with a species with greater dispersal capability. It is also recognised that a lack of records in the vicinity of the Study Area may indicate limited sampling effort rather than species' absence, and that previous records may include historic or presumed erroneous information which may misrepresent a species' current distribution.

Where the determination of a species' likelihood of occurrence within the Study Area deviates from the decision matrix, detailed justification for any variation is provided.

Table 3.3: Species likelihood of occurrence decision matrix

		Habitat suitability of Study Area			
		Breeding habitat present	**Foraging and dispersal habitat present**	**Marginally suitable habitat[2] present**	**No suitable habitat present**
Species Records[1]	**Recorded in Study Area**	Confirmed	Confirmed	Confirmed	Confirmed
	Recorded within 10 km of Study Area	Highly Likely	Likely	Possible	Possible
	Recorded within 10–50km of Study Area	Likely	Possible	Possible	Unlikely
	Recorded within 50–100 km of Study Area	Possible	Possible	Unlikely	Unlikely
	Recorded >100 km of Study Area	Possible	Unlikely	Unlikely	Highly Unlikely
	Species considered locally/regionally extinct	Unlikely	Unlikely	Highly Unlikely	Highly Unlikely

[1] Only records within the previous 50 years are considered.

[2] Marginally suitable habitat is habitat which is possibly used by a species but is unlikely to be depended upon; for example, it may be used only when in proximity to core breeding, foraging or dispersal habitat.

3.2. Limitations

No limitations were encountered during the survey which are expected to have significantly impacted the results of the survey and/or the determined likelihood of occurrence assessments for significant vertebrate fauna species within the Study Area. Targeted sampling methods for some species could not be completed (i.e. camera trapping for northern quoll) as per relevant guidelines and recommendations due to time constraints of the survey. Where possible, these methods were substituted or supplemented with additional targeted searches where appropriate. Additionally, no high density populations of the species are known to occur in the vicinity of the Study Area, therefore the absence of camera trapping for the species is unlikely to have impacted the survey's outcomes and assessment of the species' occurrence.

3.3. Results and Discussion

3.3.1. Broad Fauna Habitats

Following completion of the field survey, the Biologic (2021a) broad fauna habitat mapping within the Study Area was revised to reflect observed habitats more accurately as a result of ground truthing during the field survey. A total of four broad fauna habitat types have been identified and mapped within the Study Area (Table 3.4; Figure 3.2), comprising, in decreasing order of extent (Table 3.4):

- Footslope and Plain (109.73 ha; 46.13%);
- Hillcrest and Hillslope (81.58 ha; 34.30%);
- Mixed Acacia Woodland (29.52 ha; 12.41%); and
- Gorge/ Gully (11.07 ha; 4.65%).

The remaining 2.5% (5.95 ha) of the Study Area comprised Disturbed areas, including land that has been cleared of vegetation for access tracks and/or exploration activities.

The majority (80.43%) of the Study Area is comprised of Footslope and Plain (46.13%) and Hillcrest and Hillslope (34.30%) habitats. These habitats are characterised by open plain, footslope and hill areas with a rocky substrate and scattered trees and shrubs over a low hummock grassland. Important habitat features include old-growth spinifex, fallen boulders and outcropping ironstone containing overhangs and crevices.

Of the four broad fauna habitat types identified within the Study Area, one (Gorge/ Gully) was deemed to be of high value for vertebrate fauna, as it provides critical habitat for numerous species of conservation significance (Table 3.4). A further two habitats (Footslope and Plain and Mixed Acacia Woodland) were deemed to be of moderate value, as they provide supporting habitat (foraging and/or dispersal) for numerous species of conservation significance (Table 3.4). These habitats are, however, relatively common and widespread in the surrounding region, and the occurrence of many of these species within the extent of these habitats within the Study Area is dependent on the occurrence of other critical or high value habitat (i.e. breeding, nesting and/or roosting habitat) in proximity to the Study Area. The remaining habitat (Hillcrest and Hillslope) was deemed to be of low value due to the absence of characteristics (i.e. potential roost caves, denning sites and/or foraging habitat) likely to support significant species identified in the desktop assessment (Table 3.4).

All broad fauna habitats mapped within the Study Area are relatively common and widespread within the broader vicinity of the Study Area and throughout the Pilbara region. While these habitats generally support significant species in the broader area, they do not appear to be of increased value to vertebrate fauna within the Study Area due to the absence of caves likely to support ghost bat and Pilbara leaf-nosed bat, water features likely to support Pilbara olive python and given that no known high density populations of northern quoll are known to occur in the local area.

3.3.1. Habitat Features

No water features or potential roost caves likely to support species of conservation significance were recorded within the Study Area during the field survey.

Table 3.4: Fauna habitat descriptions

Habitat Type	Description	Extent within the Study Area	Critical habitat for target Species	Representative Photo
Footslope and Plain **Extent in Study Area: 109.73** ha; (46.13%) **Vertebrate Fauna Value:** Moderate	Footslope and Plain comprise low-lying open plains and the rolling hills below upland areas. The substrate consists of gravel and pebbles, with vegetation dominated by *Triodia*, although scattered trees also occur. Vegetation within this habitat varied in composition but was generally dominated by scattered Mulga and *Acacia pruinocarpa* forming an over-storey, with a mid-storey comprising *Eremophila* and *Ptilotus* spp., over low hummock grasslands of *Triodia wiseana, T. basedowii, T. longifolia and T. pungens*. Scattered *Corymbia hamersleyana, Eucalyptus leucophloia, and E. gamophylla* were also present.	Footslope and Plain habitat exists in the low-lying areas the Study Area, often representing the transition zone between Hillcrest and Hillslope and the lower lying habitats. Footslope and Plain habitat is common and widespread both within the Study Area and in the surrounding region.	• **Ghost Bat –** primary foraging and/or dispersal (if proximal to primary roosting and breeding habitat) • **Pilbara leaf-nosed bat –** secondary foraging and/or dispersal (if proximal to primary roosting and breeding habitat) • **Grey falcon –** secondary foraging (if proximal to primary nesting and breeding habitat) • **Peregrine falcon –** primary foraging and/or dispersal (if proximal to primary nesting and breeding habitat) • **Fork-tailed swift –** secondary foraging and/or dispersal • **Short-tailed mouse** – core (breeding, foraging and dispersal) habitat • **Western pebble-mound mouse –** core (breeding, foraging and dispersal) habitat	
Hillcrest and Hillslope **Extent in Study Area:** 81.58 ha (34.30%) **Vertebrate Fauna Value:** Low	A common feature of this habitat is a rocky substrate, often with exposed bedrock, and skeletal red soils. These can contain cracks and crevices. Instances of Gorge or Gully is contained within this habitat. This habitat is usually dominated by open *Eucalyptus* woodlands, *Acacia* and *Grevillea* scrublands and *Triodia* low hummock grasslands.	Hillcrest and Hillslope makes up most of the higher elevation areas within the Mt Ella East Survey Area. This habitat is a very common habitat throughout the surrounding region. No occurrence of this habitat within the Deposit J Survey Area.	• **Northern quoll** – primary foraging and/or dispersal (if proximal to primary denning/ shelter habitat) • **Pilbara leaf-nosed bat** – secondary foraging and/or dispersal (if proximal to primary roosting and breeding habitat) • **Fork-tailed swift** – secondary foraging and/or dispersal • **Western pebble-mound mouse –** core (breeding, foraging and dispersal) habitat • **Pilbara barking gecko –** core (breeding, foraging and dispersal) habitat • **Pilbara flat-headed blind-snake –** core (breeding, foraging and dispersal) habitat	
Mixed Acacia Woodland **Extent in Study Area:** 29.52 ha; (12.41%) **Vertebrate Fauna Value:** Moderate	Mixed Acacia Woodland habitat comprises areas where vegetation is a dense mix of *Acacia*, with a mixture of Mulga (*Acacia aneura*), *A. maitlandii* and *A. pruninocarpa* over a mixture of sparse small shrubs and grasses, such a *Triodia* and *Senna* species and *Ptilotus* sp. Dense leaf litter, and woody debris is a common feature of this habitat type.	The Mixed Acacia Woodland occurs within a small area within the Mt Ella East Survey Area; however, is considered common and widespread in the surrounding region. No occurrence of this habitat within the Deposit J Survey Area.	• **Ghost Bat –** primary foraging and/or dispersal (if proximal to primary roosting and breeding habitat) • **Pilbara leaf-nosed bat –** secondary foraging and/or dispersal (if proximal to primary roosting and breeding habitat) • **Fork-tailed swift –** secondary foraging and/or dispersal • **Brush-tailed mulgara –** core (breeding, foraging and dispersal) habitat • **Short-tailed mouse –** core (breeding, foraging and dispersal) habitat	

Habitat Type	Description	Extent within the Study Area	Critical habitat for target Species	Representative Photo
Gorge/ Gully **Extent in Study Area:** 11.07 ha; (4.65%) **Vertebrate Fauna Value:** High	Often occurring within area of Hillcrest and Hillslope habitat. This habitat often contains exposed rock outcropping and breakaway. Usually dominated by open *Eucalyptus* woodlands, *Acacia* and *Grevillea* scrublands and *Triodia* low hummock grasslands.	Within the Study Area Gorge/ Gully habitat occurs in few instances amongst Hillcrest or Hillslope habitat within the Mt Ella East Survey Area. No occurrence of this habitat within the Deposit J Survey Area.	• **Northern quoll –** core (denning/shelter, foraging and/or dispersal) • **Pilbara leaf-nosed bat –** secondary foraging and/or dispersal (if proximal to primary roosting and breeding habitat) • **Pilbara olive python –** secondary denning, foraging and/or dispersal (particularly if proximal to instances of Gorge/ Gulliy habitat that may contain water intermittently) • **Peregrine falcon –** primary nesting and breeding • **Fork-tailed swift –** secondary foraging and/or dispersal • **Pilbara flat-headed blind-snake –** core (breeding, foraging and dispersal) habitat	

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7452000

7440000

7428000

Great Northern Hwy

West Angelas

Legend

- Development Envelope
- Operating Mine
- Local Road
- State Road

Study Area

- Deposit J
- Mt Ella East

Broad Fauna Habitat

- Disturbed
- Footslopes and Plains
- Gorge/ Gully
- Hillcrest and Hillslope
- Mixed Acacia Woodland

N

biologic Environmental Survey

Scale: 1:150,000

0 2 4 6 8 Km

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994 Created 04/03/2022

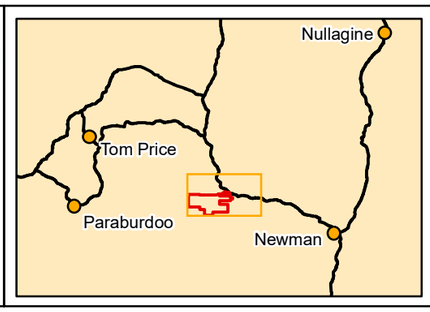

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Figure 3.2: Broad fauna habitats of the Study Area

3.3.2. Desktop Assessment

A total of 24 species of significance were identified as potentially occurring within the Study Area from the desktop assessment completed for the West Angelas Beyond 2020 Detailed Fauna Assessment (Biologic, 2021a) (Table 3.5).

No species of significance have previously been recorded within the Study Area. Four species have previously been recorded within 5 km of the Study Area, including:

- ghost bat (*Macroderma gigas* – Vulnerable EPBC Act/BC Act) ~2.6 km northwest (Biologic, 2014);
- fork-tailed swift (*Apus Pacificus* – Migratory APBC Act/BC Act), ~1.2 km west;
- western pebble-mound mouse (*Pseudomys chapmani* – Priority 4 DBCA), ~ 70 m south; and
- Pilbara barking gecko (*Underwoodisaurus seorsus* – Priority 2 DBCA), ~4 km northwest.

3.3.3. Field Survey

During the current survey, a total of 33 species of vertebrate fauna species were recorded, comprising 12 mammals (one introduced and 11 native), 17 birds and four reptiles (Appendix E). Of the 24 significant species identified as potentially occurring within the Study Area in the desktop assessment, one species was confirmed as present within the Study Area during the current survey: western pebble-mound mouse (Table 3.5; Appendix F):

Western pebble-mound mouse was recorded on 32 occasions within the Study Area from secondary evidence (pebble-mounds), including 18 times within the Deposit J Survey Area (comprising three active, eight recently inactive and seven inactive mounts) and 14 times within the Mt Ella East Survey Area (comprising two active, six recently inactive and six inactive) (Figure 3.3; Appendix F). The majority of records of the species occurred within Footslope and Plain (n = 27) habitat, with the remainder occurring within Hillcrest and Hillslope (n = 3) and Mixed Acacia Woodland (n = 2) habitats (Figure 3.3). A further five opportunistic observations of western pebble-mound mouse pebble-mounds were recorded within 50 m of the Study Area (Figure 3.3; Appendix F). The species is likely to occur throughout these habitats within the Study Area, where suitable resources for burrow and mound construction are present, particularly Footslope and Plain habitat.

Within the Mt Ella East Survey Area, a further four species are considered Highly Likely (Pilbara barking gecko) or Likely (ghost bat, Pilbara leaf-nosed bat and fork-tailed swift) to occur and an additional seven species are considered to Possibly occur (Table 3.5). The remaining 12 species are considered Unlikely or Highly Unlikely to occur within the Mt Ella East Survey Area, primarily due to the absence of suitable habitat to support the species occurring.

Within the Deposit J Survey Area, two additional species are considered Highly Likely (fork-tailed swift) or Likely (Pilbara leaf-nosed bat) to occur and a further five species are considered to Possibly occur (Table 3.5). The remaining 16 species are considered Highly Unlikely (n = 9) or Unlikely (n = 7) to occur within the Deposit J Survey Area, primarily due to the absence of suitable habitat likely to support the species occurring within the Study Area.

The Pilbara barking gecko was not recorded within the Study Area; however, has previously been recorded approximately 4 km northwest of the Mt Ella East Survey Area and is considered Highly Likely to occur. Suitable habitat was not present within the Deposit J Survey Area, therefore the species is considered Unlikely to occur within this Study Area. Within the Mt Ella East Survey Area, the species is likely to occur as a resident within Hillcrest and Hillslope habitat, particularly where suitable rock cover occurs. Previous records of the species are sparsely distributed (DBCA, 2021a); however, are often associated with stony and rocky habitats (Chapple *et al.*, 2019; Doughty & Oliver, 2011).

No evidence of ghost bat or Pilbara leaf-nosed bat was recorded within the Study Area during the Survey; however, Pilbara leaf-nosed bat is considered Likely to occur within the Mt Ella East and Deposit J Survey Areas and ghost bat is considered Likely and Possible to occur within the Mt Ella East and Deposit J Survey Areas respectively. Although no roosting habitat occurs within the Study Area, suitable foraging and/or dispersal habitat (primarily Footslope and Plains and Mixed Acacia Woodland) does occur within the Study Area. Both species' occurrence within the Study Area is likely infrequent and limited to foraging and/or dispersal activities only, with frequency of occurrence dependent on the occurrence of roost caves (particularly diurnal roosts) proximal to the Study Area. Both species have previously been recorded within 20 km of the Study Area, with ghost bat recorded as close as 2.6 km from the Mt Ella East Survey Area.

The fork-tailed swift was not recorded during the current survey; however, the species has previously been recorded (2013) approximately 1.2 km west of the Mt Ella East Survey Area and 4.8 km north-northwest of the Deposit J Survey Area. The fork-tailed swift is a wide ranging but sparsely distributed species that occurs in a wide range of dry and/or open habitats (Johnstone & Storr, 1998). The species does not breed in Australia, migrating from breeding grounds in the northern Hemisphere. During its occurrence in Australia, the species is almost exclusively aerial, feeding and possibly also roosting aerially (DoE, 2018). Therefore, the species is considered Likely to occur within the Study Area as an infrequent visitor, during which it may forage in the airspace above all habitats occurring within the Study Area. Landing or nesting within the Study Area is unlikely.

Of the nine species considered Likely or Possible to occur, critical habitat (breeding/ nesting, foraging and dispersal), with the potential to support the species is present within the Study Area for peregrine falcon, brush-tailed mulgara, short-tailed mouse and Pilbara flat-headed blind-snake only. The remaining species (northern quoll, ghost bat, Pilbara leaf-nosed bat, grey falcon and Pilbara olive python) are only considered as potentially occurring due to the presence of moderate value supporting habitat (i.e. foraging and dispersal) within the Study Area. Utilisation and occurrence of habitats within the Study Area by these species is likely to be dependent on the presence of critical high value habitat (i.e. denning and shelter, roosting (i.e. diurnal roost caves) and/or nesting habitat) proximal to the Study Area.

664000 676000 688000 700000 712000

7452000

7440000

7428000

Great Northern Hwy

West Angelas

Legend

- Development Envelope
- Operating Mine
- Local Road
- State Road

Study Area

- Deposit J
- Mt Ella East

Broad Fauna Habitat

- Disturbed
- Footslopes and Plains
- Gorge/ Gully
- Hillcrest and Hillslope
- Mixed Acacia Woodland

Western pebble-mound mouse

- Burrow/ Mound - Active
- Burrow/ Mound - Recently Inactive
- Burrow/ Mound - Inactive

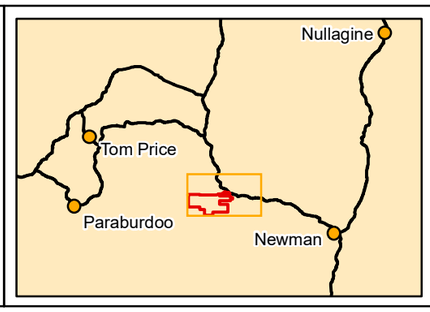
N

biologic Environmental Survey

Scale: 1:150,000

0 2 4 6 8 Km

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994 Created 04/03/2022



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Mt Ella East and Deposit J Targeted Flora and Fauna Survey

Figure 3.3: Significant fauna recorded in the Study Area

Table 3.5: Likelihood of occurrence of significant vertebrate fauna species within the Study Area

Species	Conservation Status			Preferred Broad Habitats	Nearest Records to the Study Area		Potential Habitat Within the Study Area					Likelihood of occurrence		Comments
	EPBC Act	BC Act	DBCA		Mt Ella East Survey Area	Deposit J Survey Area	Footslopes and Plains	Gorge/ Gully	Hillcrest and Hillslope	Mixed Acacia Woodland	Disturbed	Mt Ella East	Deposit J	
Mammals														
Dasyuridae														
Brush-tailed mulgara (*Dasycercus blythi*)			P4	Brush-tailed mulgara show a preference for spinifex *Triodia* spp. grasslands on sand plains and the swales between low dunes (Pavey *et al.*, 2012; Woolley, 2006). Mature spinifex hummocks appear to be important for protection from introduced predators (Körtner *et al.*, 2007).	~40 km SW (2014) (DBCA, 2021b)	~33 KM SSW (2014) (DBCA, 2021b)	•			•		Possible	Possible	May occur as a resident in Footslope or Plain or Mixed Acacia Woodland habitats where suitable burrows permitting burrow construction are present.
Northern quoll (*Dasyurus hallucatus*)	EN	EN		The species tends to inhabit rocky habitats which offer protection from predators and are generally more productive in terms of availability of resources (Braithwaite & Griffiths, 1994) (Oakwood, 2000). Other microhabitat features important to the species include rock cover, proximity to permanent water and time-since last fire (Woinarski *et al.*, 2008).	~26 km NW (2017) (DBCA, 2021b)	~37 km NW (2017) (DBCA, 2021b)		•	•			Possible	Unlikely	May occur in Gorge/ Gully and Hillcrest and Hillslope habitats within the Mt Ella East Study Area, though occurrence likely to be limited to foraging and /or dispersal activities. Occurrence likely to be infrequent and dependent on proximity of areas of suitable denning/ shelter habitat in the vicinity of the Mt Ella East Study Area. Suitable habitat not present within Deposit J Study Area.
Hipposideridae														
Pilbara leaf-nosed bat (*Rhinonicteris aurantia* (Pilbara form))	VU	VU		The Pilbara leaf-nosed bat roosts within caves and abandoned mines with high humidity (95%) and temperature (32°C) (Armstrong, 2001). The species forages in caves and along waterbodies with fringing vegetation (TSSC, 2016b).	~17 km WNW (2013) (DBCA, 2021b)	~12 km NW (2013) (DBCA, 2021b)	•	•	•	•		Likely	Likely	Likely to infrequently occur within the Study Area during foraging and/or dispersal activities. Foraging may occur in Priority 2 (Gorge/Gully), Priority 3 (rocky outcrop; within Hillcrest and Hillslope habitat) and Priority 5 (open grassland and woodland, within Footslopes and Plains habitat) habitats (as defined by TSSC (2016b)) present. Occurrence however, likely to be limited and influenced by the proximity of the Study Area to suitable roost caves. No roost caves present within the Study Area
Megadermatidae														
Ghost bat (*Macroderma gigas*)	VU	VU		Ghost bats roost in deep, complex caves beneath bluffs of low, rounded hills, granite rock piles and abandoned Mines (Armstrong & Anstee, 2000). These features often occur within habitats including gorge/gully, hill crest/ hill slope and low hills (Armstrong & Anstee, 2000). Forages broadly across habitats, particularly woodland and open woodland habitats, including eucalypt and mulga woodlands (Biologic, 2020a; Richards *et al.*, 2008; Tidemann *et al.*, 1985; TSSC, 2016a).	~2.6 km NW (2014) (Biologic, 2014)	~19 km NE (2014) (Biologic, 2014)	•			•		Likely	Possible	Species Likely occur within the Mt Ella East Study Area and Possible within the Deposit J Study Area; however, occurrence likely to be infrequent and only during foraging and/or dispersal movements within Footslopes and Plains and Mixed Acacia Woodland habitats. Occurrence likely to be infrequent, but likely to be dependent on the proximity of the Study Area to suitable roost caves. No roost caves present within the Study Area
Muridae														
Short-tailed mouse (*Leggadina lakedownensis*)			P4	The species occupies a diverse range of habitats from the monsoon tropical coast to semiarid climates, including spinifex and tussock grasslands, samphire and sedgelands, *Acacia* shrublands, tropical eucalypt and Melaleuca woodlands and stony ranges; however, the species is usually found in seasonally inundated habitats on red or white sandy-clay soils (Moro & Kutt, 2008)	~29 km WNE (1997) (DBCA, 2021b)	~7 km NWN (1997) (DBCA, 2021b)	•			•		Possible	Possible	May occur as a resident within Mulga Woodland and Footslopes and Plains habitats of the Study. Occurrence and abundance likely to fluctuate seasonally when resources are abundant.

Species	Conservation Status			Preferred Broad Habitats	Nearest Records to the Study Area		Potential Habitat Within the Study Area					Likelihood of occurrence		Comments
	EPBC Act	BC Act	DBCA		Mt Ella East Survey Area	Deposit J Survey Area	Footslopes and Plains	Gorge/ Gully	Hillcrest and Hillslope	Mixed Acacia Woodland	Disturbed	Mt Ella East	Deposit J	
Western pebble-mound mouse (*Pseudomys chapmani*)			P4	This species occurs on the gentler slopes of rocky ranges where the ground is covered with a stony mantle and vegetated by hard spinifex, often with a sparse overstorey of eucalypts and scattered shrubs (Anstee, 1996; Start *et al.*, 2000).	~70 m S (2014) (Rio Tinto, 2021a)	~1 km W (2013) (Rio Tinto, 2021a)	•		•			Confirmed (this survey)	Confirmed (this survey)	Recorded on 32 occasions from secondary evidence (pebble-mounds) in Footslope and Plain (n = 27), Hillcrest and Hillslope (n = three) and Mixed Acacia Woodland (n = 2) habitats (Figure 3.3). Pebble-mound records comprised five active, 14 recently inactive and 15 inactive mounds (Figure 3.3; Appendix F) Likely to occur as a resident throughout Study Area where suitable stony substrates permitting burrow and mound construction present.
Thylacomyidae														
Greater bilby (*Macrotis lagotis*)	VU	VU		Occurs in a variety of habitats including spinifex hummock grassland and *Acacia* shrubland, on soft soils (Burrows *et al.*, 2012). In the Pilbara often associated with major drainage line sandy terraces (How *et al.*, 1991).	~29 km NW (1983) (DBCA, 2021b)	~26 km NNW (1983) (DBCA, 2021b)						Unlikely	Unlikely	Suitable habitat not present.
Aves														
Apodidae														
Fork-tailed swift (*Apus pacificus*)	MI	MI		Inhabits dry/open habitats, inclusive of riparian woodlands and tea-tree swamps, low scrub, heathland or saltmarsh, as well as treeless grassland and sandplains covered with spinifex, open farmland and inland and coastal sand-dunes (Johnstone & Storr, 1998). Almost exclusively aerial.	~1.2 km W (2013) (DBCA, 2021b)	~4.8 km NNW (2013) (DBCA, 2021b)	•	•	•	•	•	Likely	Likely	May infrequently occur within the airspace above all habitats of the Study Area during foraging and/or migratory activities; however, unlikely to land or nest.
Charadriidae														
Oriental plover (*Charadrius veredus*)	MI	MI		Occurs in a variety of habitats, including coastal habitats, such as estuarine mudflats and sandbanks, on sandy or rocky ocean beaches as well as open inland environments such as, semi-arid or arid grasslands, where the grass is short and sparse (Johnstone & Storr, 2004).	~120 km NE (2011) (DBCA, 2021a)	~130 km NE (2011) (DBCA, 2021a)						Highly Unlikely	Highly Unlikely	Suitable habitat not present
Falconidae														
Peregrine falcon (*Falco peregrinus*)		OS		Occupies arid areas and is most often encountered along cliffs above rivers, ranges and wooded watercourses where it hunts birds (Johnstone & Storr, 1998). It typically nests on rocky ledges occurring on tall, vertical cliff faces between 25 m and 50 m high (Olsen *et al.*, 2004; Olsen & Olsen, 1989).	~27 km N (2007) (DBCA, 2021b)	~24 km SW (2014) (DBCA, 2021b)	•	•				Possible	Possible	May occur as a resident within the Study Area, particularly where suitable nesting sites occur within Gorge/ Gully habitat. May forage more broadly across other habitats of the Study Area, particularly Footslopes and Plains. Occurrence within the Study Area likely to be restricted to occasional visitation for foraging. Frequency of visitation may vary depending on proximity of nesting sites within or in the vicinity of the Study Area.
Grey falcon (*Falco hypoleucos*)	VU	VU		Inhabits timbered lowlands, particularly *Acacia* shrubland and along inland drainage systems. Also frequents spinifex and tussock grassland habitats to forage (Burbidge *et al.*, 2010; Olsen & Olsen, 1986).	~18 km NW (1997) (DBCA, 2021b)	~16 km NNW (1997) (DBCA, 2021b)	•					Possible	Possible	May possibly occur within the Study Area to forage. Nesting unlikely to occur within the Study Area as suitable high nesting structures (trees, power line and/or transmission towers) not present. Frequency of visitation likely to vary depending on proximity of nesting location.
Hirundinidae														
Barn swallow (*Hirundo rustica*)	MI	MI		The barn swallow is a non-breeding summer visitor to the Pilbara. It favors areas near water (Johnstone *et al.*, 2013).	~200 km N (2005) (DBCA, 2021a)	~200 km N (2005) (DBCA, 2021a)						Highly Unlikely	Highly Unlikely	Suitable habitat not present

Species	Conservation Status			Preferred Broad Habitats	Nearest Records to the Study Area		Potential Habitat Within the Study Area					Likelihood of occurrence		Comments
	EPBC Act	BC Act	DBCA		Mt Ella East Survey Area	Deposit J Survey Area	Footslopes and Plains	Gorge/ Gully	Hillcrest and Hillslope	Mixed Acacia Woodland	Disturbed	Mt Ella East	Deposit J	
Motacillidae														
Grey wagtail (*Motacilla cinerea*)	MI	MI		A rare vagrant to Western Australia where it has been recorded within various habitats with open waterbodies (Johnstone & Storr, 2004).	~120 km N (2012) (DBCA, 2021a)	~125 km N (2012) (DBCA, 2021a)						Highly Unlikely	Highly Unlikely	Suitable habitat not present
Yellow wagtail (*Motacilla flava*)	MI	MI		An uncommon but regular visitor to the Pilbara region (Johnstone *et al.*, 2013). Occupies a range of damp or wet habitats with low vegetation although favors edges of fresh water, especially sewage ponds (Johnstone & Storr, 2004).	~500 km NNE (2003) (DBCA, 2021a)	~500 km NNE (2003) (DBCA, 2021a)						Highly Unlikely	Highly Unlikely	Suitable habitat not present
Psittacidae														
Night parrot (*Pezoporus occidentalis*)	EN	CR		The night parrot prefers sandy/stony plain habitat with old-growth spinifex for roosting and nesting in conjunction with native grasses and herbs for foraging (DPaW, 2017).	~105 km NNE (2005) (DBCA, 2021a)	~112 km NNE (2005) (DBCA, 2021a)						Unlikely	Unlikely	Suitable habitat not present.
Rostratulidae														
Australian painted snipe (*Rostratula benghalensis australis*)	EN	EN		Generally, occupies shallow terrestrial freshwater wetlands (i.e. temporary and permanent lakes, swamps and claypans) with rank emergent tussocks of grass, sedges, rushes or reeds, or samphire (Johnstone & Storr, 1998)	~92 km NE (2012) (DBCA, 2021a)	~105 km NW (2012) (DBCA, 2021a)						Highly Unlikely	Highly Unlikely	Suitable habitat not present.
Scolopacidae														
Sharp-tailed sandpiper (*Calidris acuminata*)	MI	MI		Favors flooded samphire flats and grasslands, mangrove creeks mudflats, beaches, river pools, saltwork ponds, sewage ponds and freshwater soaks (Johnstone *et al.*, 2013).	~104 km ENE (2007) (DBCA, 2021a)	~116 km ENE (2007) (DBCA, 2021a)						Highly Unlikely	Highly Unlikely	Suitable habitat not present.
Curlew sandpiper (*Calidris ferruginea*)	CR / MI	CR / MI		Inhabits intertidal mudflats in sheltered coastal areas (i.e. estuaries, bays, inlets and lagoons) (Geering *et al.*, 2007). This rare species generally roosts on bare dry shingle, shell or sand beaches, sandspits and islets in or around coastal or near-coastal lagoons and other wetlands (Geering *et al.*, 2007).	~90 km E (2005) (DBCA, 2021a)	~104 km E (2006) (DBCA, 2021a)						Highly Unlikely	Highly Unlikely	Suitable habitat not present.
Pectoral sandpiper (*Calidris melanotos*)	MI	MI		Coastal lagoons, estuaries, bays, swamps, lakes, inundated grasslands, saltmarshes, river pools, creeks, floodplains and artificial wetlands (Johnstone & Storr, 2004; Johnstone *et al.*, 2013). It prefers wetlands with open fringing mudflats and low, emergent or fringing vegetation (Geering *et al.*, 2007)	~300 km N (2014) (DBCA, 2021a)	~300 km N (2014) (DBCA, 2021a)						Highly Unlikely	Highly Unlikely	Suitable habitat not present.
Common sandpiper (*Tringa hypoleucos*)	MI	MI		Estuaries and deltas of streams, as well as banks farther upstream; around lakes, pools, billabongs, reservoirs, dams and claypans (Geering *et al.*, 2007).	~116 km ENE (2018) (DBCA, 2021a)	~128 km ENE (2018) (DBCA, 2021a)						Highly Unlikely	Highly Unlikely	Suitable habitat not present.
Reptiles														
Carphodactylidae														
Pilbara barking gecko (*Underwoodisaurus seorsus*)			P2	Little is known about the ecology of the Pilbara barking gecko, but the species is thought to prefer rocky areas, often associated with high elevation, with spinifex and low tree cover habitats (Chapple et al., 2019; Doughty & Oliver, 2011).	~4 km NW (1997) (DBCA, 2021b)	~8 km NE (1997) (DBCA, 2021b)			•			Highly Likely	Unlikely	Highly Likely to occur as a resident in Hillcrest and Hillslope habitat of the Mt Ella East Study Area, particularly where suitable rock cover occurs. Unlikely to occur within habitats present within the Deposit J Study Area.

Species	Conservation Status			Preferred Broad Habitats	Nearest Records to the Study Area		Potential Habitat Within the Study Area					Likelihood of occurrence		Comments
	EPBC Act	BC Act	DBCA		Mt Ella East Survey Area	Deposit J Survey Area	Footslopes and Plains	Gorge/ Gully	Hillcrest and Hillslope	Mixed Acacia Woodland	Disturbed	Mt Ella East	Deposit J	
Pythonidae														
Pilbara olive python (*Liasis olivaceus barroni*)	VU	VU		Associated with drainage systems, including areas with localised drainage and watercourses (Pearson, 1993). In the inland Pilbara the species is most often encountered near permanent waterholes in rocky ranges or among riverine vegetation (Pearson, 1993).	~10 km NNE (1900) (DBCA, 2021b)	~21 km NE (1900) (DBCA, 2021b)		•				Possible	Unlikely	May occur as a occasional visitor in Gorge/ Gully habitat or the Mt Ella East Study Area. Occurrence likely to be limited to foraging and/or dispersal activities only due to the absence of permanent or long-standing waterbodies. Suitable habitat not present within the Deposit J Study Area.
Scincidae														
Lined soil-crevice skink (*Notoscincus butleri*)			P4	Recorded in areas dominated by spinifex and near water courses (Wilson & Swan, 2014). Records are restricted to a coastal area within the Lower Fortescue Hedland region.	~205 km NNW (2011) (DBCA, 2021a)	~200 km NNW (2011) (DBCA, 2021a)						Unlikely	Unlikely	Study Area occurs outside species' current known range. Record returned in the desktop assessment likely to be erroneous.
Typhlopidae														
Pilbara flat-headed blind-snake (*Anilios ganei*)			P1	Little is known of the species' ecology, but it is often associated with moist soils and leaf litter within gorges and gullies (Wilson and Swan 2014), and potentially within a wide range of other stony habitats. The species has been recorded from numerous habitats but is most likely to be present in rocky terrain and along drainage lines (DBCA, 2019)	~16 km NNE (1999) (DBCA, 2021b)	~26 km NW (1999) (DBCA, 2021b)		•	•			Possible	Unlikely	May occur as a resident in the Mt Ella East Study Area in Hillcrest and Hillslope or Gorge/ Gully habitats, particularly where moist substrates and leaf litter accumulation occurs over prolonged periods. Suitable habitat not present within the Deposit J Study Area.

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Appendix A: Flora Likelihood of Occurrence

Species	Conservation Status			Habitat	Likelihood of Occurrence		Comments
	EPBC Act	BC Act	DBCA		Pre-survey	Post-survey	
Hibiscus sp. Gurinbiddy Range (M.E. Trudgen MET 15708)			P2	Hilltops, upper hillslopes.	Likely	Confirmed	Some suitable habitat present in Study Area. Closest record ~ 4 Km from Study Area.
Indigofera gilesii			P3	Skeletal red-brown loam on rocky slopes, gorges, and creeklines.	Highly Likely	Confirmed	Some habitat in Study Area. Found at Dep J/ Mount Ella East
Rhagodia sp. Hamersley (M. Trudgen 17794)			P3	Mulga (Acacia aneura) and Snakewood (A. xiphophylla) vegetation on clay plains.	Confirmed	Confirmed	Confirmed from Rio Tinto records (2021)
Solanum kentrocaule			P3	Hillsides and mountain crests, creek beds; skeletal red-brown soil over ironstone on basalt or scree.	Likely	Confirmed	Limited suitable habitat present in Study Area, closest record is ~ 4 km away
Triodia sp. Mt Ella (M.E. Trudgen 12739)			P3	Light orange-brown to red-brown pebbly loam on hill slopes and in gullies.	Confirmed	Confirmed	Confirmed from Rio Tinto records (2021)
Acacia bromilowiana			P4	Skeletal loam soils on rocky hills, breakaways, scree slopes, gorges and rocky creek beds.	Highly Likely	Confirmed	Some suitable habitat present in Study Area. Recorded from Deposit J/ Mt Ella East
Eremophila magnifica subsp. *magnifica*			P4	Rocky hillslopes, breakaways.	Likely	Confirmed	Some suitable habitat present in Study Area. Closest record is ~ 2 Km from the Study Area.
Oxalis sp. Pilbara (M.E. Trudgen 12725)			P2	Red-brown loam on rocky hillslopes and in gorges.	Likely	Possible	Some suitable habitat present in s Study Area. Closest record with ~ 3 Km of Study Area.
Goodenia nuda			P4	Alluvial plains, creeks.	Likely	Possible	Some suitable habitat present in Study Area (creekline). Recorded from Deposit J/ Mt Ella East. Closest record is ~ 3 Km from the Study Area.
Eremophila sp. West Angelas (S. van Leeuwen 4068)			P1	Skeletal red-brown soil on hill summits high in the landscape.	Possible	Unlikely	Some potentially suitable habitat is present in Study Area (but infrequent).
Hibiscus sp. Mt Brockman (E. Thoma ET 1354)			P1	Gorges, rocky areas.	Unlikely	Unlikely	Taxon mainly restricted to Brockman/Nammuldi area (nearby records likely erroneous).
Aristida lazaridis			P2	Major drainage areas through clayey flats.	Likely	Unlikely	No suitable habitat present
Eremophila pusilliflora			P2	Alluvial plains.	Possible	Unlikely	Some habitat, closest record ~ 11 Km east southeast
Isotropis parviflora			P2	Undulating ironstone plains.	Possible	Unlikely	Some potentially suitable habitat present in Study Area. Records within 20 km.
Tetratheca fordiana			P2	Shale pockets amongst ironstone on free rock faces.	Possible	Unlikely	Limited habitat. Closest record is ~ 5 Km from the Study Area.

Species	Conservation Status			Habitat	Likelihood of Occurrence		Comments
	EPBC Act	BC Act	DBCA		Pre-survey	Post-survey	
Acacia daweana			P3	Stony red loamy soils on low rocky rises and along drainage lines.	Possible	Unlikely	Some suitable habitat present in Study Area. Closest record ~ 6 Km of Study Area
Acacia effusa			P3	Stony red loam; scree	Likely	Unlikely	Some suitable habitat present in Study Area. Closest record ~ 4 Km of Study Area
Eremophila magnifica subsp. *velutina*			P3	Skeletal soils over ironstone on summits and breakaways.	Unlikely	Unlikely	Some suitable habitat present in Study Area.
Eremophila sp. Hamersley Range (K. Walker KW 136)			P3	Skeletal red-brown silty loam on hill crests, cliff tops, gorges.	Highly Likely	Unlikely	Some habitat. Nearest record ~ 6 Km from Study Area
Euphorbia clementii			P3	Gravelly hillsides, stony ground.	Possible	Unlikely	Some suitable habitat present in Study Area. Closest record ~ 9 Km from Study Area
Geijera salicifolia			P3	Skeletal and stony soils in massive rock scree, rockpiles and gorges.	Possible	Unlikely	Closest record is ~ 7 Km from the Study Area
Grevillea saxicola			P3	Upper scree slopes on banded ironstone, usually with Mulga.	Possible	Unlikely	Some suitable habitat present in Study Area. Closest record ~ 20 Km from Study Area
Oldenlandia sp. Hamersley Station (A.A. Mitchell PRP 1479)			P3	Stony undulating clay plains.	Possible	Unlikely	Marginal habitat present within Study Area, and closest record is ~14km away.
Olearia mucronata			P3	Hills and rocky drainage channels.	Likely	Unlikely	Some potentially suitable habitat present in Study Area. Closest record ~ 5 Km from the Study Area.
Sida sp. Barlee Range (S. van Leeuwen 1642)			P3	Steep slopes, rocky gullies and breakaways.	Possible	Unlikely	Some potentially suitable habitat present. Recorded from Deposit J/ Mt Ella East. Closest record is ~9 km from the Study Area.
Sida sp. Hamersley Range (K. Newbey 10692)			P3	Base of rocky cliff habitats in red skeletal stony soils or ironstone.	Likely	Unlikely	Some suitable habitat present in Study Area. Recorded from Deposit J/ Mt Ella East. Closest record is ~ 5 Km from Study Area.
Themeda sp. Hamersley Station (M.E. Trudgen 11431)			P3	Clay plains.	Possible	Unlikely	Marginal habitat present (Study Area has minimal clay), but there is a record ~3 km away.
Xerochrysum boreale			P3	Loamy, sandy or gravelly soils on plains.	Possible	Unlikely	Some suitable habitat present in Study Area. Closest record ~28 km SW.

Species	Conservation Status			Habitat	Likelihood of Occurrence		Comments
	EPBC Act	BC Act	DBCA		Pre-survey	Post-survey	
Lepidium catapycnon			P4	Skeletal soils on hill slopes.	Possible	Unlikely	Limited suitable habitat present in Study Area.
Thryptomene wittweri		T		Breakaways and stony creek beds on high mountains (>1,000 m in elevation).	Highly Unlikely	Highly Unlikely	No suitable habitat present.
Eragrostis sp. Mt Robinson (S. van Leeuwen 4109)			P1	Red-brown skeletal soils, ironstone; steep slopes, summits of tall hills.	Unlikely	Highly Unlikely	Some potentially suitable habitat is present in Study Area (but infrequent). Closest record is ~19km away.
Eremophila spongiocarpa			P1	Weakly saline alluvial plain, on margins of marsh.	Highly Unlikely	Highly Unlikely	No suitable habitat present
Euphorbia inappendiculata var. *queenslandica*			P1	Heavy clay soils on open plains and gentle slopes.	Unlikely	Highly Unlikely	No suitable habitat present
Rhodanthe ascendens			P1	Cracking clay.	Unlikely	Highly Unlikely	Limited to no suitable habitat present
Synostemon hamersleyensis			P1	Breakaway formations and rocky outcrops.	Highly Unlikely	Highly Unlikely	Some potentially suitable habitat is present in Study Area, but infrequent. Species is restricted to Koodaideri locality.
Triodia sp. Karijini (S. van Leeuwen 4111)			P1	Skeletal dark orange-brown to red-brown soil on upper slopes and summits of mountains.	Unlikely	Highly Unlikely	Some potentially suitable habitat is present in Study Area, but infrequent. Closest record is ~17km away.
Vittadinia sp. Coondewanna Flats (S. van Leeuwen 3835)			P1	Mainly on red clay on plains, low in the landscape.	Likely	Highly Unlikely	Some potentially suitable habitat present in Study Area. Closest record ~ 1.8 Km from the Study Area.
Adiantum capillus-veneris			P2	Moist sheltered sites in gorges and on cliff walls.	Highly Unlikely	Highly Unlikely	Some potentially suitable habitat present in Study Area, but species is restricted to the Brockman-Nammuldi area.
Arthropodium sp. Ironstone (J. Bull & J. Waters ONS PJ 36.01)			P2	Gorges and steep Banded Ironstone slopes.	Unlikely	Highly Unlikely	Some potentially suitable habitat present in Study Area, but closest record is more than 50 km away.
Cladium procerum			P2	Perennial pools.	Highly Unlikely	Highly Unlikely	No suitable habitat present
Euphorbia australis var. *glabra*			P2	Banks of semi-permanent pools or creeklines, or alluvial flats, on sandy to clayey-loam alluvium.	Highly Unlikely	Highly Unlikely	No water features found during survey. Species is restricted to Karijini to Brockman-Nammuldi localities.
Ipomoea racemigera			P2	Drainage lines.	Unlikely	Highly Unlikely	Closest record is ~50km away.

Species	Conservation Status			Habitat	Likelihood of Occurrence		Comments
	EPBC Act	BC Act	DBCA		Pre-survey	Post-survey	
Kohautia australiensis			P2	Calcareous plains and rises, gullies.	Highly Unlikely	Highly Unlikely	Closest record is >50km away.
Teucrium pilbaranum			P2	Crab hole floodplains; margins of calcrete tables.	Highly Unlikely	Highly Unlikely	No suitable habitat present
Acacia subtiliformis			P3	Calcrete platforms.	Highly Unlikely	Highly Unlikely	No suitable habitat present
Ampelopteris prolifera			P3	Near water, or in wet ground.	Unlikely	Highly Unlikely	No suitable habitat present
Aristida jerichoensis var. *subspinulifera*			P3	Hardpan clay plains.	Likely	Highly Unlikely	No suitable habitat present
Dampiera metallorum			P3	Skeletal red-brown gravelly soil over banded ironstone; steep slopes and hill summits at high elevation.	Unlikely	Highly Unlikely	Some steep slopes and hills found in Study Area but elevation is unlikely to be high enough.
Euphorbia stevenii			P3	Clay soils.	Unlikely	Highly Unlikely	Some potentially suitable habitat present in Study Area. Closest record ~ 17 Km from Study Area.
Fimbristylis sieberiana			P3	Mud and skeletal soil pockets near permanent pools in gorges.	Highly Unlikely	Highly Unlikely	No suitable habitat present.
Glycine falcata			P3	Black clayey sand, crabhole plains.	Highly Unlikely	Highly Unlikely	No suitable habitat present.
Goodenia lyrata			P3	Near claypans.	Unlikely	Highly Unlikely	No suitable habitat present.
Goodenia sp. East Pilbara (A.A. Mitchell PRP 727)			P3	Red-brown clay soil, typically on calcrete platforms.	Highly Unlikely	Highly Unlikely	No suitable habitat present.
Gymnanthera cunninghamii			P3	Sandy soils along creeklines.	Unlikely	Highly Unlikely	Closest record more than 50km away.
Iotasperma sessilifolium			P3	Cracking clay on plains.	Highly Unlikely	Highly Unlikely	Limited suitable habitat. Closest record ~ 70 Km from Study Area.
Pilbara trudgenii			P3	Skeletal red stony soil over ironstone; hill summits, steep slopes, screes, cliff faces.	Likely	Highly Unlikely	Limited potential habitat. Recorded from Deposit J/ Mt Ella East. Closest record with ~ 3 Km of Study Area.
Rostellularia adscendens var. *latifolia*			P3	Various; creeks, plains, low hills.	Likely	Highly Unlikely	Some suitable habitat present in Study Area. Closest record is ~ 4.5 Km from Study Area.
Stackhousia clementii			P3	Skeletal soils, sandstone hills.	Unlikely	Highly Unlikely	Marginal habitat present in Study Area, but closest record is ~23km away.

Species	Conservation Status			Habitat	Likelihood of Occurrence		Comments
	EPBC Act	BC Act	DBCA		Pre-survey	Post-survey	
Swainsona thompsoniana			P3	Creekline, claypan.	Unlikely	Highly Unlikely	Some potentially suitable habitat present in Study Area but closest record is ~17 km away.
Ptilotus mollis			P4	Stony hills and screes.	Unlikely	Highly Unlikely	Some potentially suitable habitat present, but is only adjacent to known distribution.
Rhynchosia bungarensis			P4	Drainage lines, gorges and gullies.	Highly Unlikely	Highly Unlikely	Closest record is more than 50km away and is outside of known distribution.

Appendix B: Chain of Custody Form

Chain of Custody Form – Significant Specimens

Consultant to fill in the information in the tables below, and to indicate approximate study area on Figure 1. All specimen co-ordinates are to be provided in MGA Z50.

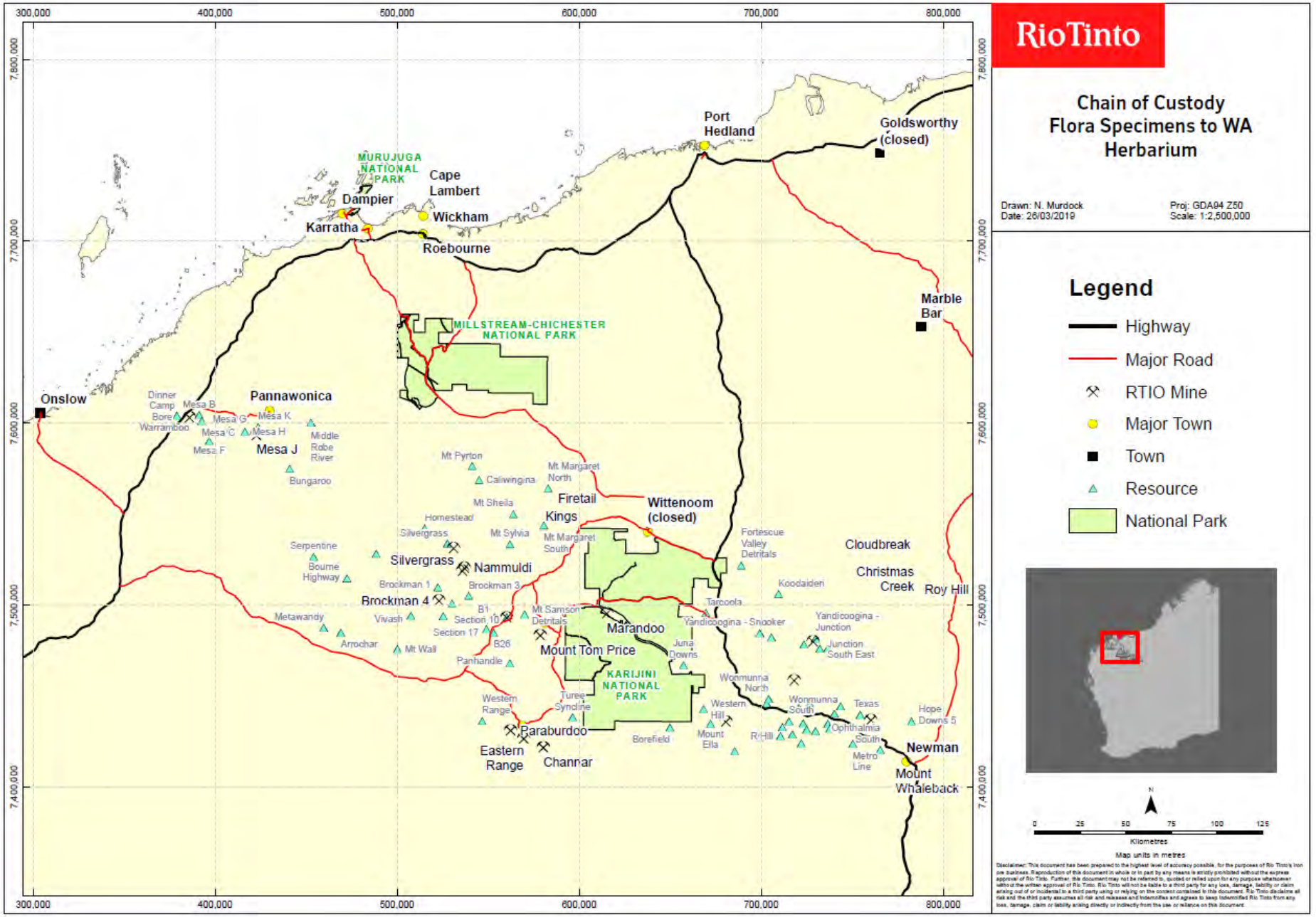
Please refer to the Herbarium Specimen Submission Procedure (RTIO-HSE-0336396) for guidelines on what should be submitted to the RTIO Sponsored Taxonomist for identification.

Consultant Company: Biologic
Consultant Contact Name: Sam Coultas
Consultant Contact Number: 0400 507 407
Consultant Job Reference: 20153 Dep J Mt Ella
Specimen Submission Date: 18/10/21

Rio Tinto Project Manager / Botanist: Hayden Ajduk
Rio Tinto Contact Number: 0436 669 973
Rio Tinto Study Area: Deposit J / Mt Ella
Rio Tinto AR Number (if applicable): NA

Nearest Named Location to Study Area: West Angelas
Distance and Direction to Nearest Town: 100km west of Newman
Central Co-ordinate of Study Area: 690666 E, 7431203 N
Field Survey Date/s: 2-6th August 2021

CONSULTANT TO FILL OUT						RTIO SPONSORED TAXONOMIST TO FILL OUT	
Collection No.	**Consultants ID**	**Easting (mE)**	**Northing (mN)**	**Plant description** Habit (e.g. shrub, tree, herb), habitat description, photos	**Reason for submission**	**Identification**	**Comment**
Please see attached specimen list spreadsheet							


RioTinto
Chain of Custody
Flora Specimens to WA
Herbarium
Drawn: N. Murdock
Date: 26/03/2019
Proj: GDA94 Z50
Scale: 1:2,500,000
Legend
Highway
Major Road
RTIO Mine
Major Town
Town
Resource
National Park
MURUJUGA NATIONAL PARK
MILLSTREAM-CHICHESTER NATIONAL PARK
KARIJINI NATIONAL PARK
Port Hedland
Goldsworthy (closed)
Cape Lambert
Dampier
Wickham
Karratha
Roebourne
Marble Bar
Onslow
Pannawonica
Mesa J
Wittenoom (closed)
Firetail
Kings
Silvergrass
Nammuldi
Brockman 4
Marandoo
Mount Tom Price
Paraburdoo
Eastern Range
Channar
Newman
Mount Whaleback
Cloudbreak
Christmas Creek
Roy Hill
Kilometres
Map units in metres

Collection No.	Latitude	Longitude	Easting	Northing	Field Name	Consultants ID	Plant Description	Landform	Vegetation Description	Reason for Submission	Consultant Comment	Formal Identification	Comments
Cvopp.04	-23.214757	118.858254	690157.2418	7431490.576	*Acacia bromilowiana*	*Acacia hamersleyensis*	Tall shrub	Gully	NA	Originally collected for potential of conservation significance	Simple inflorescence, hairy peduncles, narrow phyllodes		
COP-12	-23.21239782	118.8771055	692090.1878	7431727.039	*Acacia bromilowiana*	*Acacia* ?*bromilowiana*	Tall shrub	Rocky hill/gully	NA	Originally collected for potential of conservation significance	Sterile. Quite wide phyllodes (mostly wider than 20mm)		
COP-07	-23.21614683	118.8636605	690708.6559	7431329.574	*Acacia Prob not brom*	*Acacia hamersleyensis*	Tall shrub	Rocky hill/gully	NA	Originally collected for potential of conservation significance	Simple inflorescence, hairy peduncles, narrow phyllodes		
Cvopp.08	-23.216943	118.8567132	689996.4381	7431250.507	*Eremophila magnifica* subsp. *magnifica*	*Eremophila magnifica* subsp. *magnifica* (P4)	Shrub	Gully	NA	Potentially conservation significant			
CVopp.12	-23.216993	118.8626084	690599.7669	7431237.247	*Eremophila magnifica* subsp. *magnifica*	*Eremophila magnifica* subsp. *magnifica* (P4)	Shrub	Breakaway	NA	Potentially conservation significant			
CVopp.17	-23.2135313	118.8625555	690599.2665	7431620.677	*Eremophila magnifica* subsp. *velutina*	*Eremophila magnifica* subsp. *magnifica* (P4)	Shrub	Gully	NA	Potentially conservation significant			
Cvopp02	-23.2056089	118.880631	692460.783	7432474.205	*Goodenia nuda*	*Goodenia muelleriana*	Herb to 0.3	Stony Plain	NA	Originally collected for potential of conservation significance	Appears to have both types of hairs on outside of corolla		
Cvopp.14	-23.2172939	118.8632649	690666.5353	7431203.063	*Hibiscus* sp. Gurinbiddy Range (M.E. Trudgen MET 15708)	*Hibiscus* sp. Gurinbiddy Range (M.E. Trudgen MET 15708) (P2)	Shrub to 0.8	Gully	NA	Potentially conservation significant			
COP-05	-23.2162988	118.8544347	689764.1349	7431324.827	Indigo gorge tall	*Indigofera gilesii* (P3)	Shrub	Rocky hill/gully	NA	Potentially conservation significant	Couldn't check any of these through key or at Herbarium so these are definitely tentative		
Cvopp.10	-23.2168827	118.85458	689778.1812	7431259.974	*Indigofera* ?*gilesii*	*Indigofera gilesii* (P3)	Shrub	Rocky hill/gully	NA	Potentially conservation significant	Couldn't check any of these through key or at Herbarium so these are definitely tentative		
COP-9	NA	NA	NA	NA	*Indigofera gilesii*	*Indigofera gilesii* (P3)	Shrub	Rocky hill/gully	NA	Potentially conservation significant	Couldn't check any of these through key or at Herbarium so these are definitely tentative		
COP-03	-23.21456022	118.8572333	690053.0494	7431513.703	*Indigofera* gorge	*Indigofera gilesii* (P3)	Shrub	Rocky hill/gully	NA	Potentially conservation significant	Couldn't check any of these through key or at Herbarium so these are definitely tentative		

Collection No.	Latitude	Longitude	Easting	Northing	Field Name	Consultants ID	Plant Description	Landform	Vegetation Description	Reason for Submission	Consultant Comment	Formal Identification	Comments
COP-08	-23.21636342	118.8638765	690730.4571	7431305.304	*Indigofera* gorge tall flowers	*Indigofera gilesii* (P3)	Shrub	Rocky hill/gully	NA	Potentially conservation significant	Couldn't check any of these through key or at Herbarium so these are definitely tentative		
COP-01	-23.20512915	118.8776752	692158.9029	7432531.246	*Rhagodia* sp. Hamersley (M. Trudgen 17794)	*Rhagodia* sp. Hamersley (M. Trudgen 17794) (P3)	Shrub	Stony Plain	NA	Potentially conservation significant			
COP-04	-23.21483708	118.8567397	690002.1336	7431483.689	*Rhagodia* sp. Hamersley (M. Trudgen 17794)	*Rhagodia* sp. Hamersley (M. Trudgen 17794) (P3)	Shrub	Stony Plain	NA	Potentially conservation significant			
Cvopp.07	-23.2154339	118.8567461	690001.9412	7431417.587	*Solanum kentrocaule*	*Solanum kentrocaule* (P3)	Shrub	Breakaway	NA	Potentially conservation significant			
CvdBopp. 01	-23.2138179	118.8558155	689908.9749	7431597.764	*Triodia* sp. Mt Ella (M.E. Trudgen 12739)	*Triodia* sp. Mt Ella (M.E. Trudgen 12739) (P3)	Hummock grass	Breakaway	NA	Potentially conservation significant			
No number	-23.21139894	118.8795198	692338.7454	7431834.464	*Triodia* sp. Mt Ella (M.E. Trudgen 12739)	*Triodia* ?sp. Mt Ella (M.E. Trudgen 12739) (P3)	Hummock grass	Rocky hill/gully	NA	Originally collected for potential of conservation significance	Sterile		

Appendix C: Priority Flora Photos

Taxon	Conservation Code	Photos
Hibiscus sp. Gurinbiddy Range (M.E. Trudgen 15708)	Priority 2	

Taxon	Conservation Code	Photos
Indigofera gilesii	Priority 3	

Taxon	Conservation Code	Photos
Rhagodia sp. Hamersley (M. Trudgen 17794)	Priority 3	

Taxon	Conservation Code	Photos
Solanum kentrocaule	Priority 3	

Taxon	Conservation Code	Photos
Triodia sp. Mt Ella (M. Trudgen 12739)	Priority 3	

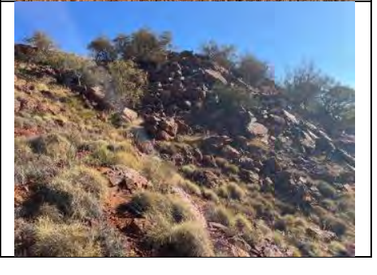
Taxon	Conservation Code	Photos
Acacia bromilowiana	Priority 4	

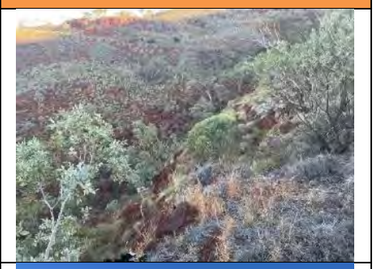
Taxon	Conservation Code	Photos
Eremophila magnifica subsp. *magnifica*	Priority 4	

Appendix D: Vertebrate Fauna Habitat Assessments

Site ID	Coord.	Date	Habitat Type	Landform	Aspect	Slope	Soil Type	Soil Avail.	Outcropping Rock Type	Rock Size	Veg. Litter	Dominant Veg. Type	Rocky Cracks / Crevices	Burrowing Suitability	Disturbances	Last Fire	Photo
VDJE-001	-23.2432, 118.7666	2/08/2021	Footslope and Plain	Stony Plain	Flat	Flat	Clay Loam	Scarce	Negligible	Gravel (1-4cm)	Scarce	Spinifex Hummock Grassland	Nil	Nil	Road/ Access Track	Recent (0 to 2 yr.)	
VDJE-002	-23.2407, 118.7669	2/08/2021	Footslope and Plain	Stony Plain	Flat	Low	Clay Loam	Scarce	Negligible	Gravel (1-4cm)	Scarce	Scattered Eucalypts, Spinifex Hummock Grassland	Nil	Nil	None Discernible	Recent (0 to 2 yr.)	
VDJE-003	-23.2037, 118.882	3/08/2021	Footslope and Plain	Stony Plain	Flat	Flat	Clay Loam	Few Small Patches	Negligible	Gravel (1-4cm)	Few Small Patches	Acacia Shrubland, Spinifex Hummock Grassland	Nil	Nil	Mining Exploration	Moderate (3 to 5 yr.)	
VDJE-004	-23.2049, 118.8784	3/08/2021	Footslope and Plain	Stony Plain	Flat	Flat	Clay Loam	Few Small Patches	Negligible	Gravel (1-4cm)	Many Small Patches	Spinifex Hummock Grassland, Acacia Shrubland	Nil	Nil	Road/ Access Track, Mining Exploration	Moderate (3 to 5 yr.)	
VDJE-005	-23.2113, 118.88	3/08/2021	Gorge/ Gully	Gully	North/ West	Steep	Clay Loam	Scarce	Extensive Outcropping, BIF	Small Rocks (11-20cm)	Scarce	Scattered Eucalypts, Spinifex Hummock Grassland	Moderate	Nil	Road/ Access Track, Mining Exploration	Moderate (3 to 5 yr.)	

Site ID	Coord.	Date	Habitat Type	Landform	Aspect	Slope	Soil Type	Soil Avail.	Outcropping Rock Type	Rock Size	Veg. Litter	Dominant Veg. Type	Rocky Cracks / Crevices	Burrowing Suitability	Disturbances	Last Fire	Photo
VDJE-006	-23.2147, 118.8747	3/08/2021	Gorge/ Gully	Gully	West	Moderate	Clay Loam	Few Small Patches	Extensive Outcropping, BIF	Gravel (1-4cm)	Few Small Patches	Scattered Eucalypts, Spinifex Hummock Grassland	Moderate	Nil	None Discernible	Moderate (3 to 5 yr.)	
VDJE-007	-23.2149, 118.8565	3/08/2021	Gorge/ Gully	Gully	West	Very Steep	Clay Loam	Scarce	Extensive Outcropping, BIF	Gravel (1-4cm)	Few Small Patches	Spinifex Hummock Grassland, Scattered Eucalypts	High	Nil	None Discernible	Moderate (3 to 5 yr.)	
VDJE-008	-23.2086, 118.8456	2/08/2021	Footslope and Plain	Stony Plain	Flat	Flat	Clay Loam	Few Small Patches	Negligible	Gravel (1-4cm)	Few Small Patches	Mulga Woodland, Spinifex Hummock Grassland, Acacia Shrubland	Nil	Nil	Road/ Access Track	Old (6+ yr.)	
VDJE-009	-23.2136, 118.8572	4/08/2021	Hillcrest and Hillslope	Hillcrest/ Upper Hillslope	North	Very Steep	Clay Loam	None Discernible	Major Outcropping, BIF	Gravel (1-4cm)	None Discernible	Spinifex Hummock Grassland, Scattered Eucalypts	Moderate	Nil	None Discernible	Recent (0 to 2 yr.)	

Site ID	Coord.	Date	Habitat Type	Landform	Aspect	Slope	Soil Type	Soil Avail.	Outcropping Rock Type	Rock Size	Veg. Litter	Dominant Veg. Type	Rocky Cracks / Crevices	Burrowing Suitability	Disturbances	Last Fire	Photo
VDJE-011	-23.217, 118.8554	4/08/2021	Footslope and Plain	Minor Drainage Line	North/ West	Steep	Clay Loam	None Discernible	Major Outcropping, BIF	Gravel (1-4cm)	Few Small Patches	Scattered Eucalypts, Spinifex Hummock Grassland	Low	Nil	None Discernible	Recent (0 to 2 yr.)	
VDJE-010	-23.2165, 118.8567	4/08/2021	Hillcrest and Hillslope	Hillcrest/ Upper Hillslope	North/ West	Steep	Clay Loam	None Discernible	Major Outcropping, BIF	Gravel (1-4cm)	None Discernible	Scattered Eucalypts, Spinifex Hummock Grassland	Moderate	Nil	None Discernible	Recent (0 to 2 yr.)	
VDJE-012	-23.216, 118.8522	4/08/2021	Footslope and Plain	Stony Plain	Flat	Flat	Clay Loam	Scarce	Negligible	Gravel (1-4cm)	Scarce	Scattered Eucalypts, Spinifex Hummock Grassland	Nil	Nil	Road/ Access Track	Moderate (3 to 5 yr.)	
VDJE-014	-23.2159, 118.8608	4/08/2021	Hillcrest and Hillslope	Hillcrest/ Upper Hillslope	North	Very Steep	Clay Loam	None Discernible	Major Outcropping, Basalt	Small Rocks (11-20cm)	Scarce	Scattered Eucalypts, Spinifex Hummock Grassland	High	Nil	None Discernible	Moderate (3 to 5 yr.)	

Site ID	Coord.	Date	Habitat Type	Landform	Aspect	Slope	Soil Type	Soil Avail.	Outcropping Rock Type	Rock Size	Veg. Litter	Dominant Veg. Type	Rocky Cracks / Crevices	Burrowing Suitability	Disturbances	Last Fire	Photo
VDJE-016	-23.2171, 118.863	4/08/2021	Gorge/ Gully	Gully	South	Very Steep	Clay Loam	Scarce	Extensive Outcropping, BIF	Small Rocks (11-20cm)	Scarce	Scattered Eucalypts, Spinifex Hummock Grassland	Moderate	Nil	Mining Exploration, Road/ Access Track	Moderate (3 to 5 yr.)	
VDJE-015	-23.2146, 118.8657	4/08/2021	Hillcrest and Hillslope	Hillslope	North/ East	Moderate	Clay Loam	Scarce	Limited Outcropping, BIF	Gravel (1-4cm)	None Discernible	Scattered Eucalypts, Spinifex Hummock Grassland	Nil	Nil	Road/ Access Track	Moderate (3 to 5 yr.)	
VDJE-017	-23.2161, 118.8622	4/08/2021	Gorge/ Gully	Gully	North/ East	Steep	Clay Loam	Scarce	Extensive Outcropping, BIF	Small Rocks (11-20cm)	Few Small Patches	Scattered Eucalypts, Spinifex Hummock Grassland	Moderate	Nil	Road/ Access Track, Mining Exploration	Moderate (3 to 5 yr.)	
VDJE-018	-23.214, 118.8634	5/08/2021	Gorge/ Gully	Gully	North	Steep	Clay Loam	Scarce	Extensive Outcropping, BIF	Gravel (1-4cm)	Few Small Patches	Scattered Eucalypts, Spinifex Hummock Grassland	Moderate	Nil	Road/ Access Track, Mining Exploration	Moderate (3 to 5 yr.)	
VDJE-013	-23.2166, 118.8601	4/08/2021	Hillcrest and Hillslope	Hillcrest/ Upper Hillslope	North	Steep	Clay Loam	None Discernible	Major Outcropping, Basalt	Gravel (1-4cm)	None Discernible	Spinifex Hummock Grassland, Scattered Eucalypts	Low	Nil	None Discernible	Moderate (3 to 5 yr.)	

Site ID	Coord.	Date	Habitat Type	Landform	Aspect	Slope	Soil Type	Soil Avail.	Outcropping Rock Type	Rock Size	Veg. Litter	Dominant Veg. Type	Rocky Cracks / Crevices	Burrowing Suitability	Disturbances	Last Fire	Photo
VDJE-020	-23.2111, 118.8433	5/08/2021	Footslope and Plain	Stony Plain	Flat	Low	Clay Loam	Scarce	Negligible	Gravel (1-4cm)	Scarce	Scattered Eucalypts, Spinifex Hummock Grassland	Nil	Nil	Road/ Access Track	Recent (0 to 2 yr.)	
VDJE-019	-23.213, 118.8785	5/08/2021	Hillcrest and Hillslope	Hillcrest/ Upper Hillslope	North/ West	Moderate	Clay Loam	Scarce	Major Outcropping, Basalt	Gravel (1-4cm)	None Discernible	Scattered Eucalypts, Spinifex Hummock Grassland	Low	Nil	Mining Exploration, Road/ Access Track	Moderate (3 to 5 yr.)	
VDJE-021	-23.2134, 118.8757	5/08/2021	Hillcrest and Hillslope	Hillslope	North/ West	Moderate	Clay Loam	Scarce	Negligible	Gravel (1-4cm)	Scarce	Scattered Eucalypts, Spinifex Hummock Grassland	Nil	Nil	Road/ Access Track	Moderate (3 to 5 yr.)	
VDJE-022	-23.2044, 118.8728	5/08/2021	Mixed Acacia Woodland	Stony Plain	Flat	Flat	Clay Loam	Few Large Patches	Negligible	Gravel (1-4cm)	Many Small Patches	Mulga Woodland, Spinifex Hummock Grassland	Nil	Low	Road/ Access Track, Mining Exploration	Old (6+ yr.)	
VDJE-023	-23.2099, 118.8488	5/08/2021	Footslope and Plain	Stony Plain	Flat	Flat	Clay Loam	Few Small Patches	Negligible	Gravel (1-4cm)	Few Small Patches	Acacia Shrubland, Spinifex Hummock Grassland	Nil	Low	Road/ Access Track, Mining Exploration	Moderate (3 to 5 yr.)	

Site ID	Coord.	Date	Habitat Type	Landform	Aspect	Slope	Soil Type	Soil Avail.	Outcropping Rock Type	Rock Size	Veg. Litter	Dominant Veg. Type	Rocky Cracks / Crevices	Burrowing Suitability	Disturbances	Last Fire	Photo
VDJE-024	-23.2069, 118.8516	5/08/2021	Footslope and Plain	Stony Plain	Flat	Flat	Clay Loam	Few Small Patches	Negligible	Gravel (1-4cm)	Few Small Patches	Acacia Shrubland, Scattered Eucalypts, Spinifex Hummock Grassland	Nil	Low	Road/ Access Track, Mining Exploration	Moderate (3 to 5 yr.)	

Appendix E: Vertebrate Fauna Recorded During the Current Survey

Species	Common Name	Conservation Status[1]		
		EPBC Act	BC Act	DBCA
MAMMALS				
CANIDAE				
Canis familiaris	dog			
EMBALLONURIDAE				
Taphozous georgianus	common sheath-tailed bat			
Taphozous hilli	Hill's sheath-tailed bat			
MACROPODIDAE				
Osphranter robustus	euro			
Osphranter rufus	red kangaroo			
Petrogale rothschildi	Rothschild's rock-wallaby			
MOLOSSIDAE				
Austronomus australis	White-striped free-tailed bat			
Chaerephon jobensis	greater northern free-tailed bat			
MURIDAE				
Pseudomys chapmani	western pebble-mound mouse			P4
VESPERTILIONIDAE				
Chalinolobus gouldii	Gould's wattled bat			
Scotorepens greyii	little broad-nosed bat			
Vespadelus finlaysoni	Finlayson's cave-bat			
BIRDS				
ARTAMIDAE				
Artamus cinereus	black-faced woodswallow			
Artamus minor	little woodswallow			
Artamus personatus	Masked woodswallow			
CACATUIDAE				
Nymphicus hollandicus	cockatiel			
COLUMBIDAE				
Geopelia cuneata	diamond dove			
Ocyphaps lophotes plumifera	crested pigeon			
CORVIDAE				
Corvus bennetti	Little crow			
CUCULIDAE				
Centropus phasianinus	pheasant coucal			
ESTRILDIDAE				
Emblema pictum	painted finch			
Taeniopygia guttata	zebra finch			

Species	Common Name	Conservation Status[1]		
		EPBC Act	BC Act	DBCA
MELIPHAGIDAE				
Gavicalis virescens	singing honeyeater			
Manorina flavigula	Yellow-throated miner			
PETROICIDAE				
Melanodryas cucullata	hooded robin			
PTILONORHYNCHIDAE				
Ptilonorhynchus maculatus guttatus	western bowerbird			
PSITTACIDAE				
Melopsittacus undulatus	budgerigar			
Platycercus zonarius	Australian ringneck			
RHIPIDURIDAE				
Rhipidura leucophrys	willie wagtail			
REPTILES				
AGAMIDAE				
Ctenophorus caudicinctus	western ring-tailed dragon			
SCINCIDAE				
Carlia munda				
Cryptoblepharus ustulatus				
Ctenotus inornatus				

Appendix F: Significant Vertebrate Fauna Species Recorded During the Field Survey

Site	Zone	Easting	Northing	Date	Species	Common Name	EPBC Act	BC Act	DBCA	Abundance	Record Type	Comments	Photo
Opportunistic	50	680716	7428607	2/08/2021	*Pseudomys chapmani*	western pebble-mound mouse			P4	1	Burrow/Mound	Inactive	
Opportunistic	50	680762	7428582	2/08/2021	*Pseudomys chapmani*	western pebble-mound mouse			P4	1	Burrow/Mound	Recently inactive	
Opportunistic	50	680826	7428730	2/08/2021	*Pseudomys chapmani*	western pebble-mound mouse			P4	1	Burrow/Mound	Recently inactive	

Site	Zone	Easting	Northing	Date	Species	Common Name	EPBC Act	BC Act	DBCA	Abundance	Record Type	Comments	Photo
Opportunistic	50	680985	7428515	2/08/2021	*Pseudomys chapmani*	western pebble-mound mouse			P4	1	Burrow/Mound	Inactive	
Opportunistic	50	680854	7428304	2/08/2021	*Pseudomys chapmani*	western pebble-mound mouse			P4	1	Burrow/Mound	Recently inactive	
Opportunistic	50	680661	7428473	2/08/2021	*Pseudomys chapmani*	western pebble-mound mouse			P4	1	Burrow/Mound	Active	
Opportunistic	50	680678	7428287	2/08/2021	*Pseudomys chapmani*	western pebble-mound mouse			P4	1	Burrow/Mound	Recently inactive	

Site	Zone	Easting	Northing	Date	Species	Common Name	EPBC Act	BC Act	DBCA	Abundance	Record Type	Comments	Photo
Opportunistic	50	680796	7428259	2/08/2021	*Pseudomys chapmani*	western pebble-mound mouse			P4	1	Burrow/Mound	Recently inactive	
Opportunistic	50	680847	7428447	2/08/2021	*Pseudomys chapmani*	western pebble-mound mouse			P4	1	Burrow/Mound	Active	
Opportunistic	50	680922	7428519	2/08/2021	*Pseudomys chapmani*	western pebble-mound mouse			P4	1	Burrow/Mound	Inactive	
Opportunistic	50	680963	7428593	2/08/2021	*Pseudomys chapmani*	western pebble-mound mouse			P4	1	Burrow/Mound	Active	

Site	Zone	Easting	Northing	Date	Species	Common Name	EPBC Act	BC Act	DBCA	Abundance	Record Type	Comments	Photo
Opportunistic	50	680948	7428636	2/08/2021	*Pseudomys chapmani*	western pebble-mound mouse			P4	1	Burrow/Mound	Recently inactive	
Opportunistic	50	680799	7428702	2/08/2021	*Pseudomys chapmani*	western pebble-mound mouse			P4	1	Burrow/Mound	Recently inactive	
Opportunistic	50	680769	7428764	2/08/2021	*Pseudomys chapmani*	western pebble-mound mouse			P4	1	Burrow/Mound	Inactive	
Opportunistic	50	680750	7428341	2/08/2021	*Pseudomys chapmani*	western pebble-mound mouse			P4	1	Burrow/Mound	Recently inactive	

Site	Zone	Easting	Northing	Date	Species	Common Name	EPBC Act	BC Act	DBCA	Abundance	Record Type	Comments	Photo
Opportunistic	50	680781	7428382	2/08/2021	*Pseudomys chapmani*	western pebble-mound mouse			P4	1	Burrow/Mound	Recently inactive	
Opportunistic	50	680814	7428478	2/08/2021	*Pseudomys chapmani*	western pebble-mound mouse			P4	1	Burrow/Mound	Inactive	
Opportunistic	50	680811	7428630	2/08/2021	*Pseudomys chapmani*	western pebble-mound mouse			P4	1	Burrow/Mound	Inactive	
Opportunistic	50	692507	7432601	3/08/2021	*Pseudomys chapmani*	western pebble-mound mouse			P4	1	Burrow/Mound	Active	No Photo Available
Opportunistic	50	692579	7432586	3/08/2021	*Pseudomys chapmani*	western pebble-mound mouse			P4	1	Burrow/Mound	Active	

Site	Zone	Easting	Northing	Date	Species	Common Name	EPBC Act	BC Act	DBCA	Abundance	Record Type	Comments	Photo
Opportunistic	50	692460	7432471	3/08/2021	*Pseudomys chapmani*	western pebble-mound mouse			P4	1	Burrow/Mound	Recently inactive	
Opportunistic	50	692054	7432748	3/08/2021	*Pseudomys chapmani*	western pebble-mound mouse			P4	1	Burrow/Mound	Inactive	
Opportunistic	50	691862	7432704	3/08/2021	*Pseudomys chapmani*	western pebble-mound mouse			P4	1	Burrow/Mound	Recently inactive	
Opportunistic	50	691866	7432518	3/08/2021	*Pseudomys chapmani*	western pebble-mound mouse			P4	1	Burrow/Mound	Recently inactive	

Site	Zone	Easting	Northing	Date	Species	Common Name	EPBC Act	BC Act	DBCA	Abundance	Record Type	Comments	Photo
Opportunistic	50	691963	7432382	3/08/2021	*Pseudomys chapmani*	western pebble-mound mouse			P4	1	Burrow/Mound	Inactive	
Opportunistic	50	680750	7428839	2/08/2021	*Pseudomys chapmani*	western pebble-mound mouse			P4	1	Burrow/Mound	Recently inactive	No Photo Available
Opportunistic	50	680743	7428356	2/08/2021	*Pseudomys chapmani*	western pebble-mound mouse			P4	1	Burrow/Mound	Inactive	No Photo Available
Opportunistic	50	689450	7432147	3/08/2021	*Pseudomys chapmani*	western pebble-mound mouse			P4	1	Burrow/Mound	Recently inactive	No Photo Available
Opportunistic	50	688781	7431892	5/08/2021	*Pseudomys chapmani*	western pebble-mound mouse			P4	1	Burrow/Mound	Recently inactive	
Opportunistic	50	688713	7431894	5/08/2021	*Pseudomys chapmani*	western pebble-mound mouse			P4	1	Burrow/Mound	Inactive	

Site	Zone	Easting	Northing	Date	Species	Common Name	EPBC Act	BC Act	DBCA	Abundance	Record Type	Comments	Photo
Opportunistic	50	688745	7431993	5/08/2021	*Pseudomys chapmani*	western pebble-mound mouse			P4	1	Burrow/Mound	Inactive	
Opportunistic	50	688499	7432095	5/08/2021	*Pseudomys chapmani*	western pebble-mound mouse			P4	1	Burrow/Mound	Inactive	
Opportunistic	50	688477	7432189	5/08/2021	*Pseudomys chapmani*	western pebble-mound mouse			P4	1	Burrow/Mound	Recently inactive	

Site	Zone	Easting	Northing	Date	Species	Common Name	EPBC Act	BC Act	DBCA	Abundance	Record Type	Comments	Photo
Opportunistic	50	692377	7431966	6/08/2021	*Pseudomys chapmani*	western pebble-mound mouse			P4	1	Burrow/Mound	Recently inactive	
Opportunistic	50	690701	7431727	6/08/2021	*Pseudomys chapmani*	western pebble-mound mouse			P4	1	Burrow/Mound	Inactive	
Opportunistic	50	689865	7431583	6/08/2021	*Pseudomys chapmani*	western pebble-mound mouse			P4	1	Burrow/Mound	Recently inactive	

Site	Zone	Easting	Northing	Date	Species	Common Name	EPBC Act	BC Act	DBCA	Abundance	Record Type	Comments	Photo
Opportunistic	50	689842	7431727	6/08/2021	*Pseudomys chapmani*	western pebble-mound mouse			P4	1	Burrow/Mound	Inactive	

D.5: West Angelas: Baseline Groundwater Dependent Ecosystem Assessment for the Greater West Angelas Areas

BASELINE GROUNDWATER DEPENDENT ECOSYSTEM ASSESSMENT FOR THE GREATER WEST ANGELAS AREA

Prepared for:

Rio Tinto
Central Park
152-158 St Georges Terrance
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360 Ref: 4985
Version No: Rev 3
October 2022

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BASIS OF REPORT

This report has been prepared by 360 Environmental Pty Ltd (360) part of SLR Consulting Australia Pty Ltd (SLR) with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with Rio Tinto (the Client). Information reported herein is based on the interpretation of data collected, which has been accepted in good faith as being accurate and valid.

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360 disclaims any responsibility to the Client and others in respect of any matters outside the agreed scope of the work.

DOCUMENT CONTROL

Reference	Date	Prepared	Checked	Authorised
4985AA_Rev0	20 October 2022	D. White	S. Walker	
4985AA_Rev0	22/02/2022	D. White	S. Walker	
4985AA_Rev1	01/03/2022	360 Environmental	Rio Tinto	
4985AA_Rev2	20/04/2022	360 Environmental	Rio Tinto	
4985AA_Rev2	20/04/2022	360 Environmental	Rio Tinto	

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Appendix D: Figures

1 Introduction

The West Angelas iron ore mine is located just south (23.18°S and 118.76° E) of the West Angelas airport, approximately 100 km southeast of the town of Tom Price and adjoining the eastern margin of Karijini National Park. The mine has been operational since 2002, and an expansion of operations is proposed that will develop resources at Western Hill, Deposit F, Deposit J, Deposit H and Mt Ella East (Figure 1).

The average annual rainfall (1950 to 2020) in this area is 330 mm while average annual Priestley-Taylor potential evaporation (Priestley, C., and Taylor, 1972) is 2640 mm. Average monthly potential evaporation exceeds rainfall in every month of the year. In this environment, persistent open forest or woodlands that includes any or all of *Melaleuca argentea*, *Eucalyptus camaldulensis* and *E. victrix* indicate that the vegetation probably has access to a source of water additional to incident rainfall. Sources of additional water include regional aquifers, small local aquifers, perched ephemeral aquifers and inflow stored in alluvium or clay soils.

Vegetation that depends on regional or local groundwater, or on inflow of surface water, may be vulnerable to changes in local hydrology that disrupt the supply of additional water. Such features should be identified, along with the source of water on which they depend, so that their vulnerability to changes in local hydrology due to mining can be assessed and managed.

In this report, potential GDE features in the West Angelas study area are identified based on desktop data sources and analysis of remotely sensed vegetation indices. The likelihood that these features are dependent on groundwater (negligible, low, moderate, high, very high) is assessed based on the presence, abundance, and condition of keystone tree species and relevant understory floristics (biological evidence) and on the inferred depth to groundwater (simple hydrological evidence) and other local h. The likely source of potential groundwater is interpreted from hydrological data and local hydrogeological knowledge as a basis for an assessment of the likelihood that development might influence the assessed features. Finally, the biological significance of any features with a low to moderate or greater likelihood of groundwater dependence is rated.

1.1 Objectives

1. Identify all potential GDE features of relevance across the study area, focusing on the presence of persistent vegetation features (as well as other characteristics) with a NDVI in excess than 0.32 more than 60% of the time.

2. Using multiple lines of biological evidence and basic hydrologic evidence, allocate these features to one of five classes of “likelihood of groundwater dependence”.

3. For each feature with a low to moderate or greater likelihood of groundwater dependence, rate the biological significance of each feature using a matrix of three tiers and three sub-classes within each tier where significance is based on the multiple factors including the structure and composition of the vegetation and the presence of surface water.

1.2 Theoretical basis for the proposed methodology

1.2.1 The link between hydrology and the composition and function of vegetation in the Pilbara

Ecosystem composition and function in the Pilbara are strongly determined by the spatial and temporal pattern of water availability, which is highly variable. In the very hot and arid environment in the West Angelas area (see climate description in section 2), persistent open forest or woodland in riparian settings is typically an indication that the trees can access water additional to incident rainfall (Eamus & Froend, 2006).

The likely level of dependence of persistent vegetation on groundwater can be inferred from several pieces of evidence. Perhaps most relevant is the presence and abundance of known obligate or facultative phreatophytes (Eamus & Froend, 2006; Murray, B. R., Hose, G. C., Eamus, D., & Licari, D., 2006), where:

- Obligate phreatophytes are species confined to habitats with access to groundwater via the capillary fringe
- Facultative phreatophytes are species that tend to utilize groundwater to satisfy a proportion of their ecological water requirement when it is available.

For very large areas such as the West Angelas development envelope, comprehensive riparian vegetation surveys are time consuming. It has need demonstrated that possible groundwater dependent ecosystems may be identified based on the persistence of remotely sensed vegetation indices that are indicative of a minimum stable 'greenness' and 'wetness' (Barron, Emelyanova, Van Niel, Pollock, & Hodgson, 2014).

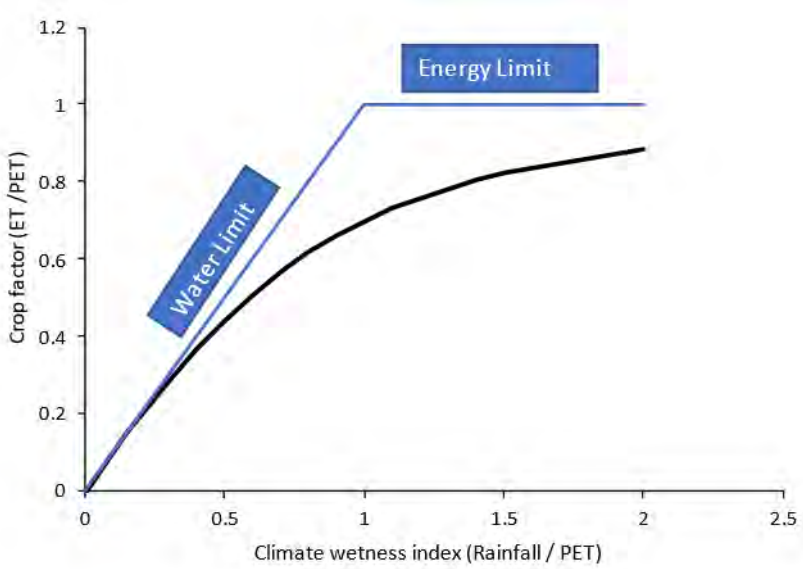
1.2.2 Applying equilibrium and ecological optimality hypotheses to identify possible groundwater dependent ecosystems

The annual water use of vegetation in equilibrium with rainfall can be estimated as a function of indices of cover or from climatic variables such as rainfall or the climate wetness index (ratio of rainfall to potential evaporation). In Australia, the importance of rainfall as a determinant of vegetation cover has long been recognised and was first formalised by Specht, (1972). This concept was developed further by Eagleson, P.S., (1982) as 'ecological optimality'. Relationships between vegetation (cover) and climate indices have been exploited to identify vegetation with access to sources of water in addition to incident rainfall in the context of the management of dryland salinity (T Hatton & Evans, 1998; Tom Hatton, Reece, Taylor, & McEwan, 1998), to quantify the effect of commercial plantations on water resources (Benyon, Theiveyanathan, & Doody, 2006; O'Grady, Carter, & Bruce, 2011) and to identify potential ground water dependent ecosystems (Barron et al., 2014; Doody et al., 2017). The development of remote sensing approaches to quantify the density and vigour of vegetation cover has led to the development and application of 'vegetation indices' that are correlated with water use and productivity. The efficacy of remotely sensed vegetation indices is founded on two fundamental biophysical principles of vegetation growth and water use.

1.2.2.1 Water use is fundamentally limited by available water and energy

The water use of vegetation is limited by available water and available energy. This is summarized in the Budyko framework (Budyko, 1974) and these principles, of energy and water limits, are the basis for equilibrium models of water use by dryland agriculture and forests (Zhang, Dawes, & Walker, 2001).

If the crop factor (ratio of evapotranspiration to potential evaporation) is plotted as a function of the climate wetness index (ratio of rainfall to potential evaporation), then a domain of biophysically possible rates of water use can be identified (Graph 1). For values of the climate wetness index less than one, the water use of vegetation is rainfall limited and evapotranspiration approximates rainfall. In a study of planted forest with access to groundwater, O'Grady et al., (2011) demonstrated that measured annual groundwater use was equal to the difference between the actual crop factor and the theoretical rainfall limited water use. This means that evapotranspiration estimated from remotely sensed reflectance (McVicar et al., 2007), might be used to quantify groundwater use if the relationship between the crop factor and the climate wetness index has been defined for the vegetation of interest. Broad relationships for tall and short vegetation have been defined by Zhang et al., (2004) and a curve fitted to global data for forests is shown in Graph 1.



Graph 1 The Budyko framework showing the energy and water limits and a fitted relationship for global forests from Zhang et al., (2004). In the Pilbara the climate wetness index is between 0.1 and 0.2 so we would expect vegetation water use to approach the water limit or annual rainfall. Rates of water use that exceed the water limit are indicative of alternative sources of water and are indicated by persistent values of leaf area index more than equilibrium values.

1.2.2.2 Growth and water use are correlated with radiation interception

Growth and water use of vegetation is strongly correlated with radiation absorption which may in turn be estimated as a function of leaf area index (Linder, 1985). Where the climate wetness index is less than about 0.5 then the correlation between leaf area index and water use is approximately linear (Larsen & Kershaw Jr, 1996; Saeki, 1960). While the general relationship amongst cover, climate and water use are very useful they are an oversimplification; the availability of nitrogen and phosphorus may also be important limits on cover and water use, particularly in more mesic environments (Battaglia, Cherry, Beadle, Sands, & Hingston, 1998; White et al., 2010). Nonetheless, as a first order approximation, elevated vegetation cover is a good indicator of vegetation out of equilibrium with incident rainfall. This fundamental relationship between radiation absorption and water use is exploited in the application of remotely sensed vegetation indices to indicate enhanced vegetation persistence.

2 Environment

2.1 Regional Setting

Water from the area that includes the five mineral deposits of Western Hills, Deposit F, Deposit H, Deposit J and Mt Ella East, flows into three regional catchments, Turee Creek East, Angelo River, and Weeli Wolli Creek, as shown in (Figure 2).

West Angelas is surrounded by steep ranges with multiple short drainage lines conveying flow to broad, flat valley plains. Owing to the flat gradient throughout the lower parts of the catchment, the main channel of Turee Creek East, which flows to the south of Western Hill and the southwest of Deposit H, is a relatively low energy creek system. At the far eastern extent of West Angelas there is a poorly defined catchment divide, with parts of Deposit F and Deposit H flowing east to Weeli Wolli Creek which drains to the Fortescue Marshes to the north.

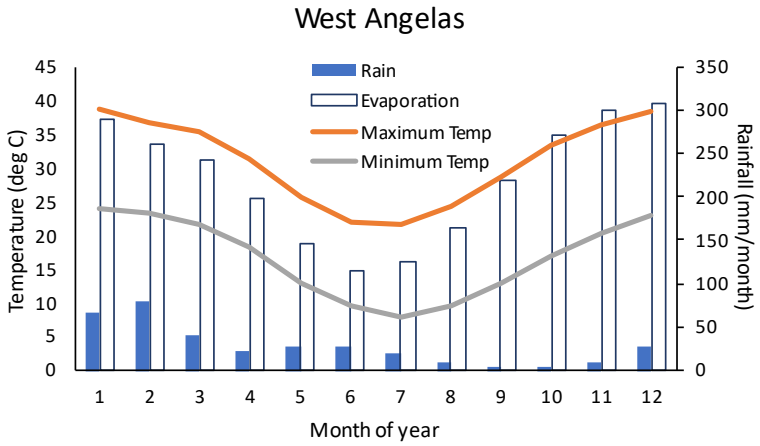
To the south of West Angelas, the Angelo River catchment hosts Deposit J. Steep ranges surround the northern section of this catchment, with multiple small tributaries discharging to flat terrain occupied by mulga communities through a central basin area. On the slopes the tributaries are incised and high-energy, however as they enter the plains the channel form is lost in detrital deposits and colluvium. Overland flow is the primary mechanism of drainage, and it is likely that connectivity across the plain to the south of Deposit J is poor, with significant infiltration losses occurring between the ranges and the outlet of the area in the south.

2.2 Climate

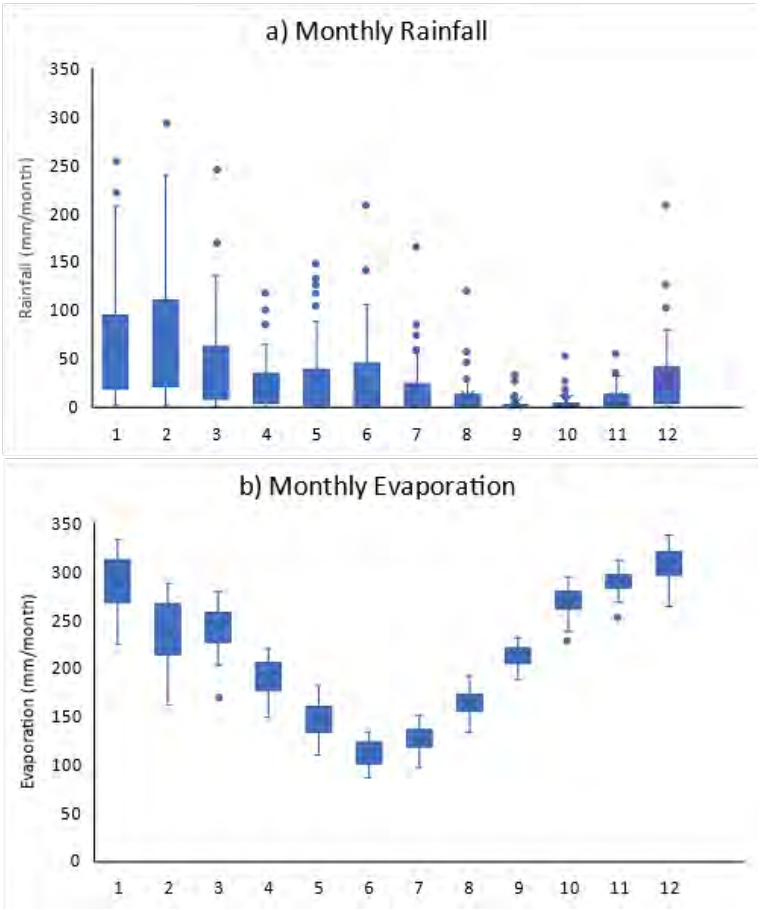
Under the Köppen climate classification scheme (http://www.bom.gov.au/) the West Angelas area is described as grassland, hot and persistently dry. Using a seasonal rainfall classification, the broader Pilbara region is considered “arid” with average rainfall generally less than 350 mm. Rainfall is highly seasonal, with more than 85% of this rain falling in the wet season between October and May (Graph 2).

Rainfall records are available from weather stations within or near the Weeli Wolli catchment. The data sequences from these stations are short and for the purposes of describing the climate we downloaded Silo data (Jeffrey, Carter, Moodie, & Beswick, 2001) from January 1900 to November 2021 for the West Angelas location (23.15 S, 118.75 E). During this period, average annual rainfall at West Angelas was 270 mm and average annual evaporation was 2646 mm (calculated after Priestley, C., and Taylor, (1972) using a coefficient for forests of 1.26). Evaporation and radiation are in phase with rainfall, but evaporation exceeds rainfall by between 90 and 290 mm per month during the year. This deficit creates the possibility of severe water stress for plants at any time of year unless rainfall is supplemented by additional sources of water such as inflow, local or regional groundwater. Since 1990 this effect has been at least partly offset by annual rainfall about 10% greater than the long-term average.

For vegetation the highly variable nature of this rainfall is just as important as the long-term average monthly rainfall. Box and whisker plots show large variation in monthly rainfall, particularly in the wet months of January and February. While the long-term average rainfall for both months is approximately 50 mm, months with more than 100 mm occur in more than 25% of all years (Graph 3). The storage of rainfall during these wet months, in alluvium, clay or in groundwater/aquifers is essential for the persistence of woody vegetation in this environment.



Graph 2 **Average monthly rainfall throughout the year and calculated between 1900 and 2021. The data were downloaded from the SILO interpolated data set (Jeffrey et al., 2001).**



Graph 3 **Box and whisker plots for monthly rainfall between January and December and calculated using measurements from 1900 to 2021. The mean (x), median, 5th, 25th, 75th and 95th percentile values are shown for each calendar month as well as any outliers. The data were downloaded from the SILO interpolated data set (Jeffrey et al., 2001).**

2.3 Topography and Hydrogeology

Groundwater in the West Angelas area can be partitioned into three categories based on the nature and extent of the system:

1. Regional to local scale deep aquifers – unconfined aquifers in highly permeable geologies.
2. Local, (relatively small scale) shallow surficial aquifers – typically represented by shallow, unconsolidated alluvial aquifers commonly expressed along waterways.
3. Other perched groundwater - small typically perched aquifers (including alluvial aquifers), very small, fractured rock aquifers and partially saturated or slow drying alluvial formations. These often form within the subsurface of impervious rock basements or atop clay lenses with unconsolidated alluvial formations. Generally, highly seasonal, and dependent on regular surface inflows and therefore have high seasonal variability.

For the purposes of this assessment, aquifers are grouped as 1) Large scale, 2) Small scale and 3) Perched as defined above.

The water from the zones of hydrologic influence of the proposed developments flow mostly into the Turee Creek catchment (Figures 1 and 2). Some water from both Deposit F and Deposit H, Deposit F and Mt Ella East flows east to the Weeli Wolli catchment while water from the southern part of Deposit J flows south into the Angelo River catchment and in flood condition this flow reaches extensive mulga (*Acacia* spp.) woodlands.

The area is characterized by ranges which rise above broad flat valleys which are underlain by an extensive regional aquifer (Figure 1).

The deposits that will be developed beyond 2021 sit in ranges to the North, South, and East of Turee Creek which flows from the divide at Deposit H to the West and South of Western Hill and to the North of Deposit F and Deposit J. The immediate zone of direct hydrological influence of these deposits sits above the regional groundwater system but of course the area contributes water to this system.

The capacity of vegetation to use water from the capillary fringe above this aquifer is affected both by the depth below ground (see section 3.4 for details) and by the predominant geology in the area. Hammersley formation extends from the north to the northern parts of Western Hill and Deposit H and is much more permeable, having higher saturated conductivity, then the Fortescue formation to the south (Figure 3). The result is that, provided the aquifer is close enough to the surface, vegetation can use water from the regional, large-scale aquifer in the Hammersley rock type, but this is unlikely further south so that shallow, ephemeral aquifers of local scale and significance will be more important sources.

In general, the structure and composition of creek line vegetation in the Pilbara tends to be driven by the availability of moisture. As such, the structure and composition of vegetation present is often the most reliable indicator of the longer-term availability of moisture, providing valuable insight into groundwater proximity (and consistency of access), surface water permanence and therefore, the potential sensitivity of a riparian ecosystem to fluctuations in water availability. However, for the most part, GDE's reliant on the larger scale local-regional scale groundwater sources are of most relevance to the Environmental Impact Assessment (EIA) process. Despite this, the majority of potential GDE features encountered across the Pilbara are instead reliant on perched small scale groundwater sources. These sources are less likely to be affected by operations than larger aquifers but are also more dynamic and their presence is more difficult to infer from vegetation characteristics.

3 Methods - Assessment of Vegetation Features

3.1 Definition of terms

The rest of the report refers to three main zones in the West Angelas area and to three categorisations of vegetation features. For clarity and for reference these are now defined.

3.1.1 Study Area

This 'study area' is the greater West Angelas area which was searched for persistent vegetation with indicator phreatophyte and mesophyte species. It extends well beyond the Broad Hydrological Development Zone to Karijini National Park in the west and to include parts of the broad valleys south of Mt Ella East and north of Western Hill (Figure 1).

3.1.2 Zone of Hydrological Influence

Each of the five deposits (Western Hill, Deposits F, J and H and Mt Ella East) proposed for development has an associated zone of hydrological evidence. These were defined based on hydrological modelling of drawdown associated with dewatering of pits in each of the five deposits (Figure 1).

3.1.3 Broad Hydrological Development Zone

This zone provides a minimum of a 2.5 km buffer outside the zone of hydrological influence for each of the five deposits (Figure 1).

The study area, zone of hydrological influence and the broad hydrological development zone are shown in Figure 1 and in relation to local river systems in Figure 2 and Hydrogeology in Figure 3.

Within the study area, vegetation features were identified and then classified according to their NDVI persistence, the likelihood of their dependence on groundwater and their biological sensitivity. These terms all have a specific meaning and implications for the potential impact on them of changes to local hydrology.

3.1.4 Vegetation Persistence

Persistent vegetation maintains a level of greenness and cover during the dry season that is indicative of access to a source of water additional to incident rainfall). This was assessed quantitatively as the proportion of time that a feature has an a NDVI greater than 0.32. This threshold level of NDVI with a persistence of 60% was identified by Barron et al., (2014) as potentially groundwater dependent.

3.1.5 Likelihood of groundwater dependence

A feature with a greater 'likelihood of groundwater dependence' is more likely, based on biological or hydrological evidence or both, to depend on this water to survive periods without rain. Any disruption of access to this water is more 'likely' to affect the health, condition, and survival of vegetation with an elevated 'likelihood of groundwater dependence'.

The likelihood of groundwater dependence is based on both biological and hydrological evidence. The biological evidence includes the presence, abundance of obligate and facultative phreatophytes in the overstorey and other mesophyte and halophyte species in both the overstorey and understorey. The structure of the vegetation is also important; a woodland of a facultative phreatophyte species indicates a higher likelihood of groundwater dependence than isolated individuals.

3.1.6 Biological Sensitivity

This term is somewhat analogous to the 'likelihood of dependence' and combines elements of composition and structure to provide an indication of the dependence of the biological features that 'define this ecosystem' on groundwater which is directly indicative of the sensitivity of these defining characteristics to change.

3.2 Summary of methodology

Possible GDV features in the study area (Figure 1) were identified, assessed, and classified in four steps in a methodology adapted by Jeremy Naaykens of Rio Tinto and Biologic, (2021):

1. Within the West Angelas study area, a set of enhanced riparian features were identified and mapped using multiple desktop data sources, including remote sensing analyses to locate features with a NDVI of greater than 0.32 within more than 60% of all available Landsat and Sentinel 2 derived imagery.

2. The likelihood of groundwater dependence was then estimated and attributed to each feature through assessment of the presence and abundance of obligate and facultative phreatophytes and of understorey mesophyte and hydrophyte species. This was done in two stages using a combination of desktop analysis and field visits to a targeted subset of features.
    a. Desktop Analysis. Visual interpretations of satellite images, aerial photographs, historical flora and vegetation surveys and other available spatial datasets were used to allocate the 45 features to 1 of 5 levels of likelihood of groundwater dependence (negligible, low, moderate high and very high) based on the structure of vegetation and the presence and abundance of indicator species (obligate and facultative phreatophytes and mesophytes/hydrophytes).

b. Field visits. Vegetation features identified as potentially having a low to moderate, or higher likelihood of groundwater dependence (of being a GDE), were visited to collect targeted flora and vegetation data, and assessed against the conclusions made from the initial desktop analysis. Some lower risk features were also visited based on position, ease of access and known or potential heritage values.

At the end of step two, features were allocated to one of five classes according to the 'likelihood' of groundwater dependence.

3. In step 3, hydrogeological information was incorporated in two ways.
   a. The 'likelihood of dependence' of each feature on larger scale, regional aquifers was assessed based on the depth of these systems below ground. The features were grouped into one of three classes, likely (groundwater less<15m), possible (15-25 m), or unlikely (>25m) to access the regional, large-scale aquifers.
   b. This simple categorization was refined using local information on geology, stratigraphy, and soils. The two main geological formations (Hammersley and Fortescue) are known to have different porosity and saturated hydraulic conductivity (Hammersley being more porous and conductive). In valleys local, aquifers form in clays and alluvium and ephemeral, perched water tables can form on less permeable layers such as calcrete which is common in the area. These and other local information were used to both modify the likelihood of dependence on the regional systems estimated as step 3a, and to identify possible dependence on more ephemeral and local groundwater systems. Any relevant, local knowledge was used if available.

4. A final groundwater dependence likelihood rating was made for each feature by combining biological (step 2) and hydrological evidence (step 3). This step also considered the size of the feature and any information on local soils, water and vegetation that indicate the source of additional water and the relative 'permanence' or 'accessibility' of this source.

5. Each feature with a low to moderate or greater likelihood of being a GDE was assessed to assign a preliminary biological significance, based on biodiversity principles which leverage characteristics like vegetation structure and cover, as well as the presence and abundance of obligate and facultative phreatophytes and associated understorey mesophyte/hydrophyte composition. Rankings for biological significance range from negligible to very high.

3.3 Step 1: Identification of enhanced and persistent vegetation features (NDVI persistence) as proxies for potential GDE's.

3.3.1 Baseline vegetation surveys

In 2018, Rio Tinto conducted a baseline vegetation survey of the West Angelas envelope that integrated information from multiple historical surveys. In this process, several features, particularly associated with Turee Creek, were identified in which *E. camaldulensis* and *E. victrix* were either a dominant or co-dominant, (or at least a key associated species) overstorey species. This baseline survey work identified these riparian communities as potential GDE's (based purely on the presence of facultative phreatophytes) and as such they need to be considered as part of this assessment. These features are identified separately in the results (Section 4) and in the tabulation of all features in Appendix B.

3.3.2 Elevated Vegetation Persistence from remotely sensed NDVI

The persistence of riparian vegetation cover, and the presence of obligate or facultative phreatophytes are the primary biological indicators of a GDE. Secondary to that; the presence/absence of known understory mesophytes and hydrophytes are useful additional lines of evidence to add detail to the primary biological indicators. To ensure all possible GDEs were captured, a conservative and established methodology was used to first identify all enhanced and persistent vegetation features within the study (Figure 1). To identify these features NDVI persistence was used as a primary indicator of enhanced cover/stability and water status (see section 1.3). Live green vegetation absorbs solar radiation in key bands of the visible spectrum, whilst reflecting light in the near-infrared spectrum (Bureau of Meteorology, 2022). This pattern of light absorption is unique to living vegetation and NDVI is an index that quantifies this as

$$NDVI = \frac{rNIR - rRed}{rNIR + rRed} \qquad \text{Equation 1}$$

where, r*RED* is red reflectance and r*NIR* is reflectance of the near infra-red wavelengths. This gives an index between -1 and +1. In Australia, NDVI of vegetation ranges from 0.1 up to 0.7, with higher values associated with greater density and greenness of the plant canopy often associated with surface water (Petus, Lewis, & White, 2013). NDVI decreases as leaves come under water stress, become diseased or die. Bare soil values are close to zero, while water bodies have negative values. An NDVI value of between 0.2 and 0.4 is generally accepted as indicative of healthy growing vegetation in semi-arid environments (Barron et al., 2014).

Consistently high NDVI values throughout the year and interannually in seasonally dry environments can indicate communities that have access to water sources other than those arising directly from rainfall, such as groundwater (via the capillary fringe) or through flows fed by groundwater discharge. Persistence mapping indicates the number of images in a time interval for which a ground pixel returns a value equal to or greater than a threshold. NDVI Persistence was calculated as the number of values of NDVI for a pixel that exceeded a threshold of 0.32 divided by the total number of images analysed. In the first screening for persistence.

$$Persistence\ (\%) = 100\,\frac{n(NDVI>0.32)}{n} \qquad \text{Equation 2}$$

For this analysis both Landsat (1987-2021) and Sentinel 2 (post 2016) images were analysed. The spatial resolution for Landsat is 30 metres (m) while for Sentinel 2 the resolution is 10 m.

Using NDVI persistence, calculated using equation 2, all vegetation features were allocated to one of the following categories taken from (Biologic, 2021):

- **90 – 100 %**: Very High – increased reliance on groundwater (larger scale aquifers / small scale aquifers) highly likely for ecosystem function
- **80 – 89 %**: High – likely reliance on groundwater (larger scale/ small scale aquifers) for ecosystem function
- **70 – 79 %**: Moderate - limited potential reliance on groundwater (small scale aquifers) for ecosystem function
- **60 – 69 %**: Low – very limited potential reliance on groundwater (small scale aquifers) for ecosystem function
- **40 – 59 %**: Very low - mostly Inflow Dependent Ecosystems or upper gullies/ gorges reliant on seasonal surface flows.

The list of persistent features identified was refined, based on aerial photography interpretation, eco-physical setting and the presence, number, and structure of known phreatophytes (as well as mesophytes/hydrophytes) (step 2) and inferred depth to groundwater (step 3).

3.4 Step 2A: Likelihood of groundwater dependence - Desktop assessment of biological evidence

For all features with an NDVI more than 0.32 (anomalous clusters), the composition and structure of the vegetation was interpreted and potentially surveyed using a combination of satellite images and aerial photography.

The canopies of the main local phreatophytes, *E. camaldulensis* and *E. victrix* were generally distinguished from *E. victrix* based on:

1. Darker green canopy colour signature of *E. camaldulensis* (as opposed to quite grey canopies of the alternative species)
2. Denser canopy cover signature of *E. camaldulensis*; within areas of low likelihood for access to water from the larger scale aquifer such as minor upland waterways and drainage lines. Likely to experience elevated levels of shading from nearby landscape features
3. Different branch signature of *E. camaldulensis* canopy architecture
4. Larger (spatial extent) canopy footprint of *E. camaldulensis*.

For the Pilbara, a high-level classification of likely groundwater dependence for riparian features has been used here which allocates a likelihood of dependence rating based on the presence, size distribution, and abundance of known phreatophytes as well as mesophyte/hydrophyte species diversity and this was used to classify all the features identified in step 1. This classification has been adapted from (Biologic, 2021) but incorporates the RTIO developed Riparian ecohydrological riparian assessment framework. This riparian assessment framework is provided in Appendix A and the main characteristics of each level of likelihood are summarised below

1. **Very High Level:** Indicators of perennial water availability (NDVI Persistence > 90%). Mature and abundant *Melaleuca argentea*Mature and abundant *Sesbania formosa potentially present*
2. Vegetation generally of an open forest of greater density*E. camaldulensis* abundant in most areas and *E. victrix abundant in the fringing zones*
3. Multiple Moderate-high to Very High-level hydrophyte and mesophyte species likely to be present and abundant.
4. **Moderate to High Level:** Perennial to sub-perennial water available (NDVI Persistence 80 to 90%)cattered *Melaleuca argentea* (less prevalent in more moderately dependent systems, scattered but potentially mature in High dependence systems)Woodland to Open Forest of *E. camaldulensisE. victrix* usually present but less abundant in core riparian zone
5. **Moderate Level:** Water availability sub-perennial (periods without water annually) NDVI Persistence 70 to 80%. In a position likely to have some level of access to the larger scale aquifer or larger small-scale aquifers (such as large waterways or gullies low in the landscape) and possible shading. Woodland to Open Woodland of *E. camaldulensis (at times less abundant)* Woodland of *E. victrix* Potentially populations of *Acacia coriacea subsp. pendens, Eucalyptus xerothermica, Atalaya hemiglauca, Terminalia circumalata* also present and relatively abundant
6. **Low Level:** Ephemeral water availability. Disparate presence of possible facultative phreatophytes with NDVI persistence values 60 to 70%. Typically, within areas of low likelihood for access to water from the larger scale aquifer such as minor upland waterways and drainage lines. Likely to experience elevated levels of shading from nearby landscape features. Woodland of *E. xerothermica* Scattered to open woodland of *E. victrix*
7. **Negligible:** Slightly elevated NDVI persistence (>0.5, <60%) although within landscape positions unlikely to have access to small scale aquifers or larger scale aquifers areas (potential perched groundwater access) with high shading or broadly contains only hummock/tussock grasses and shrubs and scattered non-phreatophytic tree species with no obvious phreatophytic vegetation.

This means for example, that to be rated as having very high dependence on groundwater a vegetation feature must have an NDVI persistence of greater than 90% (Step 1) and include at least *E. camaldulensis* with a co-dominant population of mature obligate phreatophyte species.

3.5 Step 2B: Likelihood of Groundwater dependence – Targeted Field work and further assessment of biological evidence

Any features that were identified as potentially displaying moderate groundwater dependence, or more likely to be a GDE or receive scrutiny based on the current development envelope, were visited to collect targeted flora and vegetation data, and receive visual assessment. Some features that exhibited less than a 'moderate' GDE likelihood rating was also visited based on position, ease of access and known or potential heritage values. In some cases, field data considered as part of this step represents specific data/conclusions from field work completed as part of baseline flora and vegetation surveys in 2018 or between March and November of 2021. These field visits were used to confirm the remote identification of species and assessment of cover and degree of vegetation enhancement, as well as provide more detailed and nuanced flora and vegetation data of relevance to this assessment process. Where the field visit indicated a different composition or structure then the previous desktop assessment, the likelihood of groundwater dependence was revised using the categories in section 3.3

3.6 Step 3: Likelihood of groundwater dependence – Hydrological evidence

The elevation of all features within or near to known monitored larger scale aquifers in the hydrological development zone were recorded using LiDAR of feature midpoints (supplied by Rio Tinto). Site elevation was then assessed against pre-mine (where available) groundwater levels in known/ monitored larger scale aquifers by overlaying groundwater contours from the larger scale aquifer and subtracting LiDAR derived elevation from modelled groundwater depth. However, where features were of considerable distance from the nearest groundwater depth contour or bore, groundwater levels were considered unreliable and applied cautiously. These are indicated in Appendix B with ~.

After calculating/extrapolating likely depth to groundwater for each riparian feature, the feature in question was allocated to one of three categories of likelihood of access to groundwater.

1. **Depth to Groundwater typically <15m (or negative)** – Access Likely. This figure was based on the work of derived from in vitro assessment of rooting depth of *Eucalyptus camaldulensis* in a dryland environment of up to 12 m below the surface (Nolan et al., 2018) and allowing for error in the calculation of ground and groundwater elevation.
2. **Depth to Groundwater typically 15-25m (or negative)** – Access possible. While groundwater greater than 15 m is too deep to be important water sources for *Eucalyptus camaldulensis*. larger individuals can access deeper groundwater. For example (Kath, Boulton, Harrison, & Dyer, 2018) identified a drawdown threshold for *E. camaldulensis* as 22.6 m. Again, allowing some margin for uncertainty, *E. camaldulensis* can access groundwater up to 25 m below the surface.
3. **Depth to Groundwater typically >25m** – Access unlikely.

Following allocation of each feature to one of the above, notes were made about the confidence of the groundwater access interpretation as well any relevant characteristics of each feature/setting combination to interpret or highlight any barriers or constraints to groundwater access (e.g. Hydraulic conductivity, basement proximity, lithology) where relevant.

Potential GDE features high in the landscape are highly unlikely to be accessing the larger scale aquifers and are more likely to be reliant on small scale/ perched aquifers and/ or are inflow dependent. Outside of allocation to the above access determinations, where relevant, the hydrological component of the assessment will also indicate the likelihood that perched aquifers and other water sources are contributing to the features in question.

3.7 Step 4: Final GW dependence likelihood ratings

Following determination of the final biological groundwater dependence likelihood (Step 2; i.e. combination of desktop and on-ground biological evidence), the last step in determining the overall groundwater dependence likelihood rating is to consider the combined biological evidence in relation to the basic hydrological evidence.

Because the hydrological determinations were, in many cases, subject to large errors, the same process as the above combination with on-ground data (Section 3.4) was followed. As a result, the final biological evidence derived groundwater dependence likelihood rating was considered in relation to the hydrological determination for each feature and a decision was made whether to maintain, increase or decrease the rating based on the hydrological information.

3.8 Step 5: Biological significance rating of GDEs

All features interpreted to possess an elevated potential for groundwater dependence were in turn assessed to assign a preliminary biological significance. The assessment focused on biodiversity principles and considered the significance (both biological and ecological values) and the size of the feature in question to determine the potential consequence if they were significantly impacted by development.

The assessment of significance relies on considering the following:

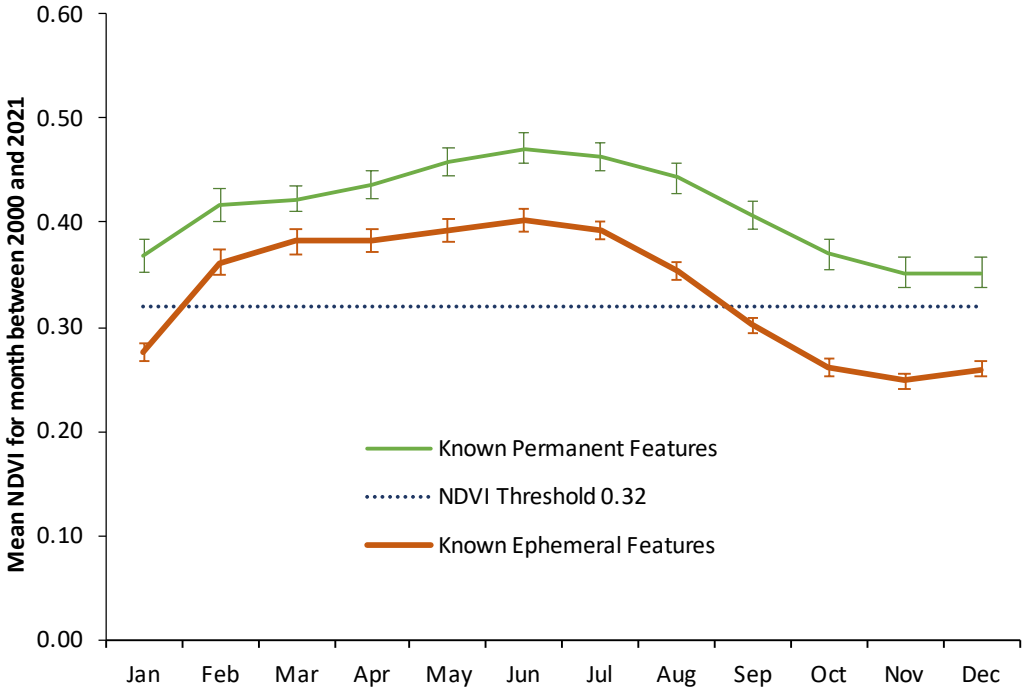
1. Consideration of the overstorey: The presence, structure, and abundance of keystone phreatophytes in the riparian feature (where available), as well as other overstorey components where phreatophytes are relatively absent or are not dominant
2. Consideration of the understorey: The presence, abundance, and diversity of mesophytic/ hydrophytic indicator species (field-based observations) in the feature (Step 2)
3. Following the determination of keystone phreatophyte and mesophyte/ hydrophyte diversity; the likely groundwater dependence and hydrological stability of the feature/habitat is assessed based on the number of taxa and the relevant indicator guilds which the taxa belong to (using the Pilbara riparian ecohydrological assessment framework [Appendix A])
4. The presence and abundance of ‘permanent’, ‘semi-permanent’, ‘persistent ephemeral’, or simply ‘ephemeral’ surface water formations (field-based observations)
5. The size of the feature, as well and the drainage size classification relevant at the location of the feature (i.e. based on the reporting catchment size at that point)
6. Whether the community in question may be representative of any listed PEC’s or TEC’s or whether it supports any priority listed flora species.

This information was used to assign the features into one of three Tiers indicative of the relative scale of biological significance (Tier 1, Tier 2, Tier 3) relevant to riparian features. The Tiers used represent a Pilbara riparian ecotype classification which was developed by the RTIO Biological Assessments division. This classification characterises riparian features based on key ecohydrologically driven vegetation attributes, hydrological/aquatic habitat characteristics as well as degrees of restriction and thus potential rareness of supported combinations of mesophytic/hydrophytic taxa. This classification is summarized in **Table 1**

All features were further assigned to one of three classes within each Tier (A, B, or C). This was done by relating/matching the description of the vegetation and the feature size to the detailed description of the features associated with each combination of Tier and sub-class. Because only a minimal degree of effort has been applied in the process of assigning riparian features in this study to the ecotype classification, the significance ratings produced represent a preliminary rating likely to be slightly refined later, once other characteristics, data and attributes have been considered and the degree of relevance of the feature to the ecotype classification can be considered in more detail.

3.9 Supporting Evidence from Seasonal NDVI Data

While applying steps 1 to 4 as described above, it became evident that the biological evidence mostly (but not exclusively) indicated access to local, ephemeral water sources rather than larger regional aquifers. One method for providing quantitative evidence to test this hypothesis is to estimate NDVI for all the pixels in the feature and to count the number of years from 2000 to 2021 in which NDVI exceeded 0.32 for a given month of the year and to compare the results with curves for previously assessed features where dependence on permanent and ephemeral water sources has been confirmed. Data for 21 known GDEs and 14 known ephemeral systems were provided and are summarised in Graph 4 below. For a feature with reliable access to a regional water source we would expect mean NDVI to exceed 0.32 for all months of the year, perhaps dipping below this value for a month or two late in the dry season. In contrast, ephemera dip below the NDVI threshold after only a month or two of the dry season (Graph 4).



Graph 4 **Box and whisker plots for monthly rainfall between January and December and calculated using measurements from 1900 to 2021. The mean (x), median, 5th, 25th, 75th and 95th percentile values are shown for each calendar month as well as any outliers. The data were downloaded from the SILO interpolated data set (Jeffrey et al., 2001).**

Table 1 **Broad definitions of the three tiers of biological significance (Biologic, 2021).**

Tier	Type and key Characters	Broad Tier Description
Tier 1	• Aquatic GDE. • Typically including permanent groundwater fed pools. • Plus, obligate Terrestrial GDV.	• Moderate to large scale Aquatic Type GDEs. • Includes the associated often high density obligate terrestrial GDV formations. • Generally coinciding consistently with shallow Groundwater (Permanently* 0-4 m below ground level). • Occurs within variable landforms from open plains to valley floors to upland gorge type formations.
Tier 2	• Broadly Obligate Terrestrial GDV / GDEs. • Plus some semi-permanent to permanent aquatic habitats.	• Small to Large scale (and greater) terrestrial type GDE formations • Generally coinciding with groundwater of various sources typically occurring less ≤ 5 m from the surface. • Often accompanied by some intermittent surface discharge of groundwater (but typically not consistent). • Generally possessing high density overstorey formations (i.e. open forest) and no lower than woodland type density. • Often possessing some more minor and less permanent aquatic components. Generally possessing OPV and/ or OPS. Generally possessing multiple mesophytic/ hydrophytic understorey components used to indicate consistency of moisture availability.

Tier	Type and key Characters	Broad Tier Description
		• Occurs within variable landforms from open plains to valley floors to upland gorge type formations.
Tier 3	• Broadly Facultative Terrestrial GDV/ GDE's • Plus some persistent ephemeral aquatic habitats	• Generally smaller scale terrestrial type GDE/ IDE features. • Generally, where groundwater of various sources typically occurs between 5-10 m (and up to 15 m) from the surface. • Generally, FPV dominated and possessing low to moderate density overstorey formations (i.e. woodland and lower). • Typically possessing ephemeral pools (at times semi-permanent and rarely permanent pools present) and at times possessing cryptic/restricted riparian vegetation communities. Generally, with groundwater occurring 5-15 m below surface (rarely with consistent surface discharge).

Table 2 The preliminary significance ratings associated with each combination of tier and class

Tier	Sub-Type	Significance - Scale of Relevance	Significance rating based on structure, composition and GDE classification.	Drainage Size
Tier 1	A	Regionally significant	Very High	Generally Moderate to Major Sized Drainage - (some exceptions where highly restricted composition & GDE classification applies)
	B		High - Very High	
	C		High +	
Tier 2	A	Locally to Sub-regionally Significant	High	
	B		Moderate - High	Minor to Moderate Sized Drainage
	C	Generally, of Local significance	Moderate	
Tier 3	A		Low - Moderate	
	B		Low	
	C		Very Low	

4 Results and Discussion

4.1 Step 1: NDVI persistence

A total of 45 features were identified within the study area as potential GDEs that have features indicative of enhanced riparian vegetation with an NDVI persistence indicative of access to an alternate water source. Within the study area, GDV was scarce compared to other Hamersley localities, and most of the features identified were relatively small and unlikely to be dependent on the larger scale aquifers within the zone of hydrological influence. Despite this, and while most features were small (< 10 ha), the features considered ranged in area from 0.3 ha to 622 ha.

As part of the assessment process, each feature was given a unique ID number, which are listed in Appendix B and shown in Figures 3 and 4. Also shown in Figure 3 are the study area, the proposed pits and waste dumps, the zone of direct hydrological influence for each deposit and the broad hydrological development zone which allows a buffer of 2.5 km to the zone of direct hydrological influence.

Many of the enhanced, persistent riparian features identified in step 1 of the assessment are of limited spatial extent and are high in the landscape. A discontinuous series of features follows Turee Creek (East Branch) from just to the north of Deposit F though Features, 7, 31,1a and 1b, D1, and D2 and finishing at Feature 22 which is outside the hydrological development envelope within Karijini National Park (Figures 4 and 5). There are also several features (Features 2, 29, 34 and 35), one of which is large (Feature 2) that occupy protected and shaded gullies and slopes on the south facing escarpments of the range that includes Mt Ella East. Two other groups of features are noteworthy, a group of elevated valleys to the west of Deposit J (including Features 3, 4, 23. 24, 25, 27, 28 and 30) and a four small features in the broad valley to the north of Deposit H (Features 15, 16, 17 and 18), in which there is extensive mulga vegetation.

A quick survey of the features indicates that most are small, many are elevated and only seven occupy valley floor locations. The features at high elevations, on the north edge of Deposit F (7, 10, 9 and 11), and to the west of Deposit J may be important repositories for biodiversity but they are most likely to be supported by surface inflow, or small, local aquifers and water stores. This initial survey, based on landscape position, will be tested in steps 2 and 3, using more detailed biological and hydrological evidence. It is however supported by the observation that only one of the 45 features has a mean NDVI persistence greater than 80% such that all other features have a low to moderate initial likelihood of dependence on groundwater (Appendix B).

4.2 Step 2A: Likelihood of GDE – Desktop assessment of biological evidence

After identifying and describing the vegetation present in all the features from satellite and aerial images as well broad indications from baseline vegetation mapping, only 7 (D1, D2, 1a, 1b, 12a, 14, and 22) of the original 45 defined polygons were assigned a low to moderate or greater initial likelihood of groundwater dependence and none had vegetation or aerial cues indicative of a high or very high likelihood of dependence on groundwater. No obligate phreatophytes were detected in any of the features and the facultative phreatophyte *E. camaldulensis* was often absent, and mostly scattered when present, rarely reaching sufficient stature or cover to be described as a woodland (cover 10 to 30%). In all these features, *E. victrix* was the most common facultative phreatophyte, and in its absence where it wasn't replaced by *E. camaldulensis, E xerothermica* was the generally the second most abundant overstorey species. These features and some of the other elevated features possessed scattered individuals of mesophyte tree species including *E. xerothermica, Corymbia ferriticola* and *E. trivalva* among shrubs of *Acacia* and other species. While some of these features (e.g. extra 1, 2 and 3) have low, open woodlands of such species, the low density and absence of either *E. camaldulensis* or *E. victrix* is indicative of highly ephemeral vegetation and thus of a low likelihood of dependence on groundwater or stored inflow. Several features have scattered *E. camaldulensis and E. victrix* but not with the stature or canopy development that would indicate a moderate to high dependence on groundwater (e.g. Features 26 and 27). Many others show no evidence of facultative phreatophytes or other mesophytes.

The features with equal to or greater than a low moderate likelihood of groundwater dependence based on NDVI persistence and desktop biological evidence, and field visits are listed in **Table 4** (Refer to Appendix C).

4.3 Step 2B: Likelihood of Groundwater dependence - Field and further assessment of biological evidence

Features D1, 1a, 1b, 12, 22, D2 and 14 were visited either as part of broadscale vegetation surveys in 2018 or in 2021 as part of this GDE assessment. Several other features (32, 38, Extra 1, 2 and 3) close to Deposit H and Mt Ella East were also visited due to their proximity to the proposed pits and waste dumps. The following notes are provided for features where the assessment was modified based on field evidence (see Appendix B).

- Feature 1a was upgraded to moderate likelihood of groundwater dependence; a woodland dominated by *Eucalyptus camaldulensis* was found to be present along with other relevant constituents.
- Feature 1b was downgraded to moderate likelihood of groundwater dependence; only occasional, scattered *E. camaldulensis* were found.
- Feature 12 – no change was made to the classification, but it was noted that the pool at 12a (turtle pool) still had surface water in late November 2021. Feature 12 represents a medium sized branched creek section feature in the small valley to the north of deposit H. This is possibly a calcrete or clay feature with a local, ephemeral water supply.
- In Feature 14, *E. camaldulensis* was dominant in the creek channel leading up to the topographic pinch point at the head of the small valley. This feature was not upgraded but particular attention was paid to the local landforms in step 3.
- Figures D1 and D2 were downgraded to low to moderate as the *E. camaldulensis* were sparse amongst the *E. victrix*.

4.4 Step 3: Likelihood of GDE - Hydrological evidence

Of the vegetation features rated as having a low to moderate or moderate likelihood of groundwater dependence based on biological evidence, only one, Feature 22 was estimated to have groundwater with 15 meters of the surface so that this groundwater is likely to be clearly accessible to vegetation. For many of the other features, the nearest bores are kilometers away and often in a different landform or potentially different broad lithology. Since many of these features are high in the landscape it is likely that these features depend on storage of local inflow or on a small ephemeral aquifer.

4.5 Step 4: Final GW dependence likelihood ratings

The final likelihood rating allocated to each feature remained relatively consistent after combining hydrological evidence with biological and eco-physical evidence (**Figure 6**). Only one of the features in the Turee creek drainage system (Feature 22) has groundwater within 15 m of the surface. The other feature in the creek with a moderate likelihood of dependence on groundwater (Feature 1a) seems to be accessing locally stored or perched water.

Features 12 and 14 are secondary valleys that drain directly to the valley floor and do not appear have access to the regional aquifer. Nonetheless they support ecosystems with at least outcropping of vegetation patches indicative of additional sources of water. We have concluded this must be a small-scale ephemeral aquifer that forms in the weathered calcrete and basement material overlying a physical barrier to infiltration such as parent basalt. The valley which both Features 14 and 12 occur in has a reasonably large area of ground (approximately 200ha) where calcrete outcropping was observed, and this outcropping was also observed extending to a few meters below ground level in parts of Feature 14 where the creek channel cuts deeper into the alluvium. The shape of the valley and the fact that drainage out of it is topographically constricted through a range feature to the north determines that historically this area may have established a seasonally shallow groundwater table. This would explain the deposition of calcrete and the likelihood that at present groundwater may form seasonally in the local calcrete and thus may accumulate at the topographic pinch point where the vegetation is indicating enhancement. Feature 14 is a branched creek section at the head of this same valley that also drains through the range immediately to the north of Deposit H. Feature 14 has a well-structured low open woodland (with occasional patches of woodland) of *E. camaldulensis*.

4.6 Step 5: Significance rating of GDEs

The 45 features were all assessed as having a preliminary biological significance of Tier 3, and of only local significance. Of these features, 37 were assessed as having very low biological significance, seven features were assessed as of low biological significance (Feature 1b, 12a, 12b, 14, 22, D1 and D2, **Figure 7**).

Obligate phreatophytes are absent from all the features identified as moderately likely to be accessing groundwater. Thus, none were classified as Tier 2 terrestrial GDEs with either regional or sub-regional significance. As a result, all the features assessed are clearly of relatively low or very low significance and only locally significant.

The principal facultative phreatophyte in the area is *E. victrix,* often accompanied by isolated E. camaldulensis. In more enhanced, persistent vegetation areas, this *E. camaldulensis* can possess scattered abundance rising to a consistent woodland in feature 1a and very sporadically in some other areas such in features north of Deposit H. Feature 1a, is the only feature with a low-moderate (Tier 3, Class A) biological significance. It is a relatively small feature (19.2 Ha), but the value is elevated by adjacent woodlands of *E. victrix* in Feature 1b so that Feature 1a and 1b are contiguous. The other features are classed as either Tier 3 Class B or C and thus have low to very low biological significance.

4.7 Seasonal patterns of NDVI persistence and local hydrogeology

Based on both biological and hydrological evidence, except for Feature 22, all the features identified as having a low to moderate likelihood of groundwater are accessing sources of water that are ephemeral and experience periods of several months of every year when the additional water is not available or accessible. The results are vegetation where the low level facultative phreatophyte *E. victrix* is the most common phreatophyte in all features, while *E. camaldulensis* which is considered a higher level facultative phreatophyte, is less common and only forms a consistent and dominant woodland in Feature 1a.

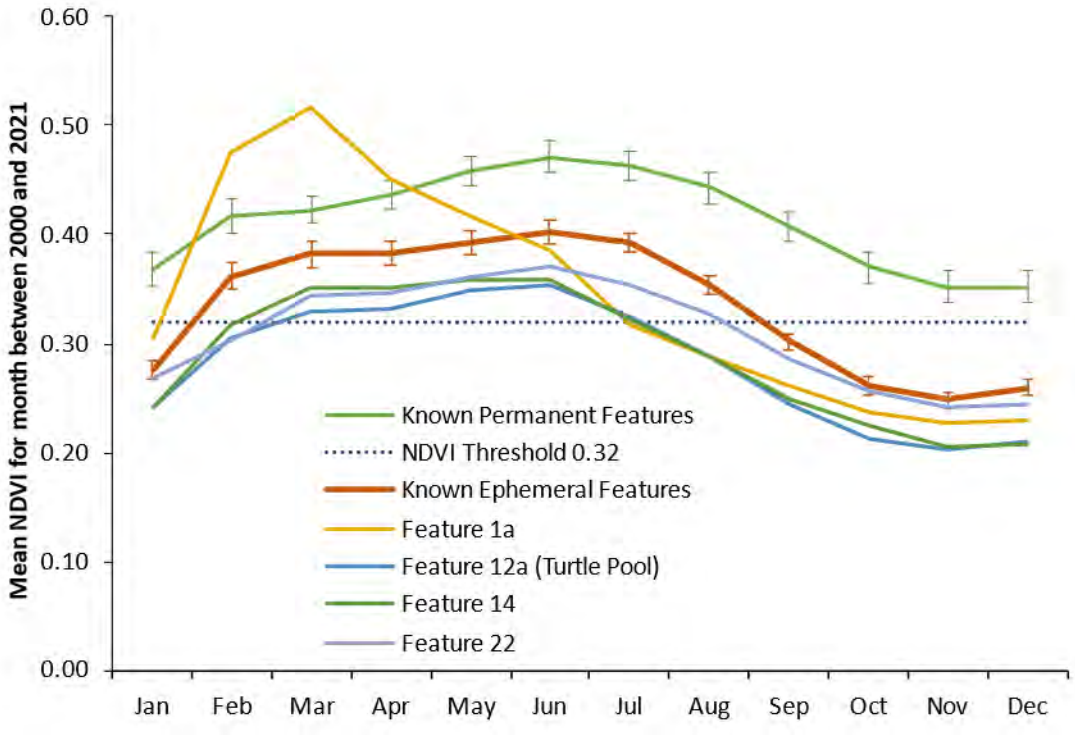
To further illuminate patterns of water availability for the Turee creek features and for Features 11 and 15, some of the phenometric attributes (aggregate annual/monthly growth profiles) and NDVI trends were considered below. NDVI was estimated for all pixels for every available image (typically 2 or more per month) captured between 2000 and Jan 2022 for both Landsat (after 2000) and sentinel 2 (post 2016). Months above the NDVI threshold of 0.32 were calculated. These notes relate to Features 1a, 14 and 22 which were both given the final classification of low to moderately likely to be assessing groundwater.

1. **Feature 1a**. Between 2000 and 2022, the mean NDVI of Feature 1a exceeds 0.32 by more than was observed for any other feature during the wet season with a peak of 0.52 in February. This is followed by a rapid decline in NDVI with the onset of the dry season, suggesting temporary access to plentiful water (Graph 5). Nonetheless there are some years (2002, 2010) when the NDVI does not exceed 0.32 and in all years the NDVI drops below this threshold for several months. Thus, while this feature is home to a woodland of *E. camaldulensis* (and other indicative mesic understorey elements), the access to groundwater would appear non-permanent (or at least seasonally constrained) and so the vegetation exhibits a broadly facultative response to an ephemeral but reasonably reliable regime of flooding and recharge. The higher prevalence of *E. camaldulensis* in Feature 1a compared to 1b may result from storage of water in a local clay soil. Despite this, it is worth noting that *Adriana tomentosa*, a Moderate-High level mesophytic indicator species is present and abundant (a dominant component of the understorey) throughout the 1a community. This species is not typically found in clay

communities and is typically present in areas which show at least seasonal access to a shallow persistent water source such as groundwater.

2. **Feature 14.** The seasonal NDVI profile indicates access to a less plentiful reliable source of water in the wet than Feature 1a (Graph 5). In most years the vegetation appears severely water limited for 5 to 6 months of the year and the mean NDVI decreases to around 0.2 during summer. This upper valley floor ecosystem appears to have access to an ephemeral source of water, probably a perched aquifer forming on a local impediment to infiltration. This valley occurs over the less permeable Fortescue formation.
3. **Feature 22.** This feature is outside the development envelope but still in the Turee creek line and within Karijini National Park. This potential GDE was studied in detail as part of the Deposit C & D Environmental Review Document (ERD) (Rio Tinto Iron Ore, 2018). The profile of NDVI indicates slightly more persistent source of water than for Feature 14 but also an ephemeral system. Although the creek flows through this section the underlying groundwater may retreat to a deeper stratum so that water stored in course alluvium might be needed to sustain these *E. victrix* trees through the summer. As a result, the NDVI also decreases steeply after June and is less than 0.25 in summer (Graph 5).

All the features identified as likely possessing moderate likelihood of groundwater dependence, are characterized by the presence of facultative phreatophytes, the absence of obligate phreatophytes and seasonal NDVI profile trends indicative of late dry season hydrological conditions which constrain vegetation growth.



Graph 5 Mean NDVI for each month of the year for Features 1a, 22, 12a and 14 compared to mean curves with standard errors for known permanent and ephemeral features (from Graph 4, Section 3.9).

5 Conclusions and Summary

A total of 45 vegetation features were identified as representing enhanced riparian vegetation with an NDVI persistence indicative of features potentially accessing an alternative water source. Of these features, none were found to have a high or very high likelihood of dependence on groundwater based on biological evidence. As a result, it can be broadly concluded that potential hydrological impacts from the proposed development are unlikely to produce a significant impact in any of the assessed features given that rainfall and inflows would most likely sustain a similar community in their place.

Four features exhibited a 'moderate' likelihood of groundwater dependence based on the biological evidence. Two of these features were in Turee creek, one (Feature 22) with access to regional groundwater and another (Feature 1a) with a local, ephemeral water source. A further two features were adjacent to elevated above deposit H with a local source of water (Features 14, and 12).

The vegetation in the four features of interest was dominated by *E. victrix* with a variable presence of the higher level facultative phreatophyte *E. camaldulensis*. This composition is generally characteristic of a Tier 3 GDE with an overstory made up mostly of facultative phreatophytes with other mesophyte trees and minimal other mesophytic understorey constituents. All features generally had a low or very low preliminary biological significance.

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Appendix A:

GDE Assessment Framework (Rio Tinto)

Appendix B:

Tabulation of all Persistent Vegetation Features

Tabulation of all persistent vegetation features showing feature size, NDVI persistence and persistence rating (step 1), likelihood of groundwater dependence based on desktop and field biological evidence (step 2) and depth to groundwater (step 3) and final likelihood of groundwater dependence rating (step 4) and a preliminary assessment of biological significance (step 5). Cells that are shaded green indicate that at the relevant step, this feature was rated as having a low to moderate or greater likelihood of groundwater dependence. Features 22, D1 and D2 were identified as part of the baseline vegetation survey, while all other features were identified based on a calculation of NDVI persistence. Species legend – Ec (Eucalyptus camaldulensis), Ev (E. victrix), Cf (Corymbia ferriticola), Et (E. trivalva), Ex (E. xerothermica), El (E. leucophloia), Ch (C. hamersleyana), Ac (Acacia citrinoviridis).

Feature ID	Area	Feature Size	Mean NDVI Persistence	NDVI Persistence Rating	Relevant Vegetation attributes interpreted from desktop data sources	Likely Groundwater Dependence desktop only	Field Visit	Relevant flora and vegetation Comments Field Visit	Likely groundwater Dependence rating (biological Evidence)	Inferred/ interpreted Groundwater Depth	Inferred likelihood of Groundwater access (Hydrological)	Likely Groundwater Dependence (Final)	In BHDZ	Biological Significance _preliminary rating
1a*	19.2	Medium	69	Low	Valley Floor - Ec/Ev overstorey along with drier eucalypts	Low to Moderate	Full	Ec dominant tree in overstorey along with Ex (woodland to open forest in places)	Moderate	>45m	Unlikely	Low to Moderate (probably local water storage)	Y	Low-Moderate
1b	43.0	Medium	64	Low	Shrubs of Acacia species, likely with open woodland of low Eucalypts spp. (Ex, Ev and sparse Ec)	Moderate	Part	Only scattered Ev and Ec	Low	>45m	Unlikely	Low	Y	Low
2	202	Large	66	Low	Shrubs of Acacia spp, likely with scattered Cf and El	Low	Yes	Callitris common in gorge, No mesic species in areas visited	Low	>100 m	Unlikely	Low-	Y	Very Low

Feature ID	Area	Feature Size	Mean NDVI Persistence	NDVI Persistence Rating	Relevant Vegetation attributes interpreted from desktop data sources	Likely Groundwater Dependence desktop only	Field Visit	Relevant flora and vegetation Comments Field Visit	Likely groundwater Dependence rating (biological Evidence)	Inferred/ interpreted Groundwater Depth	Inferred likelihood of Groundwater access (Hydrological)	Likely Groundwater Dependence (Final)	In BHDZ	Biological Significance _preliminary rating
3a	0.9	Small	78	Moderate	Incised gully vegetation - Shrubs of Acacia spp. scattered to low open woodland (likely Cf)	Low	No	NA	Low	>100	Unlikely	Low-	Y	Very low
3b	16.0	Medium	66	Low	As for 3a	Low	No	NA	Low	>100	Unlikely	Low-	Y	Very low
4	18.3	Medium	73	Moderate	As for 3a	Low	No	NA	Low	204	Unlikely	Low-	N	Very low
5	1.7	Small	79	Moderate	As for 3a	Low	No	NA	Low	199	Unlikely	Low-	N	Very low
6	10.6	Small-Medium	65	Low	Mountain slope and Incised Gully Vegetation of Acacia spp. on steep slopes, with Cf and Acacia in incised valley lines	Low	No	NA	Low	233	Unlikely	Low-	Y	Very low
7	1.0	Small	65	Low	Shrubs of Acacia spp. with scattered low Eucalypts (Likely Ex or Et mallee)	Low	No	NA	Low	72	Unlikely	Low-	Y	Very low

Feature ID	Area	Feature Size	Mean NDVI Persistence	NDVI Persistence Rating	Relevant Vegetation attributes interpreted from desktop data sources	Likely Groundwater Dependence desktop only	Field Visit	Relevant flora and vegetation Comments Field Visit	Likely groundwater Dependence rating (biological Evidence)	Inferred/ interpreted Groundwater Depth	Inferred likelihood of Groundwater access (Hydrological)	Likely Groundwater Dependence (Final)	In BHDZ	Biological Significance _preliminary rating
8	2.5	Small	62	Low	As for 7	Low	Yes	No change to assessment	Low	111	Unlikely	Low-	N	Very low
9a	18.5	Medium	60	Low	As for 7	Low	No	NA	Low	100	Unlikely	Low-	Y	Very low
9b	9.7	Small	65	Low	As for 7	Low	No	NA	Low	100	Unlikely	Low-	Y	Very low
10	0.6	Small	67	Low	As for 7	Low	No	NA	Low	103	Unlikely	Low-	N	Very low
11	9.3	Small	64	Low	Shrubs of Acacia spp., with scattered low Eucalypts (Likely Ex or Ev with occasional Et)	Low	No	NA	Low	76	Unlikely	Low-		Very low
12a (turtle pool)		Small	66	Low	Woodland of Ev and Ec co-dominant, Ex also common over Acacia shrublands	Moderate	Yes	Depth of water in November suggests water persists most of year	Moderate	~50-90	Unlikely	Low-Moderate (perched)	Y	Low
12b	32.9	Medium	66	Low	Shrubs of Acacia spp., with scattered to open woodland of low Eucalypts of Ex or Ev with sparse Ec	Low	Yes	Ec in relatively low numbers, consistent with desktop assessment	Low	~50-90	Unlikely	Low-	Y	Low
13	1.7	Small	65	Low	As for 7	Low	Yes	Veg not suggestive of persistent water	Low	~50-90	Unlikely	Low-	N	Very low

Feature ID	Area	Feature Size	Mean NDVI Persistence	NDVI Persistence Rating	Relevant Vegetation attributes interpreted from desktop data sources	Likely Groundwater Dependence desktop only	Field Visit	Relevant flora and vegetation Comments Field Visit	Likely groundwater Dependence rating (biological Evidence)	Inferred/ interpreted Groundwater Depth	Inferred likelihood of Groundwater access (Hydrological)	Likely Groundwater Dependence (Final)	In BHDZ	Biological Significance _preliminary rating
14	14.6	Medium	75	Moderate	Woodland of Ev and Ec co-dominant, Ex also common over Acacia shrublands	Moderate	Yes	Ec forms open forest in some parts of main area.	Moderate	~50-80	Unlikely	Low-Moderate (local surficial)	N	Low
15	4.9	Small	68	Low	As for 7	Low	No	NA	Low	108	Unlikely	Low-	N	Very low
16	0.7	Small	68	Low	Shrublands of mixed Acacia spp.		No	NA	Low	113	Unlikely	Low-	N	Very low
17	1.1	Small	67	Low	As for 16	Low	No	NA	Low	112	Unlikely	Low-	N	Very low
18	4.4	Small	69	Low	As for 16	Low	No	NA	Low	112	Unlikely	Low-	N	Very low
19	20.2	Medium	65	Low	Shrubs of Acacia spp., with scattered to open woodland of low Eucalypts of Ex or Ev	Low	No	NA	Low	6	Likely	Low+	Y	Very low
20	11.6	Small	68	Low	As for 19	Low	Yes	NA	Low	55	Unlikely	Low-	Y	Very low
22*	43.0	Medium	73	Moderate	Woodland of Ev and Ec, with Ex also present	Moderate	Yes	Confirmed woodlands of Ec and Ev, water present at surface	Moderate	5-10	Likely	Moderate (regional)	N	Low
23	20.0	Medium	74	Moderate	As for 19	Low	No	NA	Low	99	Unlikely	Low-	N	Very low

Feature ID	Area	Feature Size	Mean NDVI Persistence	NDVI Persistence Rating	Relevant Vegetation attributes interpreted from desktop data sources	Likely Groundwater Dependence desktop only	Field Visit	Relevant flora and vegetation Comments Field Visit	Likely groundwater Dependence rating (biological Evidence)	Inferred/ interpreted Groundwater Depth	Inferred likelihood of Groundwater access (Hydrological)	Likely Groundwater Dependence (Final)	In BHDZ	Biological Significance _preliminary rating
24	4.0	Small	74	Moderate	Incised gully vegetation - Shrubs (likely Acacia spp./Mulga) and scattered low trees likely Cf	Low	No	NA	Low	144	Unlikely	Low-	N	Very low
25	1.9	Small	68	Low	As for 24	Low	No	NA	Low	248	Unlikely	Low-	N	Very low
26	1.5	Small	71	Moderate	As for 19	Low	No	NA	Low	218	Unlikely	Low-	N	Very low
27	2.6	Small	66	Low	As for 19	Low	No	NA	Low	197	Unlikely	Low-	N	Very low
28	0.9	Small	73	Moderate	As for 19	Low	No	NA	Low	116	Unlikely	Low-	N	Very low
29	4.1	Small	64	Low	As for 24	Low	No	NA	Low	100	Unlikely	Low-	Y	Very low
30	0.3	Small	89	High	As for 24	Low	No	NA	Low	218	Unlikely	Low-	Y	Very low
31	2.8	Small	62	Low	As for 19	Low	Yes	Veg not suggestive of persistent water	Low	53	Unlikely	Low-	Y	Very low
32	3.5	Small	65	Low	As for 24	Low	Yes	Veg not suggestive of persistent water	Low	23	Possible	Low+	Y	Very low
33	1.9	Small	66	Low	Shrubs of Acacia spp. (Mulga), with scattered low woodland of Eucalypts of Ex or Et	Low	No	NA	Low	~>30	Unlikely	Low+	Y	Very low

Feature ID	Area	Feature Size	Mean NDVI Persistence	NDVI Persistence Rating	Relevant Vegetation attributes interpreted from desktop data sources	Likely Groundwater Dependence desktop only	Field Visit	Relevant flora and vegetation Comments Field Visit	Likely groundwater Dependence rating (biological Evidence)	Inferred/ interpreted Groundwater Depth	Inferred likelihood of Groundwater access (Hydrological)	Likely Groundwater Dependence (Final)	In BHDZ	Biological Significance _preliminary rating
34	5.4	Small	63	Low	Incised gully vegetation - Shrubs (likely Acacia spp./Mulga) and scattered low trees likely Cf	Low	No	NA	Low	>100	Unlikely	Low-	Y	Very low
35	6.4	Small	65	Low	As for 34	Low	No	NA	Low	>100	Unlikely	Low-	Y	Very low
36	2.3	Small	67	Low	As for 34	Low	No	NA	Low	>100	Unlikely	Low-	Y	Very low
37	5.4	Small	68	Low	As for 24	Low	Yes	Veg not suggestive of persistent water	Low	>100	Unlikely	Low-	Y	Very low
38	5.0	Small	60	Low	As for 34	Low	Yes	Some Ec, but mesic not common in general	Low	48	Unlikely	Low-	Y	Very low
D1*	?	Medium	Unknown	Moderate	Trees of Ev and Ec dominant, Ex also common over Acacia shrublands.	Moderate	Yes	Trees of Ev and Ec dominant, Ex also common over Acacia shrublands.	Low-moderate	90	Unlikely	Low (local surficial)	Y	Low

Feature ID	Area	Feature Size	Mean NDVI Persistence	NDVI Persistence Rating	Relevant Vegetation attributes interpreted from desktop data sources	Likely Groundwater Dependence desktop only	Field Visit	Relevant flora and vegetation Comments Field Visit	Likely groundwater Dependence rating (biological Evidence)	Inferred/ interpreted Groundwater Depth	Inferred likelihood of Groundwater access (Hydrological)	Likely Groundwater Dependence (Final)	In BHDZ	Biological Significance _preliminary rating
D2*	622	Large	Unknown	Moderate	Open woodland of Ev, potentially with isolated Ec individuals and Ex over Acacia shrublands (includes broad floodplain vegetation which is predominantly Acacia shrublands over mixed tussock-grass/herb lands)	Low - Moderate	Yes	Woodland of Ev with sparse Ec and Ex over Acacia shrublands (includes broad floodplain vegetation which is predominantly Acacia shrublands over mixed tussock-grass/herb lands)	Low-Moderate	41	Unlikely	Low (local surficial	Y	Low
E1	2.6	Small	Unknown	NA	Woodland of low Eucalypts of Ex or Ev with sparse Ec	Low	Yes	Woodland of low Eucalypts of Ex or Ev with sparse Ec	Low	>100	Unlikely	Low-	Y	Very low
E2	1.0	Small	Unknown	NA	As for 3a	Low	Yes	As for 3a	Low	>100	Unlikely	Low-	Y	Very low
E3	0.3	Small	Unknown	NA	As for 3a	Low	Yes	As for 3a	Low	>100	Unlikely	Low-	Y	Very low

Appendix C:
Tables

Table 3 Detailed definitions of the three Tiers of biological significance and for the three classes within each Tier.

Tier	Type and key Characters	A Class – Detailed Description	B Class – Detailed Description	C Class – Detailed Description
Tier 1	<u>Generally Aquatic GDE's & associated obligate Terrestrial GDV</u> Typically including permanent typically groundwater fed pools Including obligate Terrestrial GDV Generally coinciding consistently with shallow Groundwater (Permanently* 0-4 m below ground level). Typically associated with open forest scale overstorey riparian formations	Aquatic & terrestrial GDE type riparian formations of varying size, generally in excellent condition and often occurring in an A class Reserve. Generally, always possessing Obligate Phreatophytic species (OPS) and Obligate Phreatophytic Vegetation (OPV). In some cases, Rights reserved sites, heritage values and multiple conservation listings can lead to classification to this tier without being in an A class reserve. Example: Millstream, some of the Karijini Gorge formations.	Aquatic & terrestrial GDE type riparian formations of moderate to large scale, generally in excellent to good condition. Generally, always possessing substantial mature OPV (Obligate Phreatophytic Vegetation) formations and a series of permanent aquatic pool environments with associated interconnected pools systems of differing permanence (i.e. semi-permanent and persistent ephemeral)	Terrestrial Type GDE with varying degrees of significant Aquatic formations (less substantiated) of at least moderate scale, generally in good condition. Generally possessing OPV (Obligate Phreatophytic Vegetation) formations.
		Generally possessing multiple 'Very High' and 'High' Level Hydrophytic indicator species suggesting a Very High degree of moisture permanence in the associated habitats. Multiple 'High' and 'Moderate-High' (Likely also 'Very High' examples) Mesophytic indicator species generally common in associated terrestrial GDE habitats.		Generally possessing multiple 'High' and 'Moderate-High' (and likely an occasional 'Very High' level) Level Hydrophytic & likely Mesophytic indicator species suggesting a high to very high degree of moisture permanence in the associated habitats.
Tier 2	<u>Broadly Obligate Terrestrial GDV / GDE's</u> At times Including some semi-permanent to permanent aquatic habitats Generally coinciding with groundwater of various sources typically occurring less ≤ 5 m from the surface Typically including persistent ephemeral aquatic habitats. Typically associated with woodland to open forest scale overstorey riparian formations	Typically, moderate to Large scale Terrestrial type Riparian GDE formations. Always possessing riparian formations co-dominated by mature OPS (Melaleuca argentea) and OPV (or other well accepted species with obligate groundwater use patterns). Generally, possess semi-permanent and persistent ephemeral pool formations in key locations (permanent pools also present, but uncommon). May be small to moderate scale, but if so, typically possessing demonstrated permanent surface water formations.	Typically, moderate to Large scale Terrestrial type Riparian GDE formations. Generally possessing relatively obligate phreatophytic vegetation dominated by keystone species typically classed as moderate level FPS (Facultative Phreatophytic Species) at times with mature or at least transient-young outcrops of known OPS. As such community has relatively obligate groundwater requirements, either via a high density FPS overstorey, or via the presence of OPS or potential OPS species. Typically associated with multiple persistent ephemeral to semi-permanent pool formations in key locations. Small scale versions generally associated with outcrops of Mature OPS.	Small to Moderate scale (but lower significance) Terrestrial type Riparian GDE formations. Often possessing relatively obligate phreatophytic vegetation (in terms of water use) which is always dominated by keystone species typically classed as FPS (Facultative Phreatophytic Species – predominantly moderate level). Potential for a single OPS flora species to be present as an associated species only. Typically associated with persistent ephemeral to semi-permanent pool formations in key locations. Often represented by smaller scale formations occurring in upland gorge features, often with multiple receptors occurring sporadically at locations within the relevant landform, and associated with small scale structural features impeding groundwater flow and/or increasing permeability.
		Generally possessing multiple 'High' and 'Moderate-High' (potentially an occasional 'Very High' example) level Mesophytic indicator species, as well as multiple 'Moderate-High' and occasional 'High' level hydrophytic indicator species. These assemblages indicate a high level of permanency of moisture availability.	Generally possessing occasional 'High' level and multiple 'Moderate-High' to 'Moderate' level Mesophytic indicator species, as well as some 'Moderate-High' level and multiple 'Moderate' level hydrophytic indicator species. These assemblages indicate a moderate to high level of permanency of moisture availability.	Generally possessing occasional 'Moderate-High' level and multiple 'Moderate' to 'Low' level Mesophytic indicator species, as well as multiple 'Moderate' level (and the occasional 'Moderate-High' level) hydrophytic indicator species. These assemblages indicate a moderate to high level of permanency of moisture availability.

Tier	Type and key Characters	A Class – Detailed Description	B Class – Detailed Description	C Class – Detailed Description
Tier 3	<u>Broadly Facultative Terrestrial GDV/ GDE's</u> Some examples Including occasional persistent ephemeral aquatic habitats Generally where groundwater of various sources typically occurs between 5-10 m (and up to 15 m) from the surface. Typically associated with woodland to open woodland scale overstorey riparian formations	Typically represented by moderate level FPS (Moderate level; Eucalyptus camaldulensis) dominated riparian overstorey - generally of a woodland density, potentially with occasional patches of open forest. Persistent ephemeral pools likely.	Typically represented by moderate and low-level FPS (Low level: Eucalyptus victrix) co-dominated riparian overstorey - generally of a woodland to open woodland density. Possibly associated with Persistent ephemeral pools.	Low level FPS dominated riparian overstorey (i.e. E. victrix) (with occasional moderate level FPS typically present sporadically) - generally of a woodland to open woodland density. Associated pool formations typically ephemeral in nature.
		GDV examples of similar sensitivity/significance which do not possess well recognised moderate/low level FPS in the overstorey, will likely be dominated by Moderate/Low level mesophytes or alternative keystone mesophytes such as Acacia coriacea subsp. pendens, Eucalyptus xerothermica, Atalaya hemiglauca, Terminalia circumalata and Corymbia candida		
		Generally possessing multiple 'Moderate' and 'Low' level Mesophytic indicator species (occasionally with a Moderate-High level representative), as well as multiple low level (and the occasional moderate level) hydrophytic indicator species. These assemblages indicate a low to moderate level of moisture permanency coupled with irregular variability in moisture availability.	Generally possessing multiple 'Low" level Mesophytic indicator species and the occasional single 'Moderate' level species, as well as multiple low level hydrophytic indicator species. These assemblages indicate a low to moderate level of moisture permanency coupled with irregular to regular variability in moisture availability.	Generally possessing a small number of 'Low' level Mesophytic indicator species, as well as the occasional low level hydrophytic indicator species. These assemblages indicate a low level of moisture permanency coupled with regular variability in moisture availability.

Table 4 Features with low to moderate likelihood of groundwater dependence based on biological and hydrological evidence.

ID	Position in Landscape	Size (Small/ Medium/ large)	Mean NDVI Persistence	Relevant Vegetation data from Field work and relevant mesophytes/hydrophytes detected	Step 4: Final Likelihood of Groundwater Dependence	Interpreted Access to groundwater	Riparian Significance Tier and Sub-Class	Preliminary Biological Significance Rating	Likely additional Water Source
14	Incised, shaded valley above Deposit F	Medium	0.75	Ec dominated open woodland (to woodland in places) (includes isolated Ev), over Ex and Ch low open woodland on terraces over mixed Acacia shrublands. Field visit indicates the Ec forms open sporadic woodland densities in some locations. Mesophytes detected: *Gossypium sturtianum* (scattered), *Eulalia aurea* (2-10% cover). No Hydrophytes detected.	Low-Moderate	Unlikely (local system, calcrete?)	Tier 3, Class B	Low to Moderate	Perched aquifer likely associated with calcrete. Weathered calcrete layers observed exposed in scoured creek banks.
22	Valley floor, to the west of development envelope in Turee Creel	Large	0.70	Ev and Ec woodland (Ec dominant in some parts of the feature) over Ac tall open shrubland over mixed open-shrubland/low-open-shrubland (core riparian), or; *E. victrix* woodland over *Acacia citrinoviridis* tall open shrubland over mixed open-shrubland/low-open-shrubland. Both with a mixed open tussock grassland.	Moderate+	Likely	Tier 3, Class B	Low	Regional aquifer, however isotopic work completed, and Isotopic signature of plant water indicates young water being utilised. Thus, likely that flooding recharge of calcrete aquifer implicated.

ID	Position in Landscape	Size (Small/ Medium/ large)	Mean NDVI Persistence	Relevant Vegetation data from Field work and relevant mesophytes/hydrophytes detected	Step 4: Final Likelihood of Groundwater Dependence	Interpreted Access to groundwater	Riparian Significance Tier and Sub-Class	Preliminary Biological Significance Rating	Likely additional Water Source
				Mesophytes detected: *Melaleuca glomerata* (isolated), *Adriana tomentosa* (scattered), *Eulalia aurea* (2-5%). No Hydrophytes detected.					
1a	Elevated valley, upstream of feature D2, Turee Creek	Small	0.69	Ec dominated Woodland (with open forest patches in places) over Ex low open woodland, over *Vachellia farnesiana* and *Adriana tomentosa* open shrubland (to shrubland in places), over *Themeda triandra, Dichanthium sericeum, Eulalia aurea* and *Enteropogon ramosus* tussock grassland, over mixed very open herb land. Vegetation in polygon is variable as the riparian zone is quite wide in this area. Outer areas possess Ex woodlands with similar understoreys as above. Ev uncommon. Mesophytes Detected: *Adriana tomentosa* (2-10% cover), *Ehretia saligna* (isolated), *Enteropogon racemosus* (abundant) No Hydrophytes detected.	Low to moderate	Likely	Tier 3, Class A	Low-Moderate	Ephemeral with increased storage in a local clay feature

ID	Position in Landscape	Size (Small/ Medium/ large)	Mean NDVI Persistence	Relevant Vegetation data from Field work and relevant mesophytes/hydrophytes detected	Step 4: Final Likelihood of Groundwater Dependence	Interpreted Access to groundwater	Riparian Significance Tier and Sub-Class	Preliminary Biological Significance Rating	Likely additional Water Source
12a	Elevated valley, NE of Deposit H	Small	0.67	Ec and Ev co-dominant open woodland (to woodland in places), over Ch low open woodland over *Gossypium sturtianum, Androcalva luteiflora* shrubland (plus Vachellia farnesiana) over *Eulalia aurea* very open tussock grassland. Mesophytes detected: *Gossypium sturtianum* (2-5%), *Eulalia aurea* (2-10% cover). No Hydrophytes detected. Persistent ephemeral pool present at time of survey (late dry season), may be semi-permanent at best.	Low - Moderate	Unlikely	Tier 3, Class B	Low	Clay or calcrete forming local ephemeral aquifer. Also inflow from rocky gully.

Ev – Eucalyptus victrix, Ec – Eucalyptus camaldulensis, Ex – Eucalyptus xerothermica, Cf – Corymbia ferriticola, Ch - Corymbia hamersleyana, Ac – Acacia citrinoviridis, El – Eucalyptus leucophloia.

Appendix D:

Figures

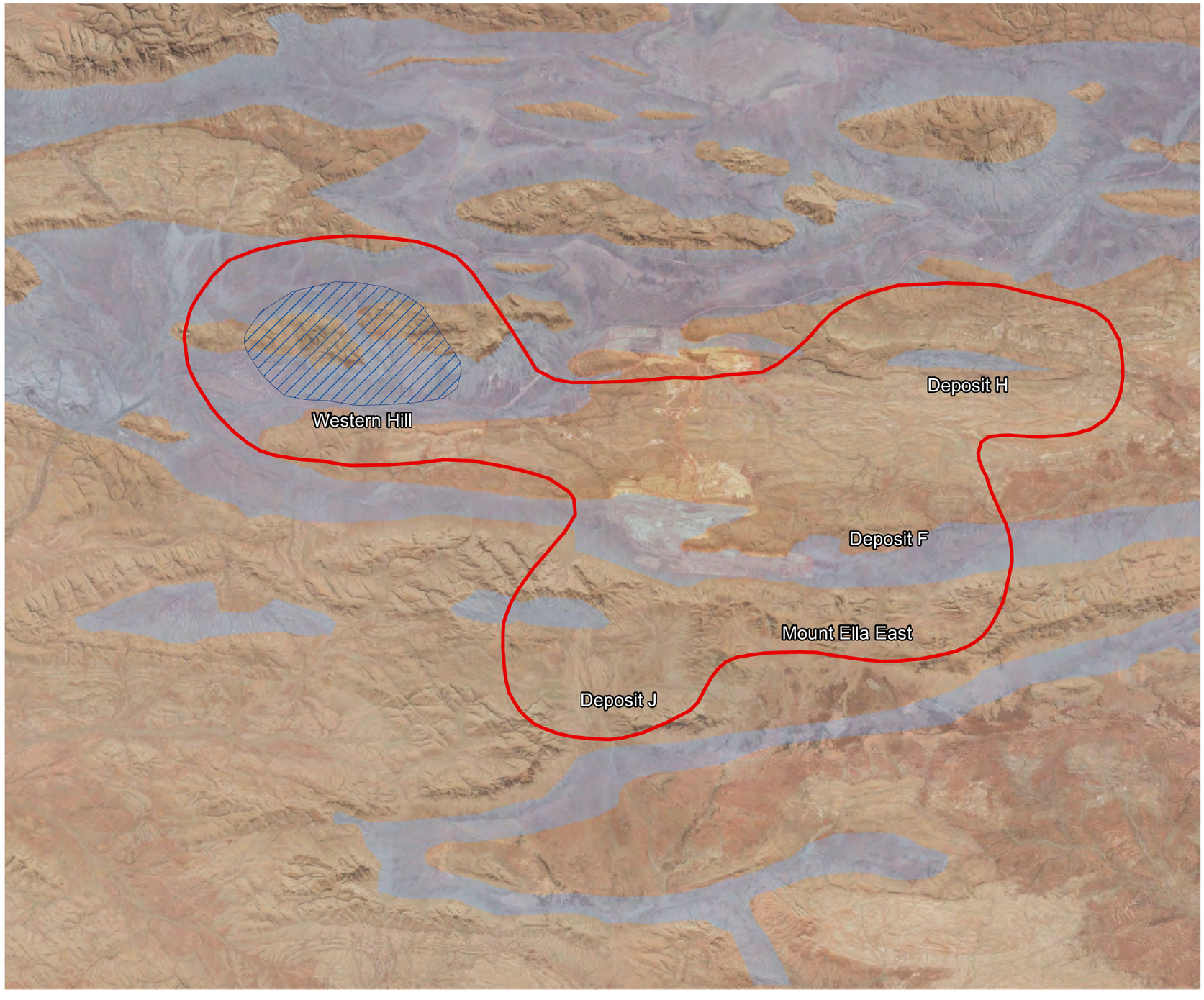

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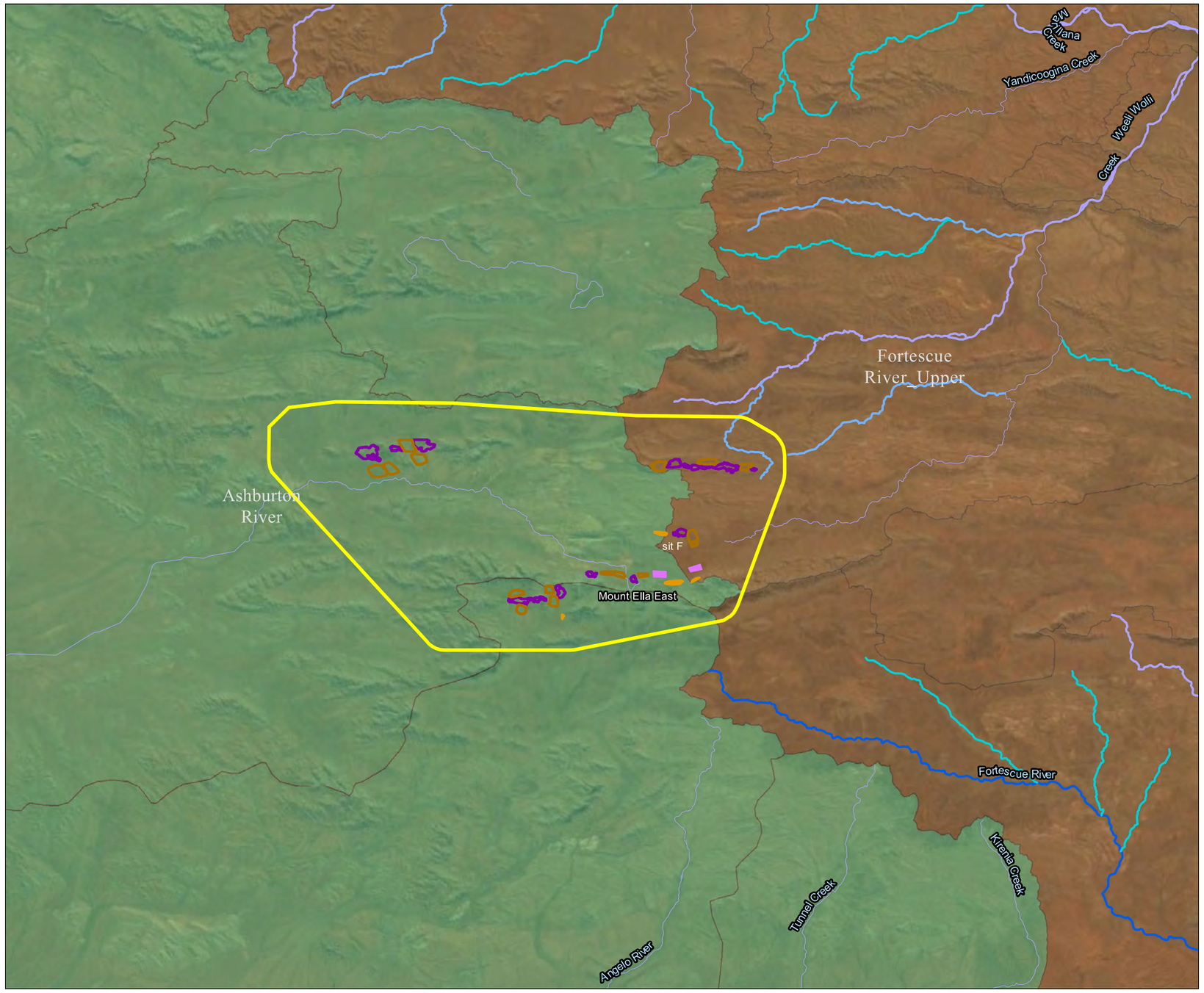
Figure 1 Satellite Image of West Angelas Area showing proposes pits and waste dumps for deposits at Western Hills, Deposit F, Deposit J, Deposit H and Mt Ella East. Also Shown are the boundaries if the study area, the zone of potential hydrological influence for each deposit and the broad hydrological development zone which allows a 2.5 km buffer outside the zone of potential hydrological influence



CREATED CHECKED APPROVED REVISION

Figure 2 West Angelas Beyond 2020 study deposits in relation to catchment boundaries and river systems.

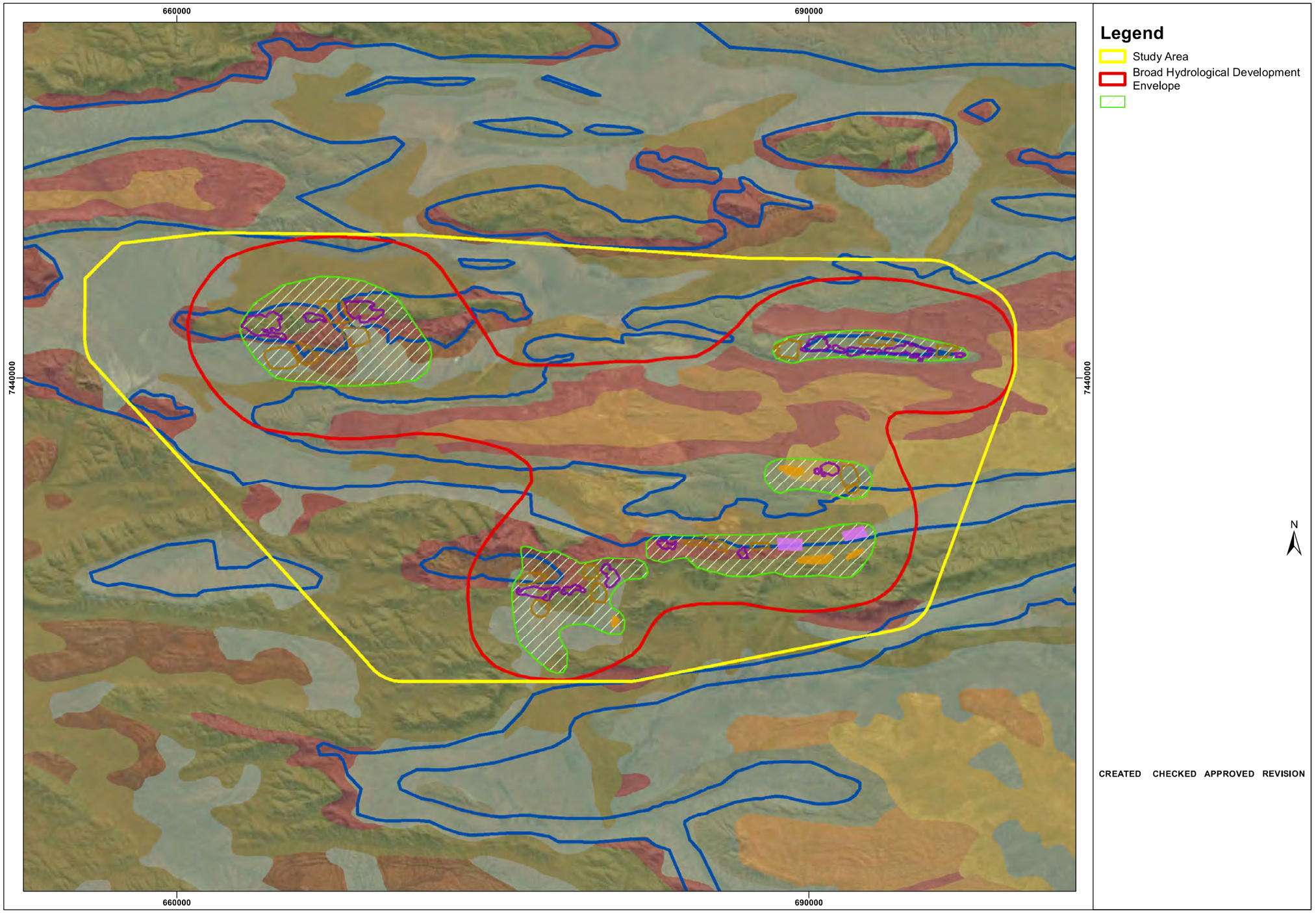


Figure 3 West Angelas Beyond 2020 study deposits in relation to the regional aquifer system and the main geological groups in the area.

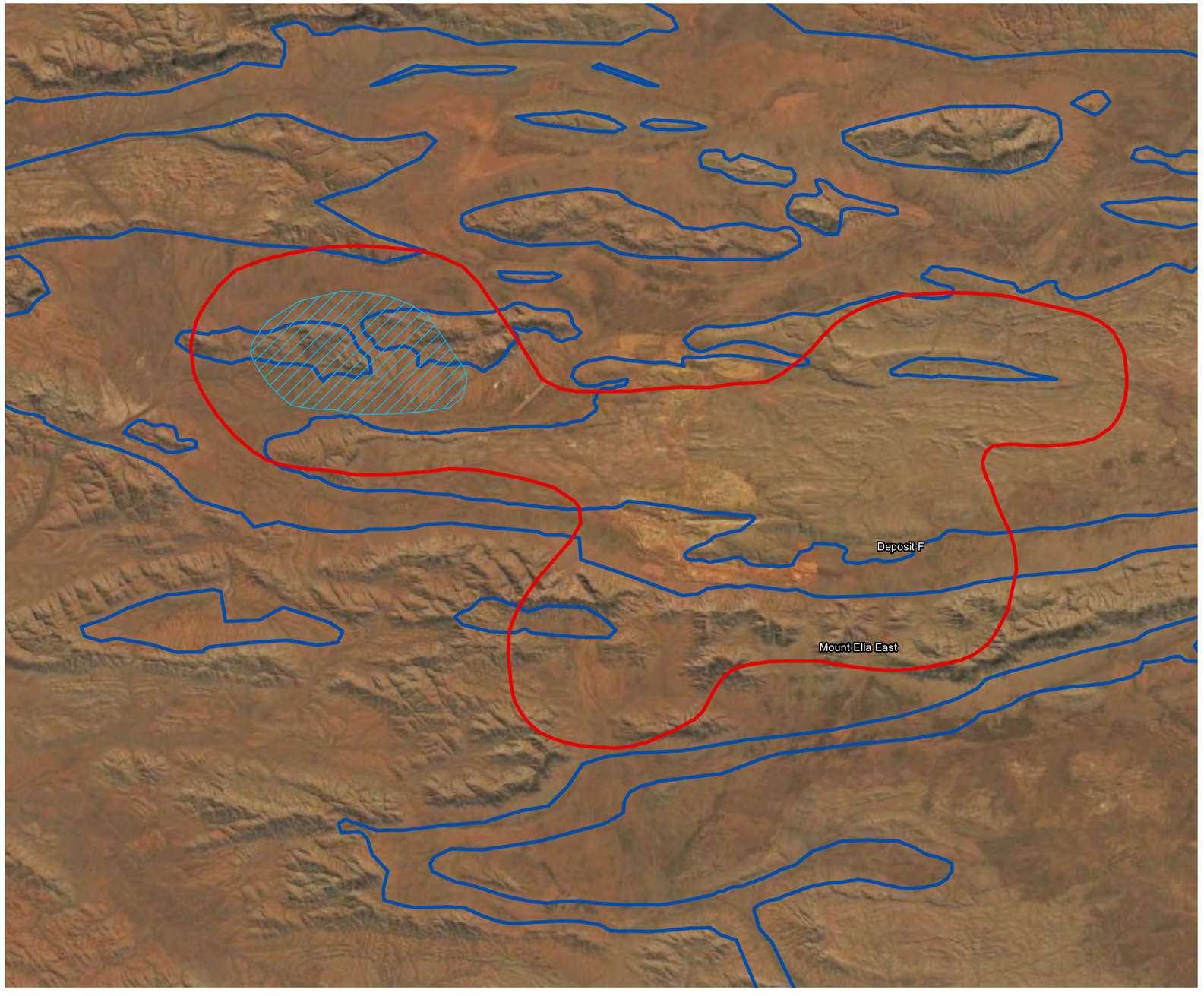


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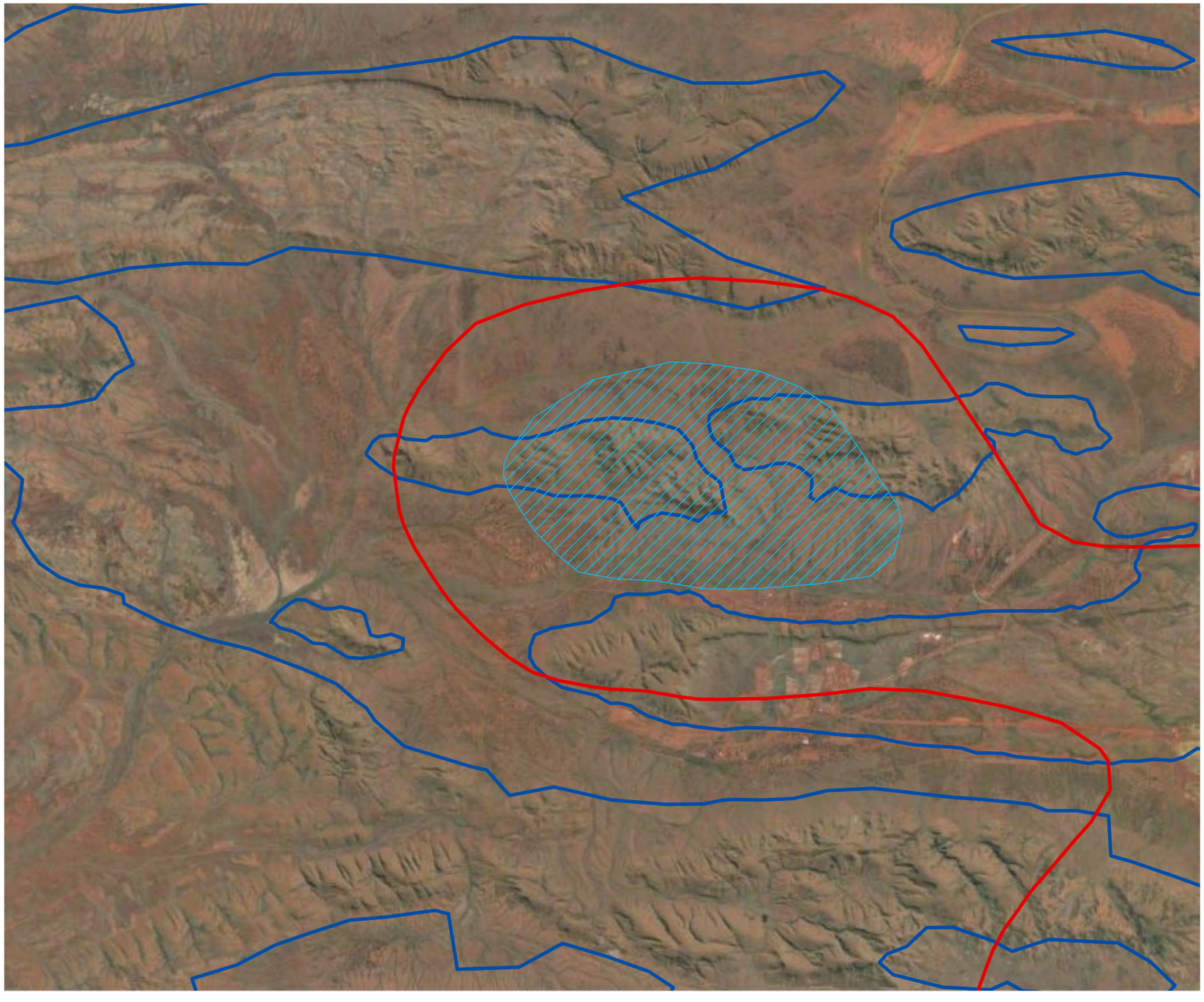
Figure 4 All vegetation features with an NDVI persistence more than 0.60, shown in relation to the zone of potential hydrological influence and the broad hydrological development zone for the proposed new developments at West Angelas in Mt Ella East, Western Hills, and Deposits F, J and H. Also shown is the regional aquifer.



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15
17
16
18
14
D1
33
13
12b
D2
36
38
32
Deposit H
12a
1a
1b
19
20
E1
31
10
11
7
37
8
Deposit F
9b
9a
Mount
Ella East
E3
6
35
34
Deposit J

690000

Legend

- Study
- Broad Hydrological Development Envelope
- Potential Hydrological Influence
- Vegetation Features (NDVI Persistence > 60%)
- Regional

- NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS
- LOCALITY MAP SOURCED LANDGATE 2022
- OTHER DATA SOURCED LANDGATE 2022
- AERIAL PHOTOGRAPHY SOURCED LANDGATE 2022
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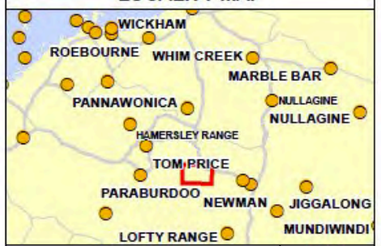
LOCALITY MAP



PROJECT ID	DATE
4985	19/04/2022

HORIZONTAL DATUM AND PROJECTION
GDA 1994 MGA Zone 50

CREATED	CHECKED	APPROVED	REVISION
CL	DW	SW	0

Rio Tinto
West Angelas
West Angelas GDE Exposure Assessmenrt
Figure 5b
Details of Location for Persistent Vegetation Features

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K:\Projects\1.0 EBS\4985\4985 F05 Details of location for persistent vegetation features.mxd

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Western Hill

D2

22

19

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24

27

26

30

28

4

Deposit J

3b

3a

660000

Legend

- Study
- Broad Hydrological Development Envelope
- Potential Hydrological Influence
- Vegetation Features (NDVI Persistence > 60%)
- Regional

- NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS
- LOCALITY MAP SOURCED LANDGATE 2022
- OTHER DATA SOURCED LANDGATE 2022
- AERIAL PHOTOGRAPHY SOURCED LANDGATE 2022
(© Western Australian Land Information Authority 2022)

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360 environmental
a 10 Bermondsey St, West Leederville, 6007 WA
t (08) 9388 8360
f (08) 9381 2360
w www.360environmental.com.au

920 0 920 1,840 2,760 Meters

1:120,000 @ A4

N

LOCALITY MAP

PROJECT ID	DATE
4985	19/04/2022

HORIZONTAL DATUM AND PROJECTION
GDA 1994 MGA Zone 50

CREATED	CHECKED	APPROVED	REVISION
CL	DW	SW	0

Rio Tinto

West Angelas

West Angelas GDE Exposure Assessmenrt

Figure 5c

Details of Location for Persistent Vegetation Features

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K:\Projects\1.0 EBS\4985\4985 F05 Details of location for persistent vegetation features.mxd

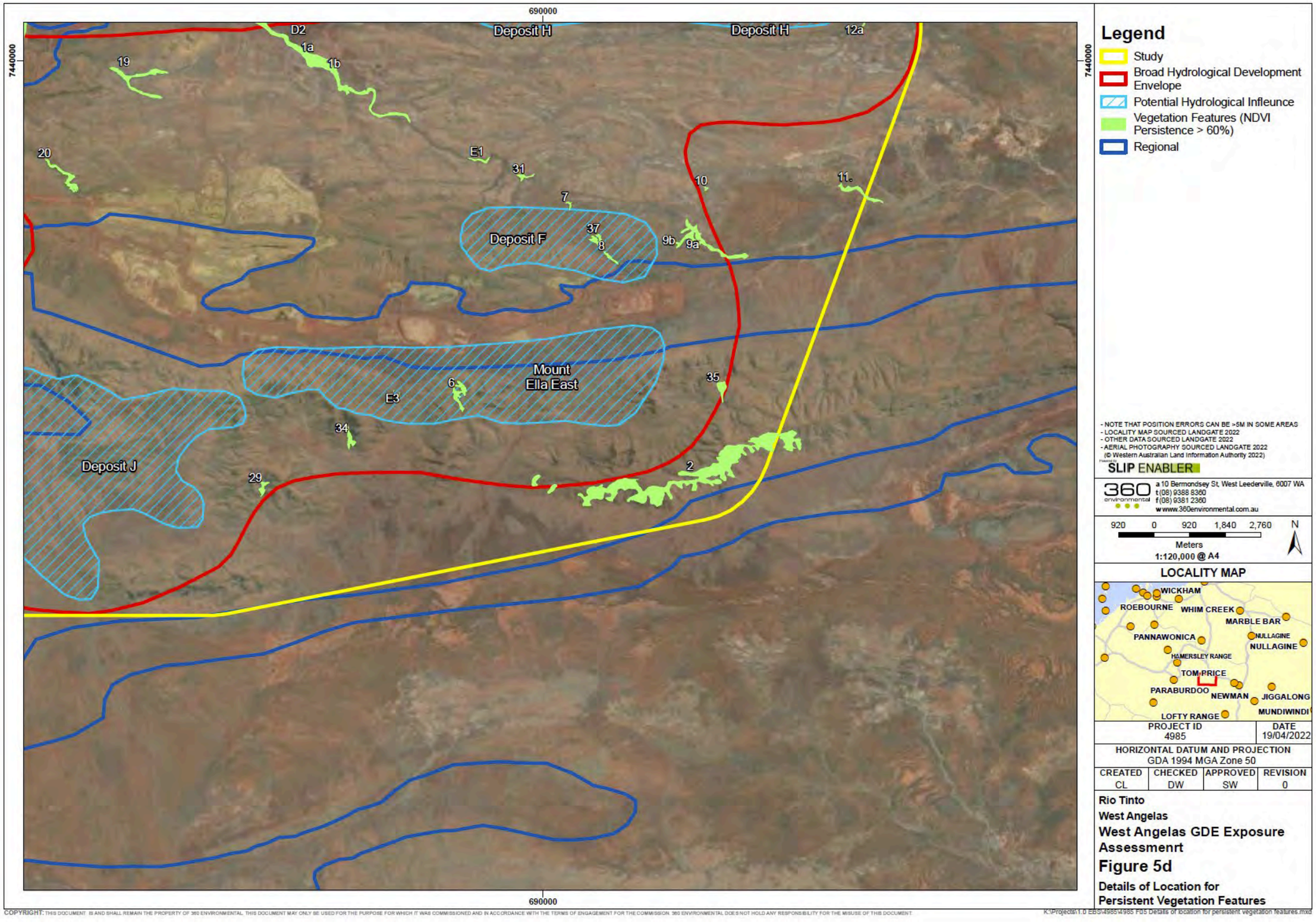

Figure 5 Details of the vegetation features with an NDVI persistence more than 0.60. Part a) Shows features East and West of Mt Ella East, Part b) shows the features near to and to the north of deposit H, Part c) shows all features in Turee creek to the south and west of western Hill.

660,000

7,440,000

Rio Tinto

Baseline Groundwater Dependent Ecosystem Assessment for the Greater West Angelas Area

Likelihood of Groundwater Dependence

FIGURE 6 a

LEGEND

Study Area

Likelihood of Groundwater Dependance

Moderate (regional)

Low

Service Layer Credits:
Esri, FAO, NOAA, USGS, Landgate / SLIP, Esri, USGS

0 1,000 2,000 Meters

Coordinate System:	GDA 1994 MGA Zone 50
Scale:	1:120,000 at A4
Project Number:	4339
Date Drawn:	18-Oct-2022
Drawn by:	EC
Reviewed by:	MR

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Path: K:\Projects\1.0 EBS\4985\4985 WestAngelasGDE_ExposureAssessment_Mapping_pro\4985 WestAngelasGDE_ExposureAssessment_Mapping_pro.aprx

680,000

700,000

7,440,000

15
17
16
18
14
33
13
12a (turtle pool)
36
38
32
12b
1a*
19
1b
31
20
10
11
7
37
9a
8
6
35
34
2

Rio Tinto

Baseline Groundwater Dependent Ecosystem Assessment for the Greater West Angelas Area

Likelihood of Groundwater Dependence

FIGURE 6 b

LEGEND

Study Area

Likelihood of Groundwater Dependance

- Low to Moderate (probably local water storage)
- Low-Moderate
- Low-Moderate (local surficial)
- Low

Service Layer Credits:
Esri, FAO, NOAA, USGS, Landgate / SLIP, Esri, USGS

0 1,000 2,000 Meters

Coordinate System:	GDA 1994 MGA Zone 50
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660,000

7,440,000

7,420,000

22

19

20

5

23

25

24

26

27

30

28

4

3a

3a

Rio Tinto

Baseline Groundwater Dependent Ecosystem Assessment for the Greater West Angelas Area

Likelihood of Groundwater Dependence

FIGURE 6 c

LEGEND

Study Area

Likelihood of Groundwater Dependance

Moderate (regional)

Low

Service Layer Credits:
Esri, FAO, NOAA, USGS, Landgate / SLIP, Esri, USGS

0 1,000 2,000 Meters

Coordinate System:	GDA 1994 MGA Zone 50
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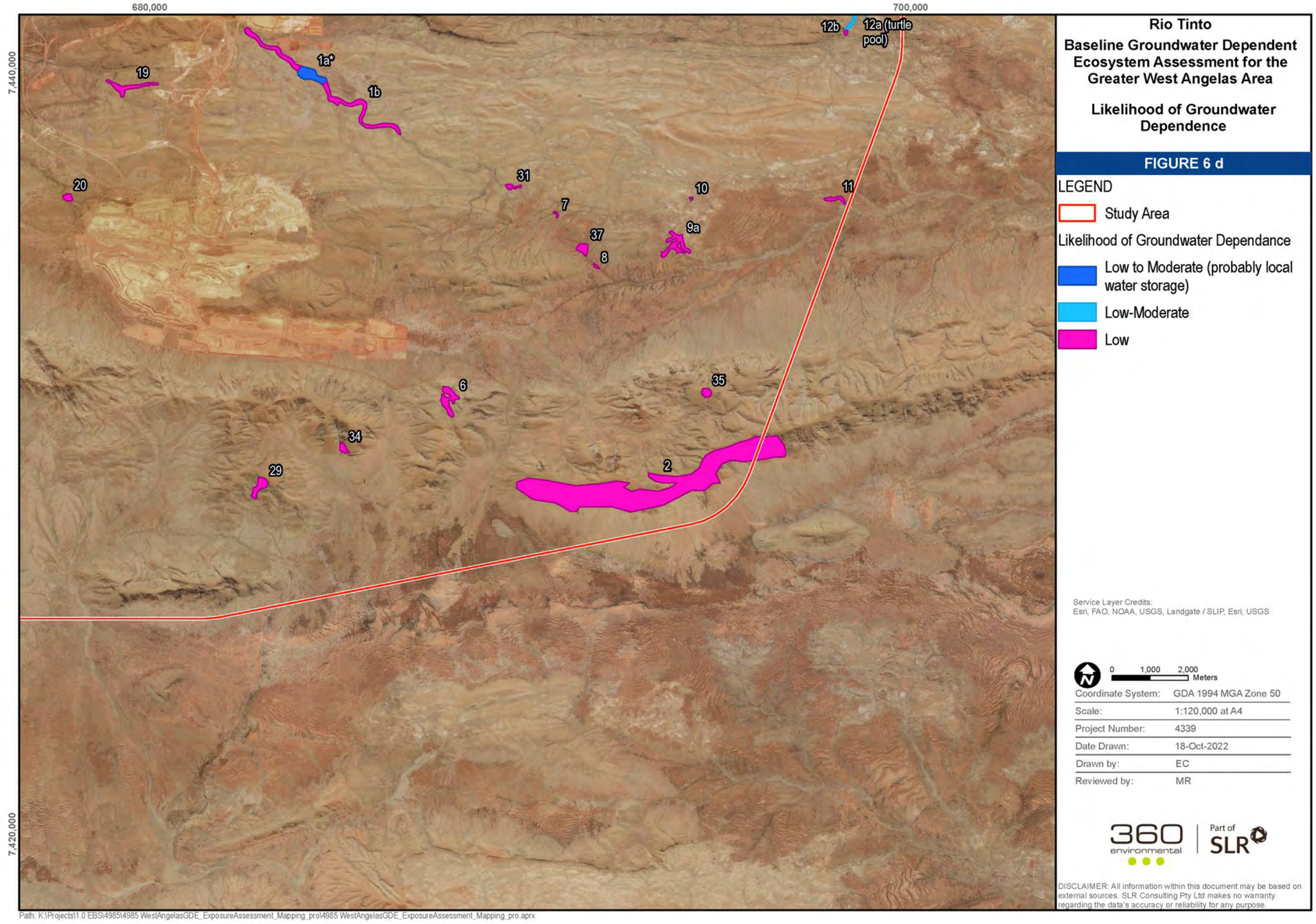

Figure 6 **Likelihood of groundwater dependence for all features with an NDVI persistence more than 0.60. Features are coloured based on estimated likelihood. Part a) Shows features East and West of Mt Ella East, Part b) shows the features near to and to the north of deposit H, Part c) shows all features in Turee creek to the south and west of western Hill.**

660,000

7,440,000

Rio Tinto

Baseline Groundwater Dependent Ecosystem Assessment for the Greater West Angelas Area

Biological Significance

FIGURE 7a

LEGEND

Study Area

Biological Significance

Low

Very Low

Service Layer Credits:
Esri, FAO, NOAA, USGS, Landgate / SLIP, Esri, USGS

0 1,000 2,000 Meters

Coordinate System:	GDA 1994 MGA Zone 50
Scale:	1:120,000 at A4
Project Number:	4339
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680,000

700,000

7,440,000

15
17
16
18
14
33
13
12a (turtle pool)
36
38
32
12b
1a*
19
1b
20
31
10
11
7
37
9a
8
6
35
34
2

Rio Tinto

Baseline Groundwater Dependent Ecosystem Assessment for the Greater West Angelas Area

Biological Significance

FIGURE 7 b

LEGEND

- Study Area

Biological Significance

- Low-Moderate
- Low
- Very Low

Service Layer Credits:
Esri, FAO, NOAA, USGS, Landgate / SLIP, Esri, USGS

0 1,000 2,000 Meters

Coordinate System:	GDA 1994 MGA Zone 50
Scale:	1:120,000 at A4
Project Number:	4339
Date Drawn:	18-Oct-2022
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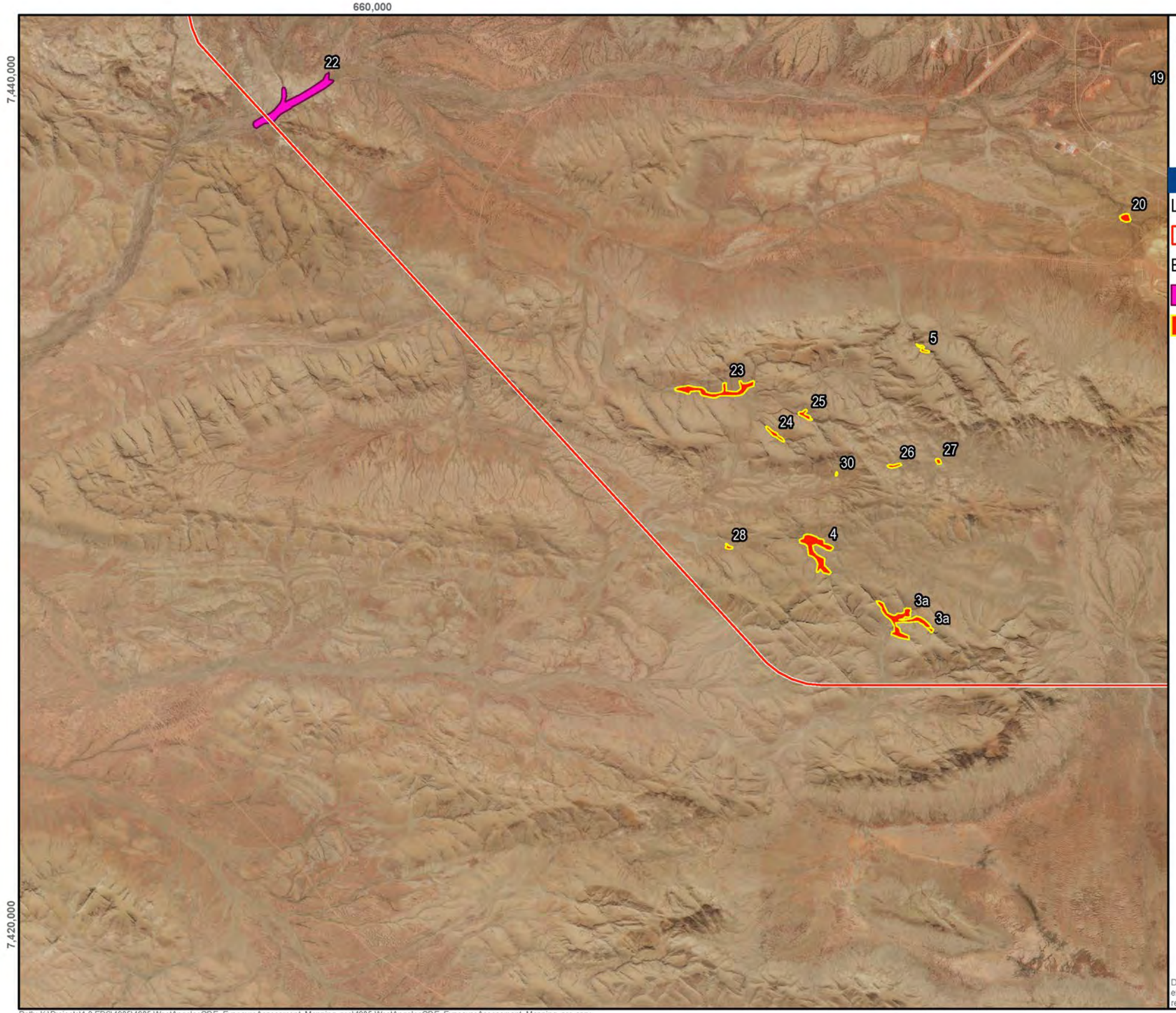
660,000

7,440,000

7,420,000



Rio Tinto

Baseline Groundwater Dependent Ecosystem Assessment for the Greater West Angelas Area

Biological Significance

FIGURE 7 c

LEGEND

Study Area

Biological Significance

Low

Very Low

Service Layer Credits:
Esri, FAO, NOAA, USGS, Landgate / SLIP, Esri, USGS

0 1,000 2,000 Meters

Coordinate System:	GDA 1994 MGA Zone 50
Scale:	1:120,000 at A4
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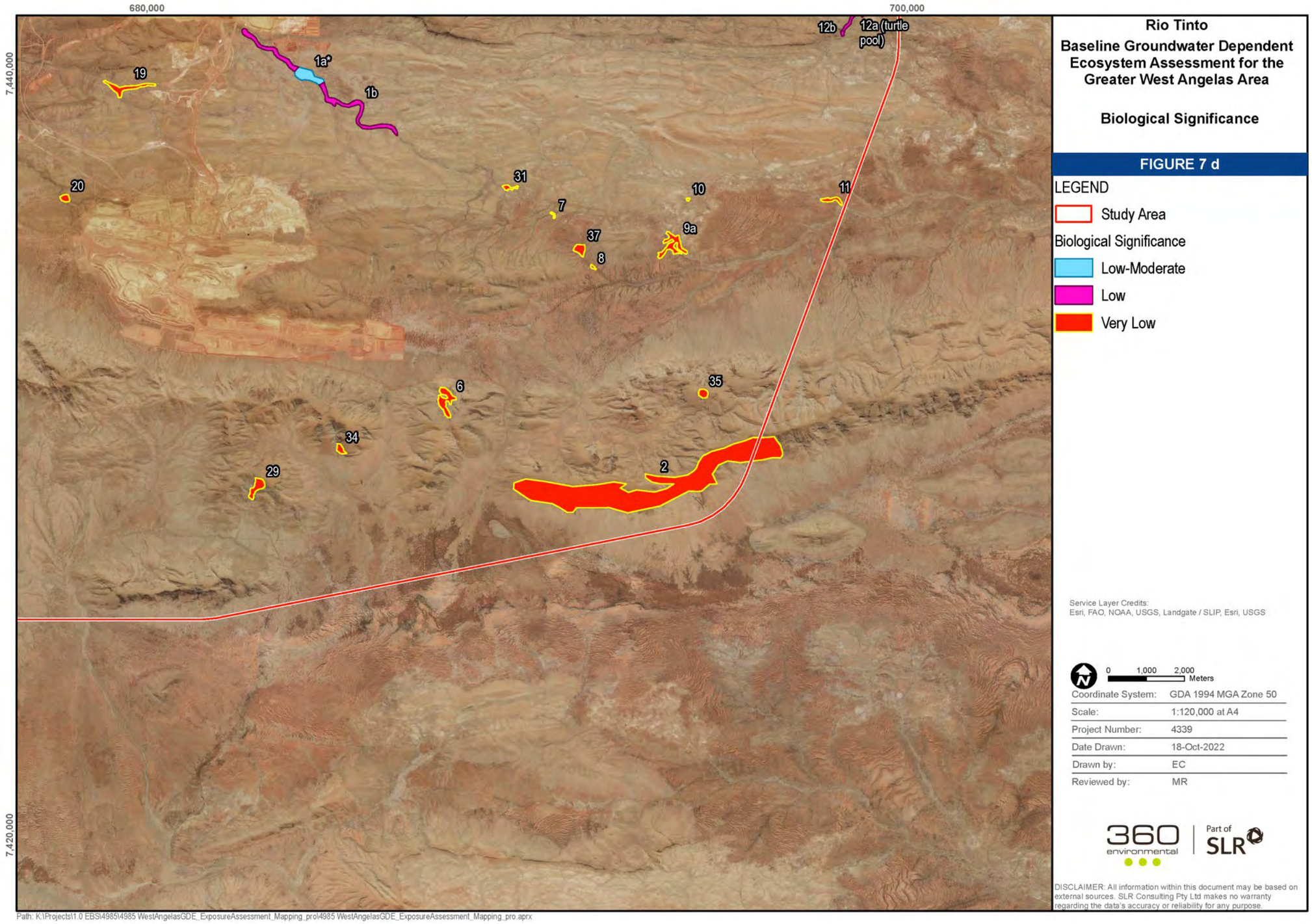

Figure 78: Biological significance of all features with an NDVI persistence more than 0.60. Features are coloured based on estimated significance Part a) Shows features East and West of Mt Ella East, Part b) shows the features near to and to the north of deposit H, Part c) shows all features in Turee creek to the south and west of western Hill.

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