Supporting Documentation

Native Vegetation Clearing Permit Application
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North Star Junction Solar Project

December 2021

NS-5600-AE-EN-0001 Rev 0

Native Vegetation Clearing Permit Application Supporting Documentation			
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1. INTRODUCTION

The Pilbara Energy (Generation) Pty Ltd (PEG), a wholly owned subsidiary of Fortescue Metals Group Limited (Fortescue), intend to develop the North Star Junction Solar Farm (the Project) an 80 MW solar farm in the Pilbara bioregion of Western Australia. The Project will be located within miscellaneous tenements L45/515 and L45/589 (Figure 1) and will involve the disturbance of up to 353.2 ha of native vegetation (Figure 2).

The Miscellaneous leases are situated adjacent to tenure on which the Fortescue integrated electricity network transmission lines and substation will be located (Figure 3). The North Star Junction Solar Farm (the Project) is a 120 MVA solar farm in the Pilbara bioregion of Western Australia. The North Star Junction solar farm is a component of the Pilbara Generation Project, complimenting the Pilbara Transmission Project.

The Project will consist of arrays of photovoltaic panels, mounted on above ground single axis trackers, with associated inverter stations. The tracking system will be mounted on pile type foundations embedded into the ground.

Electricity will be exported from the solar farms to the Fortescue integrated electricity network by connecting into the substation currently under construction. This electricity will primarily be used to supply the Iron Bridge mine site and its supporting infrastructure. The solar generation will offset the thermal generation requirements and will result in minimised dispatch of thermal generation units. It is anticipated that the approximately 64,000 tCO^2-e Scope 1 emissions will be removed across existing and future Fortescue operations.

This Native Vegetation Clearing Permit (NVCP) Application reflects the vegetation disturbance associated with the Project, under which PEG proposes to clear up to 353.2 ha of native vegetation within a 429 ha Purpose Permit Envelope (PPE) (Figure 2).

Vegetation disturbance for the Project will be located on *Mining Act 1978* tenure for which applications have been granted by the Department of Mines, Industry Regulation and Safety (DMIRS).

This report and its appendices provide all the relevant information required under Part V, Section 51E of the *Environmental Protection Act 1986* (EP Act), to assess the proposed clearing. This includes baseline environmental data, survey reports, a digital project envelope (shapefile) and assessment against the 10 Clearing Principles.

1.1 Summary of Proposal

The key details of the Project and the proposed clearing are represented in Table 1.

Table 1: Key Details of the Proposed Clearing

Site Details			
Project Name	Pilbara Energy Generation North Star Junction Solar Farm		
Description of Operation	Construct and operate an 80 MW solar array located at North Star Junction, as part of Fortescue's Pilbara Energy Generation Project.		
Total Clearing Proposed	353.2 ha of native vegetation (within a purpose permit envelope of 429 ha)		
Project Commencement Date	Construction: July 2022 Operation: November 2023		
Tenement Details	**Tenement**	**Tenement Holder**	**Status**
	L45/589 L45/515	Pilbara Energy (Generation) Pty Ltd Pilbara Energy (Generation) Pty Ltd	Granted
Clearing Method	Clearing will be undertaken by machinery, hand felling or directional pruning.		
Purpose of Clearing	The clearing is to allow for the undertaking of the following infrastructure requirements: • Photovoltaic panels mounted on above ground single axis trackers, with associated inverter stations • Tracking system • Switch rooms • Control room including office, amenity and ablution facilities • Underground and above ground power and communication cables • Access tracks for installation and maintenance • Fencing		

Proponent Details		
Company Name	Pilbara Energy (Generation) Pty Ltd	
ACN	630 303 305	
Postal Address	PO Box 6915 East Perth, Western Australia	
Key Contact	Name	Katherine Fox
	Position	Environmental Advisor - Environmental Approvals
	Phone	08 6218 8091
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1.2 Proposed Clearing Activities

Fortescue is applying to disturb a 353.2 ha Indicative Disturbance Footprint (IDF) within a PPE of 429 ha for the construction of the North Star Junction Solar Farm (Figure 2).

A breakdown of the clearing requirements is provided in Table 2 to give an indicative representation of the proposed works.

Table 2: Proposed Clearing by Activity

Item	Disturbance (ha)
Plant Site	334.4
Topsoil Stockpile	18.8
TOTAL	353.2

1.3 Mitigation Hierarchy

There has been considerable effort to design the placement of infrastructure to avoid significant environmental areas and to ensure the Project activities will have as minimal impact on the environment as practicable. The activities have been designed with the following principles in mind:

- Clearing will not have a significant impact on the environment; and
- Clearing is reversible through rehabilitation.

Using these principles, all areas of environmental significance has been avoided.

1.4 Relevant Approvals and Background

Key legislation that may affect the environmental management of the Project are included below in Table 3, as well as all relevant environmental approvals that have been sought or are required.

Table 3: Relevant Approvals for the North Star Junction Solar Farm

Relevant legislation	Environmental factor	Relevant approval/ Requirement
Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)	Biodiversity/Flora/Fauna/Ecosystems (Matters of National Environmental Significance)	Provides for the protection and regulation of impacts on the environment (Matters of National Environmental Significance). An impact assessment in Section 4 includes EPBC listed threatened fauna or fauna habitats. Fortescue undertakes MNES self-assessments for projects to assist in the determining if a referral under the EPBC Act is required.
Environmental Protection Act 1986 (EP Act) – Part IV	Preliminary key environmental factors identified: • Flora and Vegetation • Terrestrial Fauna	Provides for the protection and regulation of impacts on the environment in Western Australia. Consultation with DWER, along with impact assessment as per Section 4 indicates that no significant impacts to terrestrial fauna or flora and vegetation will occur. As such, no further approval is required, and the Project will not be formally referred under Part IV of the EP Act.
EP Act – Part V	Clearing of Native Vegetation Prescribed Premise categories	This Native Vegetation Clearing Permit (NVCP) – Purpose Permit is being submitted to facilitate land clearing associated with the scope of the Project. Works approvals and licensing are required for discharges and emissions associated with this Mining Proposal that trigger regulation under the EP Act. No prescribed premises categories, as listed in Schedule 1 of the EP Act, apply to the Project.
Biodiversity Conservation Act 2016 (BC Act)	Flora, fauna, ecological communities	Provides protection for threatened flora, fauna and ecological communities in Western Australia. The status of conservation significant flora, fauna, and communities under this Act has been considered in the NVCP. Where required, the project will obtain the appropriate approvals required under Section 40 or 40A.
Rights in Water and Irrigation Act 1914	Water resources	Provides for planning and allocation of water in Western Australia. Water will be sourced from existing licenced groundwater sources associated with Fortescue's Pilbara Mining Operations including but not limited to GWL162068, GWL162172 or GWL179289.

Relevant legislation	Environmental factor	Relevant approval/ Requirement
Aboriginal Heritage Act 1972 (AHA)	Aboriginal heritage	Protects all Aboriginal Sites, regardless of whether they are registered or not under Section 5 of the Act. There has been considerable effort to design the placement of infrastructure to avoid heritage sites and at this point, all identified sites have been avoided and no s18 applications are required.
Contaminated Sites Act 2003	Contaminated sites	Protection of human health and prevention of environmental harm by requiring owners, occupiers and polluters to report known or suspected contaminated sites and introduce a hierarchy of responsibility for remediation. The Project does not overlap with any registered contaminated site. No approvals are required under the *Contaminated Sites Act 2003*.

2. STAKEHOLDER ENGAGEMENT

Stakeholder consultation has formed part of the broader stakeholder engagement programme for Fortescue projects undergoing environmental approvals. The overarching objectives of the program are:

- To inform stakeholders about the Project and its impacts to the environment and to describe the outcomes of consultation on project design
- To establish relationships with key stakeholders that enable ongoing dialogue through implementation and regulation of the Project.

2.1 Key Stakeholders

Key stakeholders have been identified through Fortescue's existing and continued operations in the Pilbara. Fortescue has also incorporated previous recommendations from State government agencies on stakeholders that should be consulted. Key stakeholders identified to date are listed in Table 4.

Table 4: Identified Key Stakeholders for the Project

Government	Type of consultation
Department of Agriculture, Water and the Environment (DAWE)	Quarterly meeting
Department of Water and Environmental Regulation (DWER)	Monthly meeting

Government	Type of consultation
Department of Mines, Industry Regulation and Safety (DMIRS)	Quarterly meeting
Department of Biodiversity, Conservation and Attractions (DBCA)	As required or at request
Department of Planning, Lands and Heritage (DPLH)	As required or at request
Main Roads Western Australia (MRWA)	As required or at request
Town of Port Hedland (ToPH)	As required or at request
Pilbara Development Commission	As required or at request
Wildflower Society of WA	As required or at request
Conservation Council of WA	As required or at request
Kariyarra People	Regular working group meetings Regular Heritage Sub-committee meetings
Kangan Pastoral Station	As needed consultation from Fortescue's Pastoral Liaison Officer.

2.2 Stakeholder Consultation

The consultation activities undertaken to date and the feedback received by Fortescue is summarised in Table 5.

Engagement of stakeholders during the life of project will also be continued through:

- Working Group Meetings with Kariyarra during project development;
- DWER and DMIRS annual reporting on operations and/or environmental management;
- Public notices and/or advertisements in local / state wide newspapers for license or permit applications.

Table 5: Summary of Stakeholder Engagement

Date	Description of Engagement	Stakeholder	Stakeholder Comments/ Issue	Proponent Response and/or Resolution
08/05/2019	Miscellaneous Licence Applications L45/515 and L45/516 for Solar farms	Kangan Pastoral Station	Acknowledge greater impact than original powerline plan	Continue to provide updates
30/05/2019	Supply Draft Access Agreement	Kangan Pastoral Station	No comments recorded	Supply Draft Access Agreement from PEG
10/07/2019	Kangan Access Agreement Draft 2	Kangan Pastoral Station	Addition of CPI to annual payment at Kangan request	Access agreement executed 12 August 2019
20/08/2019	Objections to applications for L45/515 and L45/516	Kangan Pastoral Station	Withdraw objections to applications for L45/515 and L45/516 by PEG	Signed consent to withdraw objection

Date	Description of Engagement	Stakeholder	Stakeholder Comments/ Issue	Proponent Response and/or Resolution
23/09/2019	Kangan Access Agreement legal fees	Kangan Pastoral Station	Kangan Cost recoup of negotiations with PEG	As per access agreement
8/10/2019	General Mining Proposal and Mine Closure Plan Expectations	DMIRS	Early consultation preferred with DMIRS and other relevant government agencies. Risk assessment to be project specific and explain decision making process. Consistency between Mining Proposals is required.	Fortescue to address items raised when preparing new Mining Proposals and Mine Closure Plans.
16/10/2019	Basic project introduction and approvals strategy	DMIRS	Mining Proposal to include summary of consult with DWER regarding non-referral for Part IV.	Avoidance of high value environmental areas to be included.
			Native Vegetation Clearing Permit application to be submitted and these are a priority due to advertising periods.	Fortescue to make NVCP priority over Mining Proposal submission.
11/08/2020	Appropriate style for the Mining Proposal and request to submit Part 2 Mining Proposal	DMIRS	Given the size of the solar farms, a Part 2 Mining Proposal would not be appropriate as the activity is over 10ha.	Fortescue to prepare Part 1 style Mining Proposal for the solar farm.
21/08/2020	Payment for Granting of L45/515 and L45/516	Kangan Pastoral Station	As per Access Agreement	As per Access Agreement
26- 30 Sep 2020	Ethnographic Heritage survey KAR_147 was part of 2020_KAR_Trip4	Kariyarra Aboriginal Corporation nominated Traditional Owners.	Kariyarra Traditional Owners cleared the area ethnographically, for the related purpose.	Fortescue has received these survey and consultation results
26- 30 Sep 2020	Archaeological Heritage survey KAR_144 was part of 2020_KAR_Trip4	Kariyarra Aboriginal Corporation nominated Traditional Owners.	Kariyarra Traditional Owners and Consultants identified Archaeological sites within a portion of the survey area and requested that the infrastructure be put elsewhere.	Fortescue has reduced the proposed disturbance footprint within the activity envelope reflected in this proposal to avoid the identified archaeological sites number of sites recorded.
26- 30 Sep 2020	Archaeological Heritage survey KAR_146 was part of 2020_KAR_Trip4	Kariyarra Aboriginal Corporation nominated Traditional Owners.	Kariyarra Traditional Owners and Consultants identified Archaeological sites within a portion of the survey area and requested that the	Fortescue has reduced the proposed disturbance footprint within the activity envelope reflected in this proposal to avoid the identified archaeological sites.

Date	Description of Engagement	Stakeholder	Stakeholder Comments/ Issue	Proponent Response and/or Resolution
			infrastructure be put elsewhere.	
28/10/2020	Basic project introduction and approvals strategy in the context of existing Fortescue projects	DWER	Clearing for the solar farm will be progressed as a separate NVCP and not included as part of the Solomon rail project.	Project will not be referred under Part IV due to not meeting significance criteria. Clearing will be managed under Part V – NVCP Purpose Permit to be submitted to DMIRS.
19-29 March 2021	Archaeological Heritage survey KAR_153 was part of 2021_KAR_Trip1	Kariyarra Aboriginal Corporation nominated Traditional Owners.	Kariyarra Traditional Owners and Consultants identified minimal archaeological sites in the KAR_153 survey area.	Fortescue will base the design of the proposed infrastructure to avoid identified archaeological heritage in the area.
22/04/2021	Heritage Sub-committee Meeting included an update on the Solar Farm Project, new proposed areas for the solar farm and additional heritage survey requirements.	Kariyarra Aboriginal Corporation	Kariyarra had no concerns with the project and asked about the possibility of connecting power to caravans or nearby communities.	The high levels of generated power would not be suitable for the purpose of powering caravans or/and Aboriginal Communities.
7-16 August 2021	Ethnographic Heritage Survey KAR_154 was part of 2021_KAR_Trip4	Kariyarra Aboriginal Corporation nominated Traditional Owners.	Kariyarra Traditional Owners and the Consultants did not identify any ethnographic values in the KAR_154 area.	Fortescue has received these survey and consultation results.
30/09/2021	Heritage Sub-committee Meeting included an update on the Solar Farm Project, new proposed areas for the solar farm, recent survey results and additional heritage survey requirements.	Kariyarra Aboriginal Corporation nominated Traditional Owners.	Kariyarra asked whether the tenements for this project would be included in the current Land Access.	Fortescue's executed Land Access Agreement held with the Kariyarra automatically applies to tenure applications.
11/11/2020	New tenure application L45/589	Kangan Pastoral Station	To avoid Heritage (100% over L45/516 and part L45/515)	Awaiting feedback
23/11/2020	Kangan legal requests Form 21	Kangan Pastoral Station	Form 21 requested for L45/589	Form 21 supplied 25/11/2020 Awaiting feedback
05/01/2021	Acknowledge objection lodged against the new application L45/589	Kangan Pastoral Station	No response recorded	Advise new tenure is required due to heritage
10/03/2021	Follow up on email from 5/01/2021 re L45/589	Kangan Pastoral Station	Kangan requested heritage status of L45/589 (12/3/2021)	Supply status of surveys over L45/589 15/03/2021

Date	Description of Engagement	Stakeholder	Stakeholder Comments/ Issue	Proponent Response and/or Resolution
24/05/2021	Request if Deed of Amendment is suitable for withdrawal of objection to L45/589	Kangan Pastoral Station	Email from Kangan's Legal, requesting Deed of Variation (15/06/2021)	Prepare Deed
18/06/2021	Supply Deed for inclusion of L45/589 into existing Agreement for L45/515 & L45/516	Kangan Pastoral Station	No comments recorded	Supply Deed for inclusion of L45/589 into existing Agreement for L45/515 & L45/516
27/06/2021	Meeting at Yandeyarra to discuss tenure L45/589	Kangan Pastoral Station	No comments recorded	General update
04/08/2021	Traditional Owner Working Group Meeting	Kariyarra	No comments to date	Project update on North Star Junction Farm solar farm and other PEC projects.
9/08/2021	Again, request if Kangan's legal are comfortable with Deed of variation	Kangan Pastoral Station	Executed Deed of Variation 08 October 2021	Deed of variation
03/11/2021	Traditional Owner Working Group Meeting	Kariyarra	No comments to date	Project update on North Star Junction Farm solar farm and other PEC projects.
15/12/2021	Material provided in advance of Traditional Owner Board Meeting	Kariyarra	Endorsement of the project with letter of support provided (Appendix 1)	Project update on North Star Junction solar farm approvals summary
20/12/2021	Project update	EPAS	Impacts to flora, fauna, social surroundings and inland waters are not significant enough to warrant referral to the EPA.	Project will not be referred under Part IV due to not meeting significance criteria. Clearing will be managed under Part V – NVCP Purpose Permit to be submitted to DMIRS.
21/12/2021	Project update	DMIRS	Mine Closure Plan to consider involvement of third parties for power use.	Project will not be referred under Part IV due to not meeting significance criteria. Clearing will be managed under Part V – NVCP Purpose Permit to be submitted to DMIRS.

2.3 Heritage and Native Title

The proposal is located within the Kariyarra Native Title Determination area (Figure 11). Fortescue and The Kariyarra People are parties to a Land Access Agreement (LAA) dated 10 October 2005, as varied at 1 December 2016. The LAA assists in facilitating construction and development within the Kariyarra determined areas.

Fortescue regularly meets and consults with nominated representatives of The Kariyarra People over all matters relating to the identification, protection and management of their cultural

heritage. The Project will continue to liaise with these relevant Traditional Owner's and Native Title Groups regarding the development of the solar farm and associated infrastructure.

Fortescue has commissioned, funded and facilitated ethnographic and archaeological heritage surveys which have been completed by Kariyarra with their chosen heritage professionals. These surveys meet the requirements of the Cultural Heritage Due Diligence Guidelines (DPLH, DPC) which has been incorporated into Fortescue's Guideline for the Management of Aboriginal Cultural Heritage (Fortescue, November 2020), which guides planning and works in areas containing heritage sites.

The Project will continue to comply with the provisions of the AHA or as required under any successor legislation. Archaeological and Ethnographic survey extents and the location heritage places identified, recorded and mapped within the Disturbance Envelope are shown in Figure 9.

Implementation of the Land Use Certification (LUC) Procedure (100-PR-TA-0001) prior to any ground disturbance, rehabilitation, or land access will and continues to ensure any proposed activities are checked for purpose, including assessing for cultural heritage matters, prior to internally authorising the activity to proceed. Where required this may include the implementation of specific construction practices to minimise the risk to Aboriginal heritage.

Where heritage sites cannot be avoided, Fortescue's Heritage Approvals team will consult with Kariyarra traditional owners, before applying for a Ministerial Consent under s18 of the *Aboriginal Heritage Act 1972* (WA).

There has been considerable effort to design the placement of infrastructure to avoid heritage sites and at this point, all identified sites have been avoided and no s18 applications are required.

To ensure all project personnel and contractors give due consideration to Aboriginal heritage matters, FMG has established staff training, education, and inductions on Aboriginal Heritage and Cultural Awareness. This training provides Project personnel and contractors with an understanding of Aboriginal heritage sites, Aboriginal people, and their culture and country. This training also informs project personnel and contractors of obligations under the AHA.

3. BASELINE ENVIRONMENTAL DATA

Five surveys have been conducted within the North Star Junction project area and surrounding areas, including:

1. North Star Junction Flora and Fauna Assessments (Ecoscape, 2021) (Appendix A)
2. Pilbara Transmission Project Flora and Vegetation Desktop Assessment (Ecoscape, 2018) (Appendix B)
3. Pilbara Transmission Project Terrestrial Fauna Desktop Assessment (Spectrum, 2018) (Appendix C)
4. North Star Project Short-Range Endemic Invertebrate Survey (Ecologia, 2012) (Appendix D)
5. Fauna Habitats and Fauna Assemblage of the Proposed FMG Stage A Rail Corridor (Biota, 2004) (Appendix E).

Baseline environmental data in the following sections is discussed in the context of the proposed disturbance envelope.

3.1 Climate

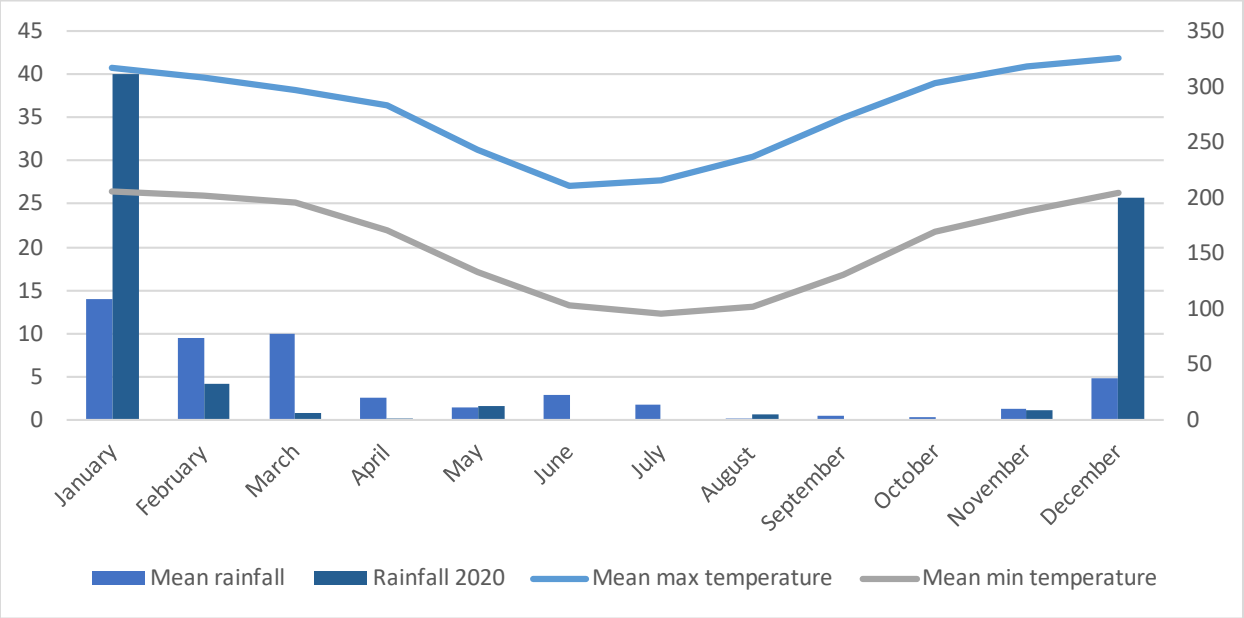
The Project is located within the Pilbara region, which includes two broad climatic zones. Coastal areas, as well as some higher rainfall inland areas, have a semi-desert tropical climate, which experience between 9 and 11 months of dry weather, with hot humid summers and warm winters. The remaining inland areas have a dry desert climate, typically with higher temperatures and lower rainfall, and often experience up to 12 months of dry weather, with hot dry summers and mild winters (van Vreeswyk, et al., 2004).

The closest BoM recording station to the proposal is Marble Bar (Site No. 004106). Marble Bar is located approximately 90 km east of the Project.

Summary statistics for the year 2000 to 2021 period (Graph 1) shows that temperatures are generally high, with mean maximum temperatures at Marble Bar ranging from 27.1°C in June to 41.9°C in December (BoM, 2021). Average minimum temperatures at Marble Bar range from 12.3°C in June to 26.5°C in January.

Mean annual rainfall is 403.1 mm, with January recording the highest monthly total of 109 mm. The annual rainfall for the year 2020 was higher than average, with 579 mm recorded, the majority (311.6 mm) of which fell in January.

Annual rainfall in the Pilbara has substantial yearly variation, but generally follows an inland to coastal and southern to northern increasing trend. Tropical cyclones, many of which originate in the Timor Sea, along with local thunderstorms, produce much of the summer and early autumn rainfall. The driest months are in spring (September to October), and winter rainfall is highly variable, generally decreasing from the coast through to inland areas (McKenzie et al. 2009).



Graph 1: Marble Bar Climate Averages (BoM, 2021)

3.2 Landscape

Land use in the region is dominated by pastoral grazing as well as mining. The Project is located entirely within the Pilbara biogeographic region of the Interim Biogeographic Regionalisation for Australia (IBRA). The Pilbara biogeographic region incorporates 17,831,892 ha and includes the subregions: Chichester and Roebourne. The Project is located within the Chichester subregion, which is described in the *2002 Biodiversity Audit of Western Australia's 53 Biogeographical Subregions* (May & McKenzie, 2003) as:

Chichester:

The Chichester subregion comprises the northern section of the Pilbara Craton. Undulating Archaean granite and basalt plains include significant areas of basaltic ranges. Plains support a shrub steppe characterised by *Acacia inaequilatera* over *Triodia wiseana* (formerly *Triodia pungens*) hummock grasslands, while *Eucalyptus leucophloia* tree steppes occur on ranges. The climate is Semi-desert-tropical and receives 300 mm of rainfall annually. Drainage occurs to the north via numerous rivers (e.g. De Grey, Oakover, Nullagine, Shaw, Yule, Sherlock). (May & McKenzie,2003)

3.2.1 Land Systems

The Project runs through two land systems, as described by van Vreeswyk et al. (2004). The Macroy land system makes up the largest percentage of area at 97.6% coverage of the IDF. The remaining 2.4% coverage can be attributed to the River System. There are no other land system intersects (Figure 7). These extents are described in Table 6.

Table 6: Land Systems Intersecting the Indicative Disturbance Footprint

Land System	Description	Percent of Indicative disturbance footprint (%)
Macroy System	Stony plains and occasional tor fields based on granite supporting hard and soft spinifex shrubby grasslands.	97.6
River System	Narrow, seasonally active flood plains and major river channels supporting moderately close, tall shrublands or woodlands of acacias and fringing communities of eucalypts sometimes with tussock grasses or spinifex.	2.4

3.3 Materials Classification

Most of the clearing associated with the Project will be conducted so that the root structure remains in place as much as reasonably practical to provide added stability to the soils for all areas of solar panel installation, exclusive of the pile foundations. Only roads requiring a supported base and any other minor infrastructure will result in the shallow disturbance of soils.

Risks associated with acidic and metalliferous drainage, sodic and dispersive materials, and naturally occurring radioactive materials are not considered relevant to the Project.

The potential occurrence of Acid Sulphate Soils (ASS) across the Disturbance Envelope was inferred from mapping provided by the Australian Soil Resource Information System (CSIRO, 2013). The entire Disturbance Envelope is mapped as having an Extremely Low to Low Probability of Occurrence.

The PPE intersects a single landscape land quality zone according to the Department of Primary Industries and Regional Development dataset DPIRD-017, described in Table 7, and mapped in Figure 8.

Table 7: Soil Zones Intersecting the Purpose Permit Envelope

Soil zone	Description	Mapped Extent within Purpose Permit Envelope (ha)
Abydos Plains and Hills	Stony plains (with some hills) on granitic rocks of the Pilbara Craton (East Pilbara Terrane) with Red deep sandy duplexes, Red shallow loams, Stony soils, Red sandy earths and Red loamy earths.	429

3.4 Flora and Vegetation

The PPE area and surrounds have been subject to extensive flora and vegetation surveys. The most relevant surveys include:

1. North Star Junction Flora and Fauna Assessments (Ecoscape, 2021) (Appendix A)
2. Pilbara Transmission Project Flora and Vegetation Desktop Assessment (Ecoscape, 2018) (Appendix B)

3. Vegetation and Flora Survey of the Proposed FMG Stage A Rail Corridor (Biota Environmental Sciences, 2004) (Appendix E)

3.4.1 Regional Vegetation Units

The PPE occurs within the Chichester subregion of the Pilbara Interim Biogeographic Regionalisation for Australia (IBRA) (as described in Section 3.2). Vegetation units have been described on a regional scale by Beard (1975) and updated by DAFWA (2012). These vegetation units are broad scale descriptors and attempt to depict the native vegetation as it was presumed at the time of European settlement. One Beard vegetation unit occurs within the disturbance footprint, shown in Table 8.

Table 8: Beard Vegetation Units Intersecting the Indicative Disturbance Footprint

Association	Description	Pre-European Extent (ha)	Current Extent (ha)	Mapped Extent within Purpose Permit Envelope (ha)
ABYDOS PLAIN – CHICHESTER 93	Hummock grasslands, shrub steppe; kanji over soft spinifex	2,476,378	2,473,007	429

3.4.2 Flora and Vegetation Studies

The PPE has been subject to extensive flora and vegetation survey efforts. Consequently, a significant number of intersecting surveys have been conducted in support of environmental approvals. The most recent survey completed by Ecoscape in 2021 included a literature review of the below flora and vegetation assessments. The flora and vegetation surveys that were reviewed and provided information for this assessment include:

Table 9: Flora and Vegetation Surveys Intersecting the Study Area

Report Title	Survey Date	Survey Type
North Star Slurry and Infrastructure Corridors, Conservation Significant Flora and Vegetation Assessment (Ecologia Environment 2015)	July 2015	Detailed
North Star Flora and Fauna Assessment (Ecologia Environment 2012)	April, June/July, August 2011	Level 2
Supplementary Vegetation and Flora Surveys of the Port Hedland to Cloudbreak Rail Corridor and Associated Borrow Pits and Infrastructure (Coffey Environments 2007)	2006	1 Phase Level 2
Vegetation and Flora Survey of the Proposed FMG Stage A Rail Corridor (Biota Environmental Sciences Pty Ltd 2004a)	2004	Detailed

3.4.3 Vegetation Communities

A total of 7 vegetation communities have been mapped within the PPE, as depicted in Table 10 and Figure 9. Six vegetation communities will be impacted by the Project's disturbance footprint.

Table 10: Vegetation Communities Intersecting the Purpose Permit Envelope

Veg Type Code	Description	Mapped Extent within Purpose Permit Envelope (ha)
AiTw	*Acacia inaequilatera* and *A. bivenosa* tall sparse shrubland over *Trioda wiseana* and *T. chichesterensis* low hummock grassland.	12.7
AoTl	*Acacia orthocarpa* and *Grevillea wickhamii* tall open shrubland over *Triodia lanigera* and *Acacia stellaticeps* low hummock grassland/shrubland.	197.5
AtTE	*Acacia tumida* var. *pilbarensis* tall sparse shrubland over *Triodia epactia* mid open hummock grassland	27.0
ChAcTe	*Corymbia hamersleyana* low open woodland over *Acacia colei* var. *colei* tall sparse shrubland over *Triodia epactia*, *T. longiceps* and *Chrysopogon fallax* mid hummock/tussock grassland.	12.9
MaAtCc	*Melaleuca argentea* and *Eucalyptus camaldulensis* subsp. *refulgens* open woodland over *Acacia tumida* var. *pilbarensis* and *A. trachycarpa* tall open shrubland over **Cenchrus ciliaris* and *Triodia epactia* low tussock/hummock grassland.	20.0
Tl	*Triodia longiceps* and *T. epactia* low hummock grassland.	155.2
Ts	*Triodia secunda* low hummock grassland	3.7

3.4.4 Vegetation Condition

The condition of vegetation communities within the IDF and PPE has been recorded and assessed using the adapted Keighery (1994) Vegetation Condition Scale for the Eremaean and Northern Botanical Provinces. The vegetation within the PPE ranges from Good to Excellent condition, with the majority of the vegetation considered to be in Excellent condition with minimal evidence of disturbance (Ecoscape, 2021). Vegetation in Good condition was mapped in the major drainage line corresponding with vegetation type MaAtCc, with higher abundances of weed species (particularly **Cenchrus ciliaris*) and cattle grazing.

3.4.5 Conservation Significant Vegetation Communities

In Western Australia, a vegetation community can be classified as a Threatened Ecological Community (TEC) by the Western Australian Minister for Environment, based on the assessment and recommendation of the Threatened Species Scientific Committee. TECs that are listed to be of State conservation significance in Western Australia are considered to be Environmentally Sensitive Areas (ESA) under Part V of the EP Act.

Potential TECs that do not meet survey criteria are added to the Priority Ecological Community (PEC) list under Priority 1, 2 or 3. Ecological communities that are adequately known, are rare but not threatened, meet criteria for "Near Threatened", or that have been recently removed

from the threatened list, are placed in Priority 4. Conservation dependent ecological communities are placed in Priority 5.

There are no TECs and PECs within the PPE, therefore no impact is anticipated.

3.4.6 Sheetflow Dependent Vegetation

The term 'sheetflow dependent vegetation' refers to vegetation communities that are dependent on an overland flow of water, which occurs on broad plains with a very gradual slope. Sheetflow dependent vegetation has not been mapped within the PPE.

3.4.7 Groundwater Dependent and Potentially Groundwater Dependent Vegetation

Groundwater Dependent Vegetation (GDV) is defined as terrestrial vegetation that is dependent on the presence of groundwater to meet some, or all, of its ecological water requirement (Astron, 2016).

The McAtCc vegetation type mapped within the Disturbance Envelope is considered to represent GDV as it is dominated by *Melaleuca argentea* and *Eucalyptus camaldulensis* (Ecoscape, 2021). These species are considered phreatophytic and groundwater dependent.

Riparian vegetation associated with creeklines in the east of the PPE is shown in Figure 10.

Ground disturbance associated with this proposal is unlikely to result in direct or indirect impacts to GDV or riparian vegetation. There will be no interference through groundwater abstraction, disposal or injection and minor deviations to surface water flows from vegetation clearing, ground disturbance and the construction of infrastructure will be limited. No activities will be undertaken within major creek or drainage lines.

3.4.8 Flora Taxa

A flora and vegetation survey of the wider North Star Junction project areas was conducted in Map 2021 (Ecoscape, 2021). The survey area totals 1,023 ha.

210 vascular flora species were recorded during the survey. The most commonly represented families recorded during the survey were Fabaceae (40 taxa), Poaceae (34, one introduced) and Malvaceae (20). The most commonly represented genera were Acacia with 14 taxa, Senna (seven) and Cyperus and Triodia (six each).

3.4.9 Flora of Conservation Significance

No Threatened Flora listed under the *Environment Protection and Biodiversity Conservation Act 1999* or the *Biodiversity Conservation Act 2016* have been recorded or mapped within the PPE.

Six species of Priority flora listed under Biodiversity Conservation Act 2016, have been recorded within the disturbance envelope, as listed in Table 11 and shown in Figure 11. Only *Goodenia nuda* and *Triodia chichesteriensis* have been recorded within the disturbance footprint (Ecoscape, 2021).

Table 11: Priority Flora Intersecting the Purpose Permit Envelope and Indicative Disturbance Footprint

Species	DBCA Conservation Status
Goodenia nuda	Priority 4
Nicotiana umbratica	Priority 3
Gymnanthera cunninghamii	Priority 3
Triodia chichesterensis	Priority 4
Rothia indica subsp. *australis*	Priority 3
Bulbostylis burbidgeae	Priority 4

3.4.10 Weeds

No Weeds of National Significance (WONS) were identified within the PPE and IDF. However, the following alien species were observed within the PPE.

- *Calotropis procera (Calotrope)
- *Cenchrus ciliaris (Buffel Grass)

Of the above, Fortescue considers the species in bold as a priority for management within our tenements. This species is classified as a Declared Pest plant under the Western Australian *BAM Act*.

3.5 Vertebrate Fauna

The Project area and surrounds have been subject to extensive fauna surveys. The most relevant survey include:

- North Star Junction and Flora and Fauna Assessments (Ecoscape, 2021)
- Pilbara Transmission Project Terrestrial Fauna Desktop Assessment (Spectrum, 2018)
- North Star Project Short-Range Endemic Invertebrate Survey (Ecologia, 2012)
- Fauna Habitats and Fauna Assemblage of the Proposed FMG Stage A Rail Corridor (Biota, 2004).

These surveys have been used to assess the fauna and fauna habitat of the disturbance envelope that the disturbance footprint is contained within.

3.5.1 Fauna Habitat

Three broad fauna habitat types, as mapped by Ecoscape (2021), were recorded to occur within the Disturbance Envelope (Figure 12). Details regarding these habitat types are listed in Table 12, including whether they support conservation significant fauna. Habitat quality varied from degraded to moderate dependent on the level of disturbance from clearing, fire history and trampling by Cattle.

Table 12: Fauna Habitats Intersecting the Purpose Permit Envelope

Habitat Type	Description	Significant Fauna & Suitability of Habitat Type	Mapped Extent within Purpose Permit Envelope (ha)
Creeklines	Riparian vegetation consisting of tall Eucalypts over Acacia and mixed shrubs over grasses	This habitat type is an important seasonal water source for many species. Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia* Pilbara form) could utilise large Eucalypt trees to roost during the wet season	28.7
Granite Outcrops (boulder piles)	Granite outcrops surrounded by spinifex grasslands	Provides potential habitat for *Ctenotus nigrillineatus*. Suitable granite outcrops may provide habitat for North Quoll (*Dasyurus hallucatus*)	27.0
Hummock Grassland	Spinifex grasslands with scattered granites on sandy and clay soils	Conservation-listed species such as Brush-tailed Mulgara (*Dasycercus blythi*) and Greater Bilby (*Macrotis lagotis*) are likely to use suitable sandy areas for burrows. Pebble-mound Mouse (*Pseudomys chapmani* P4) may use suitable areas with a stony surface within this habitat.	373.2
Total (ha)			429.0

3.5.2 Conservation Significant Fauna

Two vertebrate fauna species, listed as either threatened fauna (*EPBC Act*, *BC Act* Schedule) or as priority fauna (DBCA Priority list) have previously been recorded within the IDF, including:

- Brush-tailed Mulgara (*Dasycerus blythi*) – Priority 4 DBCA status
- Bilby (Macrotis lagotis) – Vulnerable EPBC and DBCA status

Additionally, the following species were determined to have a high likelihood of occurrence within the PPE:

- Northern Quoll (*Dasycerus hallucatus*) – Endangered EBPC and DBCA status
- Pilbara Leaf-nosed Bat (Rhinoniceteris aurantia) – Vulnerable EPBC and DBCA status

- Western Pebble-mound Mouse (*Pseudomys chapmani*) – Priority 4 DBCA status
- Spectacled Hare-wallaby (*Lagorchestes conspillatus*) – Priority 3 DBCA status

Brushed-tailed Mulgara

The Brush-tailed Mulgara inhabit arid sandy regions that support spinifex grasslands. Brush-tailed Mulgara burrows were recorded from four locations in Hummock Grassland habitat (Ecoscape, 2021). The species has previously been recorded from scattered locations nearby. Brush-tailed Mulgara are generally solitary, except during mating season. They occupy several burrows within their home range, which can have several entrances and pop holes.

Greater Bilby

The Greater Bilby (*Macrotis lagotis*) is listed as vulnerable under the EPBC Act and BC Act. Wild populations persist in the Northern Territory and parts of the Pilbara and Kimberley of Western Australia. They are generally found in arid rocky soil habitats with little ground cover to semi-arid shrublands and woodlands (Australian Museum, 2019).

Diggings most likely attributable to Bilby were recorded in Hummock Grassland habitat near a small granite outcrop. Bilbies have previously been recorded from scattered locations nearby. Evidence of Greater Bilby has been recorded from several locations across the Main Line Rail with the majority occurring in suitable habitat adjacent the Turner and Yule river systems (Spectrum, 2018).

Northern Quoll

The Northern Quoll is listed as Endangered under the EPBC Act and BC Act and within Western Australia is restricted to the Pilbara and Kimberley regions (Ecoscape, 2021). Northern Quolls do not have highly specific habitat requirements, occurring over a range of habitat types. The Pilbara population is associated with rocky habitats where they find refuge during the day. Drainage lines are used for dispersal and foraging where foraging can occur across any adjacent habitat type provides suitable cover and food resources. Small and isolated areas of these habitats are less suitable than larger areas.

The Northern Quoll has not previously been recorded within the survey area, however, has been recorded from several locations across the Main Line Rail (Spectrum, 2018). As a habitat generalist suitable foraging habitat may exist across the disturbance envelope and denning habitat restricted to the granite outcrops

Pilbara Leaf-nosed Bat

The Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*) is listed as vulnerable under the EPBC Act and BC Act. Its range is known to occur throughout the Pilbara and Kimberley regions of Western Australia, and they're generally encountered in rocky areas and disused underground mines, or in low abundance/ detection in flat land systems (DoEE, 2016).

No conservation significant bat species were identified from the full spectrum WAV-format recordings of their echolocation calls was based on measurements of characteristic frequency, observation of pulse shape, and the pattern of harmonics (Ecoscape, 2021).

No suitable for roosting habitat has been recorded in the disturbance envelope thus Pilbara Leaf-nosed Bats are highly unlikely to be resident within the proposal area. The open grassland and woodland, rocky areas and major watercourses, may provide potentially suitable foraging habitat, with distance from suitable roost structures considered the main limitation.

Western Pebble-mound Mouse

The Western Pebble-mound Mouse is native and endemic to Western Australia, where it lives in pebbly soils in arid tussock grassland and acacia woodland (Kitchener, 1983). Like other pebble-mound mice, the Western Pebble-mound Mouse creates its own microhabitat by scattering a mound of pebbles around its burrows (Dunlop & Pound, 1981). The preferred habitat of the species is hummock grasslands and is associated with eroding sands at natural features which expose small stones (pebbles).

No mounds were recorded within the disturbance envelope. Two mounds of the Western Pebble-mound Mouse (*Pseudomys chapmani*) have been recorded within 2 km north of the disturbance envelope.

Spectacled Hare-wallaby

The Spectacled Hare-wallaby (*Lagorchestes conspillatus*) occurs over much of northern Australia and has been recorded as inhabiting Spinifex grasslands in the Pilbara, requiring large grass hummocks for shelter. There are no records of this species recorded within the PPE.

3.5.3 Short Range Endemic Invertebrates

Short-range endemic (SRE) fauna are defined as animals that display restricted geographic distributions, nominally less than 10,000 km^2, that may also be disjunct and highly localised (Harvey 2002; Ponder & Colgan 2002).

The following reports were utilised to assess the short-range endemics of the local area.

- North Star Short Range Endemic Invertebrate Survey (Ecologia, 2012)

Analysis of the surveys for SRE invertebrates determined no significant SRE species have been recorded within the Disturbance Envelope. These studies covered an extensive range of habitats and microhabitat types that are considered suitable for SRE species. The impact of the project on potential SRE populations is expected to be low as the design and placement of infrastructure will typically not be within landscape features associated with SRE invertebrate habitats such as creeklines and rocky slopes.

3.5.4 Feral Animals

There are several introduced mammal species that are known to occur within the Pilbara region, including:

- Feral cat
- European Fox
- Wild dog
- House mouse
- Feral camel
- Feral horse/ donkey

3.6 Hydrology

Pilbara creeks are typically ephemeral and are dry for the majority of the year, with the exception of pools and groundwater fed springs. Pilbara soils typically have high initial infiltration rates for dry catchment conditions, i.e. when the antecedent moisture content of the soils is low. Significant streamflow usually occurs when antecedent moisture content of the soils is high, which is caused by significant rainfall in the days or weeks preceding a storm event.

There are typically two different types of climatic events which cause flood response in the Pilbara, namely: Cyclonic activity/Tropical Low-Pressure Systems, and localised diurnal thunderstorms.

Cyclonic activity can result in severe and widespread flooding, generally on a river catchment scale. The occurrence of this flooding activity can be forecast in advance (albeit with significant uncertainty), so catchment wide flood warnings are typically issued. This type of flooding typically produces large peak flows and may result in damage to infrastructure due to the magnitude of flow. However, not all cyclones will result in severe flooding.

Isolated thunderstorms have the potential to create fast and localised flooding, referred to as flash flooding. These events are much harder to predict as they can occur in the upper reaches of catchments. These events generally have a lower potential for widespread damage as the extent and magnitude of flooding is much smaller than cyclonic events.

The Disturbance Envelope is located within the Turner River Catchment and intersects tributaries of the Turner River along the eastern boundary with overall drainage towards the north. Surface water is mapped in Figure 13. During the ground disturbance phase of the project, surface water erosion risks will be managed by temporary erosion velocity and sediment control devices appropriate to the risk,

The proposed infrastructure associated with the Project is not expected to provide any significant impediment to drainage as the proposed clearing will focus on vegetation removal and mulching rather than removing topsoil in most areas. Any surface water flows during flood conditions will be able to easily move over the access tracks and permanent infrastructure adjusted as necessary to prevent any significant impacts to major creek flow paths.

4. ENVIRONMENTAL IMPACTS AND MANAGEMENT

The environmental impacts of the proposed vegetation clearing have been considered in the following section.

4.1 Potential Impacts to Flora and Vegetation

Potential impacts to flora and vegetation resulting from the clearing of vegetation for the Project include:

- Direct loss of vegetation at a local level
- Direct loss of conservation significant flora
- Degradation of vegetation due to indirect impacts such as:
    - Fragmentation, leading to edge effects
    - Spread or introduction of weeds
    - Dust deposition
    - Chemical spills and leaks
    - Changes to surface hydrology

4.1.1 Direct Loss of Vegetation

The Project will result in the disturbance of approximately 353.2 ha of native vegetation, comprising of a total of 7 vegetation communities, detailed in Table 13 and Figure 9.

Table 13: Vegetation Communities Intersecting the Indicative Disturbance Envelope

Veg Type Code	Description	Mapped Extent within Indicative Disturbance Footprint (ha)
AiTw	*Acacia inaequilatera* and *A. bivenosa* tall sparse shrubland over *Trioda wiseana* and *T. chichesterensis* low hummock grassland.	12.0
AoTl	*Acacia orthocarpa* and *Grevillea wickhamii* tall open shrubland over *Triodia lanigera* and *Acacia stellaticeps* low hummock grassland/shrubland.	195.0
ChAcTe	*Corymbia hamersleyana* low open woodland over *Acacia colei* var. *colei* tall sparse shrubland over *Triodia epactia*, *T. longiceps* and *Chrysopogon fallax* mid hummock/tussock grassland.	5.5
Tl	*Triodia longiceps* and *T. epactia* low hummock grassland.	137.0
Ts	*Triodia secunda* low hummock grassland	3.7

Project planning and scheduling have been used to avoid or minimise clearing as low as reasonably possible. Existing disturbed areas will be used wherever possible. The *North Star Junction Solar Project Land Use and Disturbance Procedure* will be implemented prior to any ground disturbance to reduce the risk associated of authorised disturbance.

4.1.2 Direct Loss of Conservation Significant Vegetation

During the design of infrastructure placement, specific attention was given to avoiding flora and vegetation communities of environmental significance. There are no TECs or PECs within the IDF.

4.1.3 Direct Loss of Sheetflow Dependent Vegetation

No sheetflow dependent vegetation has been identified within the IDF.

4.1.4 Direct Loss of Potentially Groundwater Dependent Vegetation

No potential GDV has been identified within the IDF.

4.1.5 Direct Loss of Flora of Conservation Significance

Flora spatial data was utilised in the design to avoid, where possible, any impacts to known flora of conservation significance. Design was unable to avoid direct impacts to two Priority Flora listed under the *Biodiversity Conservation Act 2016* that have been mapped within the IDF. The Project will result in the clearing of:

- *Goodenia nuda* (Priority 4) – two occurrences
- *Trioda chichesteriensis* (Priority 3) – one occurrence.

The removal of these occurrences is not considered to pose a significant threat to the conservation of either species.

No flora species listed as Threatened under the *Environment Protection and Biodiversity Conservation Act 1999* have been recorded within the IDF.

4.1.6 Degradation of Vegetation

Degradation of vegetation may occur as a result of:

- Uncontrolled vehicle access leading to physical damage of vegetation and/or the introduction or spread of weeds
- Dust deposition on vegetation resulting from land clearing and construction activities
- Introduction or spread of weed species
- interruption or reduction in surface water flows as a result of clearing, placement, design and operation of infrastructure causing flooding
- Spills or leaks of chemicals or contaminants leading to contamination of soils, surface water or groundwater

- Inappropriate disposal of domestic waste, waste hydrocarbons and chemicals, construction waste or treated sewage leading to contamination of soils, surface water or groundwater

Dust Deposition

Dust deposition can occur through movement of vehicles and earth moving. Dust deposition on foliage can impact on a plants ability to photosynthesise, or control water loss through transpiration. One published study indicates that vegetation health is not impacted by dust deposition until relatively high levels of dust are experienced, that is, greater than 7g/m2/month (Doley, 2006). The impact from dust deposition from this proposal is low as a result of the short construction timeframe due to rolling nature of construction activities and Fortescue's dust management measures (refer to Table 14).

Chemical Spills, Leaks and Leachate

Contamination of soil by chemical and contaminant spills can impede plant growth or kill vegetation. Drainage from infrastructure can contain higher levels of sediments which may cause a decline in vegetation health. Fortescue consider the risk of impacts to vegetation from contamination and pollution to be low with the implementation of the measures detailed in Table 14.

Altered Surface Hydrology

Flood modelling and LiDAR information will be used during the detailed design phase to determine the final infrastructure locations including minor surface water management where required (baseline modelling completed). No significant earthworks are anticipated in delivering the project and as such there are no anticipated changes to existing surface water flow paths within the area. Some minor earthworks will be required to provide for access tracks and pads for built infrastructure.

During the ground disturbance phase of the project, surface water erosion risks will be managed by temporary sediment control devices appropriate to the risk, such as silt traps/bunds, rock checks/weirs, diversion drains etc.

Some existing linear infrastructure is located within the project area and in the vicinity. The Project will be designed so as not to disrupt the existing surface water movement across the site in relation to this existing infrastructure.

The proposed infrastructure associated with the Project is not expected to provide any significant impediment to drainage as the proposed clearing will focus on vegetation removal and mulching rather than removing topsoil in most areas. Any surface water flows during flood conditions will be able to easily move over the access tracks and permanent infrastructure adjusted as necessary to avoid major creek flow paths.

4.1.7 Management Measures for Flora and Vegetation

There has been considerable effort expended to ensure project infrastructure will have as minimal an impact on flora and vegetation as practicable. The activities have been designed to ensure that the clearing avoids any significant impact on the environment and can be mitigated though rehabilitation.

The design and placement of infrastructure within the PPE has considered the locations of TECs, PECs and conservation significant flora species. Thus, no Threatened or Priority Flora listed under the *Environment Protection and Biodiversity Conservation Act 1999* or the *Biodiversity Conservation Act 2016* has been mapped within the IDF and no TECs or PECs will be impacted by the Stage 3 vegetation disturbance.

Mitigation measures to manage the residual risk are captured in Table 14.

Fortescue manages clearing of native vegetation through a Land Use Certification (LUC). A LUC identifies the area to be disturbed and considers multiple factors, such as environmental (significant values and approvals), heritage, tenure, pastoral leases and water, prior to disturbance being permitted. Each LUC application is reviewed for each factor by technical leads with Fortescue before approval is granted. Conditions are placed on each LUC with regards to the identified factors to ensure clearing is undertaken in accordance with legal obligations and with regards to environmental or heritage values. The LUC process allows applicants to modify their application to avoid significant or sensitive values in consultation with the technical leads prior to approval of the LUC.

Conditions of the LUC may include ground inspections for conservation significant flora or fauna depending on the receiving environment and the conditions of any environmental approval applicable to the area. No LUC would be approved without the area having been subject to heritage survey.

Table 14: Management Measures for Flora and Vegetation

Impact	Management Actions
Direct Loss of Vegetation and Flora	• Review the proposed project design against the vegetation survey data to avoid/minimise clearing of significant flora and vegetation. • Clearly delineate areas to be cleared with boundary pegging, flagging tape or other appropriate markers, or use equipment fitted with a Global Positioning System (GPS) capable of displaying clearing boundaries and avoidance area data. • Minimise clearing and vegetation disturbance to ensure significant flora and vegetation are protected. Conduct vegetation clearing in accordance with a permit issued under the *Land Use Certificate Procedure 100-PR-TA-0001* and *North Star Junction Solar Project Disturbance Procedure 540PG-0000-PR-EN-0001.* • Ensure staff and contractors are aware of the location of significant flora and vegetation on site and their responsibility to ensure they are protected.

Impact	Management Actions
Fragmentation	• Weed hygiene requirements are implemented for plant and equipment in identified weed risk areas and/or in areas where weed populations have been identified and high-risk activities are proposed to be undertaken in accordance with the *Weed Management Plan 100-PL-EN-1017.*
Dust	• Vehicle movement and speeds will be restricted. • Dust suppression will be carried out during construction. • Appropriate cover placed on open areas to minimise dust lift off post-closure.
Chemical Spills	• Adhere to the Dangerous Goods Regulations and provide Safety Data Sheets for all stored goods. • Fuelling of all vehicles and plant to always be carried out with an operator or driver in attendance. • Chemicals should be stored in designated areas in accordance with AS 1940, AS 3833 or AS 3780 to minimise the potential for environmental harm. • Maintain appropriate types and quantities of spill equipment located in strategic locations, with personnel trained in their use.
Altered surface hydrology	• Conduct a risk assessment to determine the likelihood of a change to the surface water regime that may lead to unacceptable environmental impacts. • Permanent infrastructure to be adjusted as necessary to not interfere with major creek flow paths. • Protect natural drainage lines from construction impacts where possible to minimise impacts to water quality.

4.1.8 Conclusion – Impacts to Flora

Taking into account the existing environment, proposed activities and management strategies, Fortescue believes the impacts of the proposed clearing on flora and vegetation are not significant.

4.2 Potential Impacts to Fauna

Potential impacts to terrestrial fauna, including conservation significant fauna, resulting from implementation of the Project include:

- Habitat loss from direct clearing of fauna habitat
- Habitat fragmentation, resulting in:
    - Restriction or removal of access to breeding habitat, foraging habitat or water sources through placement of infrastructure
    - Increased feral animal species

- Increased weed species
- Increased vehicle strike

4.2.1 Habitat Loss

Three broad fauna habitat types, were recorded to occur within the Purpose Permit Envelope with two being mapped within the Indicative Disturbance Footprint (Ecoscape, 2021). Details regarding these habitat types are listed in Table 15. Two vertebrate fauna species, listed as either threatened fauna (*EPBC Act*, *BC Act* Schedule) or as priority fauna (DBCA Priority list) have previously been recorded within the IDF, including:

- Brush-tailed Mulgara (*Dasycerus blythi*) – Priority 4 DBCA status
- Greater Bilby (*Macrotis lagotis*) – Vulnerable EPBC and DBCA status

Table 15: Fauna Habitats Intersecting the Indicative Disturbance Footprint

Habitat Type	Description	Significant Fauna & Suitability of Habitat Type	Mapped Extent within Indicative Disturbance Footprint (ha)
Creeklines	Riparian vegetation consisting of tall Eucalypts over Acacia and mixed shrubs over grasses	This habitat type is an important seasonal water source for many species. Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia* Pilbara form) could utilise large Eucalypt trees to roost during the wet season	1.3
Hummock Grassland	Spinifex grasslands with scattered granites on sandy and clay soils	Conservation-listed species such as Brush-tailed Mulgara (*Dasycercus blythi*) and Greater Bilby (*Macrotis lagotis*) are likely to use suitable sandy areas for burrows. Pebble-mound Mouse (*Pseudomys chapmani* P4) may use suitable areas with a stony surface within this habitat.	351.9
Total (ha)			353.2

As shown in Table 15, the majority of the IDF is mapped as Hummock Grassland, which provides habitat to the Brush-tailed Mulgara and Greater Bilby, both of which have been recorded within the IDF. Suitable granite outcrops may provide habitat for the Northern Quoll (*Dasyurus hallucatus);* however the species has not been recorded within the area with small and isolated areas of these habitats less suitable than larger areas. There has been considerable effort to design the placement of infrastructure to significant fauna habitat and at this point all mapped granite outcrops and major creeklines have been avoided.

Where possible, spatial data has been utilised in the design to avoid impacts to known conservation significant fauna habitat. Where not directly impacted by the placement footprint of permanent infrastructure, vegetation associated with significant fauna habitat will be avoided where practical.

4.2.2 Fragmentation of Habitat

Fragmentation occurs when a large expanse of habitat is transformed into a number of smaller patches due to clearing, isolating these smaller fragments from each other by cleared areas (Wilcove, McLellan, & Dobson, 1986). Where the landscape surrounding the fragments is inhospitable to species of the original habitat, and when dispersal is low, remnant patches can be considered true habitat islands and local communities will be isolates. Small habitat fragments are likely to be low in heterogeneity, that is, the habitat may not present the range of habitat variety required by some species (e.g. both foraging and breeding habitat) (Wilcove, McLellan, & Dobson, 1986).

It is possible that the vegetation disturbance for the Project may cause a barrier to some species movement within their home ranges, particularly small reptiles and mammals. Fortescue will implement the *Conservation Significant Fauna Management Plan 100-PL-EN-0022* that addresses impact to significant fauna and their habitat including, but not limited to clearing of habitat, fragmentation of habitat, vehicle strike, increased feral animals, light and noise. Significant impacts to fauna resulting from habitat fragmentation is not anticipated.

4.2.3 Increased Vehicle Strike

The undertaking of vegetation disturbance for the Project will result in an increase in the number of vehicles in the local area. Vehicles may strike fauna species on roads, particularly slow-moving animals or species that are easily startled. Vehicles travelling at night are more likely to strike native fauna when visibility is reduced and animals are more active. Species such as birds of prey are also likely to feed off dead carcases on roads and may also become victim to vehicle strike.

Fortescue keeps a record of all vehicle related fauna incidents. The species with the highest number of vehicle strikes at Fortescue's operating sites is the kangaroo, usually at dawn and dusk. There have been relatively few vehicle strikes involving significant fauna at Fortescue sites. It is not expected that the clearing activities will result in a significant increase in vehicle strikes.

4.2.4 Increased Weed Species

Clearing for development and increased movement of vehicles, including earth moving machinery may result in the spread of existing or the establishment of new, populations of weed species. Increased numbers of weeds can significantly increase the risk of fire, which can impact on fauna habitat value. Areas of dense weed infestation can also reduce the ability of fauna to move through their habitat and impact on their ability to forage. Weed species palatable to feral herbivores may attract these animals to the area causing an increase in predation of native species, potential land degradation and further spreading of weed species either by movement of soil or in the animal's dung.

No Weeds of National Significance (WONS) were identified within the PPE or IDF. The following alien species were observed within the IDF.

- ****Calotropis procera*** **(Calotrope)**
- **Cenchrus ciliaris* (Buffel Grass)

Of the above, Fortescue considers the species in bold as a priority for management within our tenements. This species is classified as a Declared Pest plant under the Western Australian *BAM Act*.

Through the implementation of weed hygiene management measures, it is not expected that the Project will result in significant spread of or the introduction of new weed populations.

4.2.5 Mitigation

Fortescue has applied the mitigation hierarchy to the Project in relation to terrestrial fauna. Mitigation measures to address potential impacts are detailed in Table 16.

Table 16: Management Measures for Fauna

Impact	Management Actions
Loss of habitat	• Land use certification (LUC) procedure. Must be adhered to before any ground disturbance, rehabilitation or land access. This ensures all proposed disturbance is checked for: purpose; cultural heritage; and environmental significance. No ground disturbance can take place without a valid land use certificate. • Ensure infrastructure location, design, construction and operation reflects risk assessment outcomes in minimising impacts on conservation significant fauna and associated habitat. • Ensure staff and contractors are provided with appropriate training to ensure conservation significant fauna and associated habitat are protected. • Prior to conducting ground disturbance activities, ensure known locations of environmentally sensitive areas to be retained and protected from disturbance are identified on the ground by appropriate signage, fencing or flagging.
Fragmentation of habitat	• Land use certification (LUC) procedure must be adhered to before any ground disturbance, rehabilitation or land access. This ensures all proposed disturbance is checked for: purpose; cultural heritage; and environmental significance. No ground disturbance can take place without a valid land use certificate.
Increased Feral Animals	• Implementation of a Feral Animal Management Program. • All domestic waste will be transported off site. • No domestic animals permitted on site.
Vehicle Strike	• To minimise the potential for fauna injuries or deaths on access roads, implement appropriate mitigation measures such as speed limit restrictions, right of way for fauna and the prohibition of off tenure driving.
Weeds	• Weed hygiene requirements are implemented for plant and equipment in identified weed risk areas and/or in areas where weed populations have been identified and high-risk activities are proposed to be undertaken in accordance with the *Weed Management Plan 100-PL-EN-1017.* • Management actions from the plan include identifying and mapping high risk areas, inducting staff and contractors, weed hygiene in high risk areas and implementation of weed control and monitoring programs.
Changes to surface water	• Drainage infrastructure location, design, construction and operation to design specifications which reflect risk assessment outcomes in minimising interference and disruption of natural surface water flows and quality in accordance with the Surface Water Management Plan 100-PL-EN-1015 • Protect natural drainage lines from construction impacts where possible to minimise impacts to water quality.

4.2.6 Conclusion – Impacts to Fauna

Taking into account the existing environment, proposed activities and management strategies, Fortescue believes the impacts to fauna and fauna habitat from the proposed clearing are not significant.

4.3 Assessment Against the 10 Clearing Principles

The *Environmental Protection Act 1986* includes 10 principles that provide decision makers with a guide on whether native vegetation should be cleared. The principles, outlined in 'Schedule 5 – Principles for Clearing Native Vegetation', are used as a comparative tool by DWER and DMIRS in determining whether clearing activities are environmentally acceptable and capable of being appropriately managed. Table 17 assesses the proposed clearing against these Principles.

Table 17: Proponent Assessment of the Clearing Principles

Proponent Assessment of the Clearing Principles
(a) Native vegetation should not be cleared if it comprises a high level of biological diversity.
Proposed clearing is not likely to be at variance to this Principle The PPE and surrounding areas have been subject to extensive flora and vegetation survey efforts, detailed throughout this document. The recent Ecoscape (2021) North Star Junction Flora and Fauna Assessments recorded a total of 210 vascular flora from 115 genera and 48 families within the wider North Star Junction area, which encompasses the PPE. The number of flora taxa recorded is relatively high compared with other nearby areas. This is considered likely indicative of the above average seasonal conditions at the time of survey. The condition of vegetation communities within the IDF and PPE has been recorded and assessed using the adapted Keighery (1994) Vegetation Condition Scale for the Eremaean and Northern Botanical Provinces. The vegetation within the PPE ranges from Good to Excellent condition, with the majority of the vegetation considered to be in Excellent condition with minimal evidence of disturbance (Ecoscape, 2021). Vegetation from drainage lines were typically in lesser condition, with higher abundances of weed species (particularly **Cenchrus ciliaris*) and cattle grazing. There are no TECs or PECs within the PPE. No Weeds of National Significance (WONS) were identified within the PPE and the IDF as detailed under section 3.4.10. Weeds species within the IDF include **Calotropis procera* (Calotrope) and **Cenchrus ciliaris* (Buffel Grass). Fortescue considers Calotrope as a priority for management within our tenements. Through the implementation of weed hygiene management measures, it is not expected that the Project will result in significant spread of or the introduction of new weed populations. Project planning and scheduling have been used to avoid or minimise clearing to as low as reasonably practicable. Existing disturbed areas will be used wherever possible. Flora spatial data has been used in design to avoid impacts to known priority flora, where possible. Taking this into account, the IDF is composed of vegetation and fauna habitat that are typical in the landscape. Thereby the proposed vegetation disturbance associated with the Project will not significantly reduce the potential biodiversity by reducing habitat diversity. Based on the above, the proposed clearing is not likely to be at variance to this Principle.

Proponent Assessment of the Clearing Principles

(b) Native vegetation should not be cleared if it comprises the whole or part of, or is necessary for the maintenance of, a significant habitat for fauna indigenous to Western Australia.

Proposed clearing is not at variance to this Principle

The PPE and surrounding areas have been subject to extensive fauna survey efforts, detailed throughout this document. Three broad fauna habitat types have been recorded within the IDF:

- Creeklines – Riparian vegetation consisting of tall Eucalypts over Acacia and mixed shrubs over grasses
- Granite Outcrops – Granite outcrops surrounded by spinifex grasslands
- Hummock Grassland – Spinifex grasslands with scattered granites on sandy and clay soils.

The quality of these habitats varied from Degraded to Moderate condition. The majority of the IDF can be attributed to the Hummock Grasslands habitat type, which provides habitat for the following conservation listed species, both of which have been recorded within the IDF:

- Brush-tailed Mulgara (*Dasycercus blyth*) – Priority 4, DBCA
- Greater Bilby (Pseudomys chapani) – Vulnerable, EPBC and DBCA

Where possible, spatial data has been utilised in the design to avoid impacts to known conservation significant fauna habitat. Where not directly impacted by the placement footprint of permanent infrastructure, vegetation associated with significant fauna habitat shall be avoided where practicable. The IDF is composed of vegetation and fauna habitat that are typical within the landscape, and therefore the proposed clearing is not expected to significantly impact fauna habitat essential for the survival or recovery of conservation listed species. The locations for proposed infrastructure have been selected to avoid watercourses, creek lines and drainage lines, and will utilise cleared areas and existing access tracks wherever possible.

Based on the above, the proposed clearing is not likely to be at variance to this Principle.

(c) Native vegetation should not be cleared if it includes, or is necessary for the continued existence of, rare flora.

Proposed clearing is not at variance to this Principle

Flora spatial data was utilised in the design to avoid, where possible, any impacts to known flora of conservation significance. Design was unable to avoid direct impacts to two Priority Flora listed under the *Biodiversity Conservation Act 2016* that have been mapped within the IDF. The Project will result in the clearing of:

- *Goodenia nuda* (Priority 4) – two occurrences
- *Trioda chichesteriensis* (Priority 3) – one occurrence.

The removal of these occurrences is not considered to pose a significant threat to the ongoing conservation of either species.

No flora species listed as Threatened under the *Environment Protection and Biodiversity Conservation Act 1999* have been recorded within the IDF. The vegetation unit that is proposed to be cleared is common in the landscape and is not considered habitat that would support threatened flora.

Based on the above, the proposed clearing is not at variance to this Principle.

(d) Native vegetation should not be cleared if it comprises the whole or a part of, or is necessary for the maintenance of a threatened ecological community.

Proponent Assessment of the Clearing Principles

Proposed clearing is not at variance to this Principle

During the design of infrastructure placement, specific attention was given to avoiding flora and vegetation communities of environmental significance. There are no TECs or PECs within the PPE.

Based on the above, the proposed clearing is not at variance to this Principle

(e) Native vegetation should not be cleared if it is significant as a remnant of native vegetation in an area that has been extensively cleared.

Proposed clearing is not at variance to this Principle

The PPE occurs within one subregion of the Pilbara Interim Biogeographic Regionalisation for Australia (IBRA), being the Chichester subregion. The Chichester subregion has not been extensively cleared nor are there vegetation communities within the IDF that would be considered remnant.

There is one Beard (1975) vegetation unit within the PPE. This vegetation community is considered widespread across the Pilbara, with over 99 percent of its pre-European extent remaining:

- ABYDOS PLAIN – CHICHESTER 93; Hummock grasslands, shrub steppe; kanji over soft spinifex

Based on the above, the proposed clearing is not at variance to this Principle.

(f) Native vegetation should not be cleared if it is growing in, or in association with, an environment associated with a watercourse or wetland.

Proposed clearing is not likely to be at variance to this Principle

The PPE is located within the Turner River Catchment and intersects tributaries of the Turner River along the eastern boundary, with overall drainage to the north. Significant disturbance to the natural drainage of water from the landscape is not anticipated under the proposed clearing.

The locations for proposed infrastructure have been selected to avoid major watercourses, creek lines and drainage lines, and will utilise cleared areas and existing access tracks wherever possible. The proposed infrastructure placement associated with the Project will not cause any significant impediment to drainage as the proposed clearing will focus on vegetation removal and mulching rather than removing topsoil in most areas. Any surface water flows during flood conditions will be able to easily move over the access tracks and permanent infrastructure adjusted as necessary to avoid significant impacts to major creek flow paths.

Based on the above, the proposed clearing is not likely to be at variance to this Principle.

(g) Native vegetation should not be cleared if the clearing of the vegetation is likely to cause appreciable land degradation.

Proposed clearing is not likely to be at variance to this Principle

The management measures detailed in previous sections will assist in reducing the likelihood of land degradation occurring as a result of vegetation disturbance for the Project. These management measures include surface water and weed management measures. The proposed clearing will focus on vegetation removal and mulching rather than removing topsoil in most areas. In addition, the proposed clearing is for the placement of infrastructure which will be maintained and used to ensure erosion does not take place in any significance.

Vehicular tracks required for the access and maintenance of the infrastructure will be developed at equal grade and level to the surrounding landscape.

Proponent Assessment of the Clearing Principles

Based on the above, the proposed clearing is not likely to be at variance to this Principle.

(h) Native vegetation should not be cleared if the clearing of the vegetation is likely to have an impact on the environmental values of any adjacent or nearby conservation area.

Proposed clearing is not at variance to this Principle

The PPE does not intersect or adjoin any conservation areas, including National Reserves, National Parks or other areas vested for conservation. The nearest conservation estate is Mungaroona Range Nature Reserve which is approximately 55 km southwest of the PPE.

The location of permanent infrastructure within the IDF will be adjusted as necessary to avoid any creek flow paths. The proposed infrastructure placement will not provide any significant impediment to drainage as the proposed clearing will focus on vegetation removal and mulching rather than removing topsoil in most areas. Any surface water flows during flood conditions will be able to easily move over the access tracks and permanent infrastructure adjusted as necessary to avoid major creek flow paths.

Based on the above, the proposed clearing is not at variance to this Principle.

(i) Native vegetation should not be cleared if the clearing of the vegetation is likely to cause deterioration in the quality of surface or underground water.

Proposed clearing is not likely to be at variance to this Principle

The PPE is located within the Turner River Catchment and intersects tributaries of the Turner River along the eastern boundary, with overall drainage to the north. Some existing linear infrastructure is located within the project area and in the vicinity. The Project has been designed so as not to disrupt the existing surface water movement across the site in relation to this existing infrastructure.

The proposed infrastructure associated with the Project is not expected to provide any significant impediment to drainage as the proposed clearing will focus on vegetation removal and mulching rather than removing topsoil in most areas. Any surface water flows during flood conditions will be able to easily move over the access tracks and permanent infrastructure adjusted as necessary to prevent any significant impacts to major creek flow paths. Appropriate stormwater, vegetation clearing, and materials handling management measures will be put in place to minimise the potential impact on water quality.

It is unlikely that the proposed clearing will impact groundwater quality due to the nature of the project having minimal interaction with groundwater as all infrastructure will be installed above the water table and water supply for construction / maintenance will be sourced from existing bores associated with Fortescue's Pilbara Mining Operations.

Potential impacts are likely to be localised and may include increased turbidity arising from topsoil disturbed areas after heavy rainfall events. Small chemical or hydrocarbon spills are unlikely to have a detrimental impact as the pathway is managed through the implementation of spill clean-up procedures. The proposal is unlikely to impede drainage or surface water flows during flood conditions as the water will be able to easily move over or around any installed infrastructure.

Based on the above, the proposed clearing is not likely to be at variance to this Principle.

(j) Native vegetation should not be cleared if the clearing of the vegetation is likely to cause, or exacerbate, the incidence or intensity of flooding.

Proponent Assessment of the Clearing Principles

Proposed clearing is not at variance to this Principle

As discussed in Principle (i), some existing linear infrastructure is located within the project area and in the vicinity. The Project has been designed so as not to disrupt the existing surface water movement across the site in relation to this existing infrastructure.

The proposed infrastructure associated with the Project is not expected to provide any significant impediment to drainage as the proposed clearing will focus on vegetation removal and mulching rather than removing topsoil in most areas. Any surface water flows during flood conditions will be able to easily move over the access tracks and permanent infrastructure adjusted as necessary to prevent any significant impacts to major creek flow paths.

Changes to surface water flows as a result of the Project will be negligible. The natural drainage features of the landscape will largely be unaffected by the IDF and hence impacts to the landscape associated with this aspect are not anticipated to occur.

Based on the above, the proposed clearing is not at variance to this Principle.

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Figure 1: Activity Envelope North Star Junction

687,000
688,500
690,000
7,651,500
7,650,000
7,648,500

L45/515
L45/589

LEGEND

- Activity Envelope - North Star Junction
- FMG Managed Tenements
- Road
- Minor Track

N

0 0.25 0.5 0.75 1

Kilometres

Figure: Activity Envelope North Star Junction

Requested By: Katherine Fox
Drawn By: Sang Li
Revised By: shlaw
Approved By:
Scale: 1:15,000
Coordinate System: GDA 1994 MGA Zone 50
Document Name: 4519OP002_MP_EN_0032.001_r1_ActivityEnvelope

Date: 4/11/2021
Size: A3P
Revision: 1
Confidentiality: 1

Data Source(s):
Landgate and FMG, 2021

FMG Fortescue

Figure 2: Site Plan

687,000

688,500

7,651,500

7,650,000

L45/515

L45/589

LEGEND

- Activity Envelope
- FMG Managed Tenements

Disturbance Footprint

- Plant Site
- Topsoil Stockpile

Other Cleared Areas

- FMG Cleared Area
- Non-FMG Cleared Area

N

0 0.25 0.5 0.75 1

Kilometres

Figure: Footprint

Requested By: Katherine Fox
Drawn By: Sang Li
Revised By: shlaw
Approved By:
Scale: 1:12,500
Coordinate System: GDA 1994 MGA Zone 50
Document Name: 4519OP002_MP_EN_0032.015_r0_Footprint

Date: 29/11/2021
Size: A3P
Revision: 0
Confidentiality: 1

Data Source(s):
Landgate and FMG, 2021

Fortescue

Figure 3: Tenure

687,500

690,000

7,652,500

7,650,000

L45/515

L45/589

LEGEND

- Activity Envelope
- FMG Managed Tenements
- Disturbance Footprint
- General Lease
- Pastoral Lease
- Road Reserve

N

0 0.25 0.5 0.75 1

Kilometres

Figure: Land Tenure

Requested By: Katherine Fox
Drawn By: Sang Li
Revised By: shlaw
Approved By:
Scale: 1:20,000
Coordinate System: GDA 1994 MGA Zone 50
Document Name: 4519OP002_MP_EN_0032.010_r1_Land_Tenure

Date: 4/11/2021
Size: A3P
Revision: 1
Confidentiality: 1

Data Source(s):
Landgate and FMG, 2021

Fortescue

Figure 4: Native Titles

680,000
690,000
7,660,000
7,650,000
7,640,000

Nyamal People #1
Native Title Determination

Kariyarra
Native Title Determination

LEGEND

- Activity Envelope
- Disturbance Footprint
- Native Title Determination (Register)

N

0 1 2 3 4

Kilometres

Figure: Native Titles

Requested By: Katherine Fox
Drawn By: Sang Li
Revised By: shlaw
Approved By:
Scale: 1:75,000
Coordinate System: GDA 1994 MGA Zone 50
Document Name: 4519OP002_MP_EN_0032.011_r1_Native_Title

Date: 4/11/2021
Size: A3P
Revision: 1
Confidentiality: 1

Data Source(s):
Landgate and FMG, 2021

Fortescue

CONFIDENTIAL Figure 5: Heritage Surveys

CONFIDENTIAL Figure 6: Heritage

Figure 7: Land Systems

687,500

690,000

7,652,500

7,650,000

River System

L45/515

L45/589

Macroy System

LEGEND

- Activity Envelope - North Star Junction
- FMG Managed Tenements
- Disturbance Footprint

Land Systems

- <all other values>
- Macroy System

N

0 0.25 0.5 0.75 1

Kilometres

Figure: Land Systems

Requested By: Katherine Fox
Drawn By: Sang Li
Revised By: shlaw
Approved By:
Scale: 1:18,739
Coordinate System: GDA 1994 MGA Zone 50
Document Name: 4519OP002_MP_EN_0032.003_r1_LandSys

Date: 4/11/2021
Size: A3P
Revision: 1
Confidentiality: 1

Data Source(s):
Landgate and FMG, 2021

FMG Fortescue

Figure 8: Soil

687,500

690,000

7,652,500

7,650,000

L45/515

L45/589

LEGEND

- Activity Envelope
- FMG Managed Tenements
- Disturbance Footprint

2M Australian Soils Atlas

- Oc62

N

0 0.25 0.5 0.75 1

Kilometres

Figure: Soil

Requested By: Katherine Fox
Drawn By: Sang Li
Revised By: shlaw
Approved By:
Scale: 1:20,000
Coordinate System: GDA 1994 MGA Zone 50
Document Name: 4519OP002_MP_EN_0032.012_r1_Soil

Date: 4/11/2021
Size: A3P
Revision: 1
Confidentiality: 1

Data Source(s):
Landgate and FMG, 2021

Fortescue

Figure 9: Vegetation Communities

687,000
688,500
7,651,500
7,650,000
AtTe
Tl
ChAcTe
AiTw
Ts
MaAtCc
L45/515
L45/589
AoTl
ChAcTe

LEGEND

- FMG Managed Tenements
- Disturbance Footprint

Vegetation Units

- AiTw
- AoTl
- AtTe
- ChAcTe
- MaAtCc
- Tl
- Ts

N

0 0.25 0.5 0.75 1

Kilometres

Figure: Vegetation Units

Requested By: Katherine Fox
Drawn By: Sang Li
Revised By: shlaw
Approved By:
Scale: 1:12,703
Coordinate System: GDA 1994 MGA Zone 50
Document Name: 4519OP002_MP_EN_0032.004_r1_VegUnits

Date: 4/11/2021
Size: A3P
Revision: 1
Confidentiality: 1

Data Source(s):
Landgate and FMG, 2021

Fortescue

Figure 10: Riparian Vegetation

687,000
688,500
690,000
7,651,500
7,650,000
7,648,500

L45/515
L45/589

LEGEND

- Activity Envelope
- FMG Managed Tenements
- Disturbance Footprint

Riparian Vegetation

- EvCc*

N

0 250 500 750 1,000

Meters

Figure: Riparian Vegetation

Requested By: Katherine Fox
Drawn By: Sang Li
Revised By: shlaw
Approved By:
Scale: 1:15,000
Coordinate System: GDA 1994 MGA Zone 50
Document Name: 4519OP002_MP_EN_0032.006_r1_RiparianVeg

Date: 4/11/2021
Size: A3P
Revision: 1
Confidentiality: 1

Data Source(s):
Landgate and FMG, 2021

FMG Fortescue

Figure 11: Conservation Significant Flora

687,000 688,500 690,000

7,651,500 7,650,000 7,648,500

L45/515

L45/589

LEGEND

- Activity Envelope - North Star Junction
- FMG Managed Tenements
- Disturbance Footprint

Conservation Significant Flora Location

- Bulbostylis burbidgeae - Priority 4 (DBCA)
- Gomphrena leptophylla
- Goodenia nuda
- Gymnanthera cunninghamii
- Heliotropium muticum
- Nicotiana umbratica
- Phyllanthus hebecarpus
- Rothia indica subsp. australis
- Triodia chichesterensis

N

0 0.25 0.5 0.75 1

Kilometres

Figure: Priority Flora Records

Requested By: Katherine Fox
Drawn By: Sang Li
Revised By: shlaw
Approved By:
Scale: 1:15,000
Coordinate System: GDA 1994 MGA Zone 50
Document Name: 4519OP002_MP_EN_0032.005_r1_PriorityFlora

Date: 4/11/2021
Size: A3P
Revision: 1
Confidentiality: 1

Data Source(s):
Landgate and FMG, 2021

FMG Fortescue

Figure 12: Fauna Habitat

687,000
688,500
690,000
7,651,500
7,650,000
7,648,500

L45/515
L45/589

LEGEND

- Activity Envelope
- FMG Managed Tenements
- Disturbance Footprint

Fauna Habitat Unit

- Drainage Line/River/Creek (major)
- Drainage Line/River/Creek (minor)
- Granite Outcrops (boulder piles)
- Hummock Grassland

N

0 0.25 0.5 0.75 1

Kilometres

Figure: Fauna Habitat Units

Requested By: Katherine Fox
Drawn By: Sang Li
Revised By: shlaw
Approved By:
Scale: 1:15,000
Coordinate System: GDA 1994 MGA Zone 50
Document Name: 4519OP002_MP_EN_0032.007_r1_FaunaHab

Date: 4/11/2021
Size: A3P
Revision: 1
Confidentiality: 1

Data Source(s):
Landgate and FMG, 2021

Fortescue

Figure 13: Surface Water

687,500

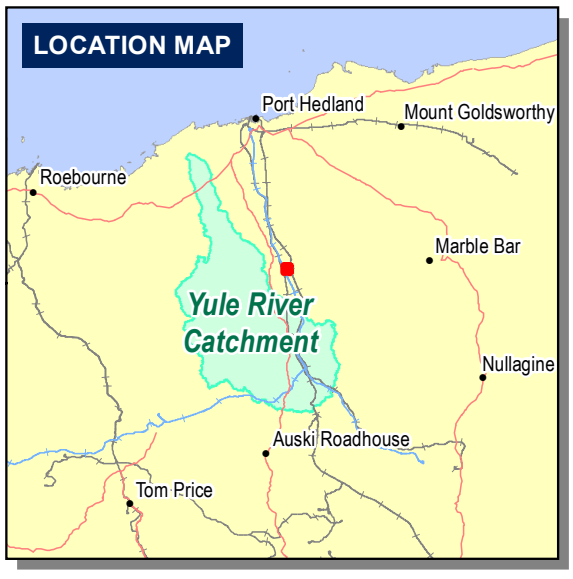
690,000

7,652,500

7,650,000

L45/515

L45/589



LEGEND

- Activity Envelope
- FMG Managed Tenements
- Disturbance Footprint

1% AEP Maximum Flood - Depths (m)

- 0 - 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1 - 1.25
- 1 - 1.5
- 1.5 - 1.75
- 1.75 - 2

N

0 0.25 0.5 0.75 1

Kilometres

Figure: Regional Surface Water Drainage and Catchments

Requested By: Katherine Fox
Drawn By: Sang Li
Revised By: shlaw
Approved By:
Scale: 1:15,000
Coordinate System: GDA 1994 MGA Zone 50
Document Name: 4519OP002_MP_EN_0032.008_r1_Hydro

Date: 4/11/2021
Size: A3P
Revision: 1
Confidentiality: 1

Data Source(s):
Landgate and FMG, 2021

Fortescue

CONFIDENTIAL Appendix 1: Kariyarra Consultation Pack

Appendix 2: North Star Junction Flora and Fauna Assessments

NORTH STAR JUNCTION FLORA AND FAUNA ASSESSMENTS

Fortescue Metals Group Limited

ecoscape

Revision	Author	QA Reviewer	Approved	Date
Draft Rev0	Stephen Kern Hugh Osborn Lyn Atkins	Lee-Anne Stewart	Lee-Anne Stewart	9/08/2021
Final Rev0	Bruce Turner Stephen Kern	Lee-Anne Stewart	Lee-Anne Stewart	3/09/2021
Final Rev1	Bruce Turner Stephen Kern	Lee-Anne Stewart	Lee-Anne Stewart	20/09/2021

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Ph: (08) 9430 8955
Prepared for Fortescue Metals Group Limited

This document should be cited as 'Ecoscape (Australia) Pty Ltd (2021)North Star Junction Flora and Fauna Assessments, prepared for Fortescue Metals Group Limited'

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EXECUTIVE SUMMARY

Fortescue Metals Group Limited (Fortescue) and FMG Magnetite Pty Ltd with joint venture partner Formosa Steel IB Pty Ltd (Formosa) approved the North Star Magnetite Project (North Star) in the Pilbara region of Western Australia approximately 100 km south of Port Hedland.

Fortescue engaged Ecoscape to undertake a Reconnaissance flora and vegetation survey and a Basic terrestrial vertebrate fauna survey of its North Star Junction project areas during May 2021 to inform and support future approvals (**Figure 1**). The survey area is 1023.05 ha.

The key findings of the desktop assessment were:

- one pre-European vegetation association has been mapped within the survey area with greater than 99% remaining at the state-wide scale
- vegetation mapping by previous surveys commissioned by Fortescue have recorded five vegetation types within the survey area
- one Priority Ecological Community (PEC) was identified in the database search (50 km buffer). The nearest occurrence of this PEC is 14 km west of the survey area
- 20 conservation-listed flora were identified in the combined database searches including six that have been recorded within the survey area
- 37 conservation-listed fauna species recorded in the database searches including three from within the survey area.

The flora and vegetation field survey and subsequent analysis identified:

- 210 vascular flora species recorded from 10 floristic quadrats and opportunistic observations including:
  - Nine Priority Flora (PF) taxa were recorded including *Gomphrena leptophylla*, *Gymnanthera cunninghamii, Heliotropium muticum*, *Nicotiana umbratica*, *Phyllanthus hebecarpus*, *Rothia indica* subsp. *australis*, *Triodia chichesterensis* (P3), *Bulbostylis burbidgeae* and *Goodenia nuda* (P4).
  - three introduced flora, none of which are Declared Pest plants or Weeds of National Significance
- eight vegetation types from seven landform types. None of the vegetation types are considered likely to represent a Threatened or Priority Ecological Community. One of the vegetation types (**MaAtCc**) is considered to represent Groundwater Dependent Vegetation.
- vegetation condition of the survey area ranged from Good to Excellent with the majority in Excellent condition with minimal evidence of disturbance.

The fauna field survey identified:

- three fauna habitat types (Hummock Grassland, Creeklines and Granite Outcrops), all of which provide habitat suitable for some conservation-listed species
- 39 vertebrate fauna species recorded, including three that are conservation-listed:
  - Bilby (*Macrotis lagotis*), identified by diggings
  - Brush-tailed Mulgara (*Dasycercus blythi*), identified by burrows from four locations
  - Western Pebble-mound Mouse (*Pseudomys chapmani*), identified by mounds from two locations
- the post-survey likelihood assessment identified six species as having a High likelihood of occurring in the survey area:
  - Northern Quoll (*Dasycercus blythi*), likely to occur in all habitat types and may den in the Granite Outcrops or Creekline habitat types
  - Ghost Bat (*Macroderma gigas*), potentially forage in the survey area although unlikely to reside due to lack of suitable roosting habitat
  - Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia* Pilbara form) had previously been recorded in the survey area, although not during this survey, likely to forage in the survey area although unlikely to reside due to lack of suitable roosting habitat

- Fork-tailed Swift (*Apus pacificus*), Grey Falcon (*Falco hypoleucos*) and Peregrine Falcon (*Falco peregrinus*), are likely to occur on occasion, but they would not be dependent on the resources present within the survey area.

ACRONYMS AND ABBREVIATIONS

Table 1: Acronyms and abbreviations

Acronyms	
BAM Act	Western Australian *Biosecurity and Agriculture Management Act 2007*
BC Act	Western Australian *Biodiversity Conservation Act 2016*
BoM	Bureau of Meteorology
C1, C2, C3	Declared Pest categories under the BAM Act
CD	Conservation Dependent (fauna; specially protected species under the Western Australian BC Act)
CR	Critically Endangered (listed under Commonwealth EPBC Act and/or Western Australian BC Act)
DAWE	Commonwealth Department of Agriculture, Water and Environment (2020-)
DBCA	Western Australian Department of Biodiversity, Conservation and Attractions
DEWHA	Commonwealth Department of the Environment, Water, Heritage and the Arts (2007-2010, now DAWE)
DPaW	Western Australian Department of Parks and Wildlife (2013-2017, now DBCA)
DotEE	Commonwealth Department of the Environment and Energy (2016-2020)
DPIRD	Western Australian Department of Primary Industries and Regional Development
DSEWPaC	Commonwealth Department of Sustainability, Environment, Water, Population and Communities (2010-2013, now DAWE)
EN	Endangered (listed under Commonwealth EPBC Act and/or Western Australian BC Act)
EP Act	Western Australian *Environmental Protection Act 1986*
EPA	Western Australian Environmental Protection Authority
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
GDA 94	Geographic Datum of Australia 1994
GDE	Groundwater Dependent Ecosystem
GDV	Groundwater Dependent Vegetation
IBRA	Interim Biogeographic Regionalisation for Australia
IUCN	International Union for Conservation of Nature
MA	Marine species (fauna; protected under international agreements and EPBC Act)
MI	Migratory species (fauna; specially protected species under the Western Australian BC Act, also EPBC Act)
NVIS	National Vegetation Inventory System
MNES	Matters of National Environmental Significance
OS	Other specially protected species (fauna; specially protected species under the Western Australian BC Act)
P; P1, P2, P3, P4, P5	Priority Flora and Fauna species rankings (P1-P4) or Priority Ecological Communities (P1-P5)
PEC	Priority Ecological Community
PF	Priority Flora
PMST	Protected Matters Search Tool (hosted by DAWE, used to search for MNES)
SFDV	Sheet Flow Dependent Vegetation
S1	Schedule 1 Fauna species listed under the BC Act
TEC	Threatened Ecological Community
TF	Threatened Flora (formerly termed Declared Rare Flora, DRF, in Western Australia)
VU	Vulnerable (listed under Commonwealth EPBC Act and/or Western Australian BC Act)
WAH	Western Australian Herbarium
WAOL	Western Australian Organism List
WoNS	Weeds of National Significance
*	Introduced flora species (i.e. weed)

1 INTRODUCTION

1.1 BACKGROUND

Fortescue Metals Group Limited (Fortescue) and FMG Magnetite Pty Ltd with joint venture partner Formosa Steel IB Pty Ltd (Formosa) approved the North Star Magnetite Project (North Star) in the Pilbara region of Western Australia.

To support future approvals, Fortescue is required to thoroughly understand the key environmental factors that may be impacted by its developments. Fortescue requested flora and fauna surveys of two project areas in close proximity to each other at the North Star junction within the Fortescue Main Line Rail:

- Pilbara Energy Connect North Star Junction solar project area
- North Star Junction project area.

1.2 SURVEY AREA

The North Star Junction project areas, known collectively as the 'survey area' in this report, is located within the Town of Port Hedland in the Pilbara region, approximately 100 km south of Port Hedland (**Figure 1**). The survey area is comprised of two polygons (933.30 ha and 89.75 ha) occupying a total area of 1,023.05 ha.

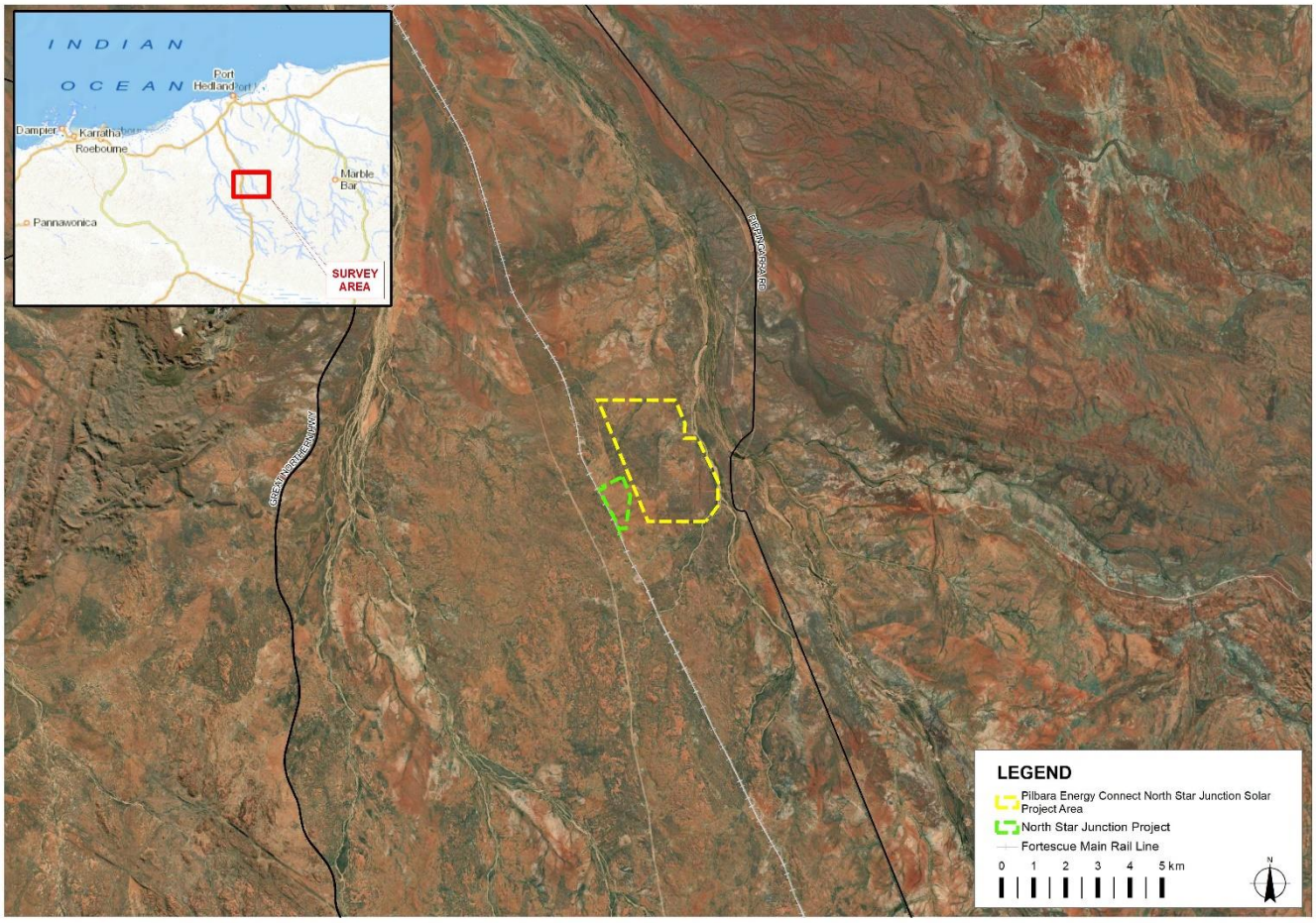

Figure 1: Survey area location

1.3 SURVEY REQUIREMENTS

The scope of works was to conduct a Reconnaissance Flora and Vegetation survey and Basic Fauna survey incorporating:

- a desktop assessment including a literature review and to demonstrate that the survey meets the relevant guidelines
- consolidation of existing information where available
- a field flora and vegetation survey including:
  - establishment and single-phase sampling of floristic quadrats representative of each vegetation type within the survey area
  - description and mapping of vegetation types, particularly where they may represent a conservation significant ecological community
  - description and mapping of vegetation condition, including identifying and recording the abundance of weeds
  - compilation of a flora species inventory for the survey area
  - targeted conservation significant flora searches in areas of preferred habitat
- a field fauna survey that includes:
  - active diurnal survey and assessment of representative habitat and microhabitat sites within the survey area
  - capture and analysis of motion sensitive camera images from areas where conservation significant fauna are considered likely to be present
  - capture and analysis of bat and additional fauna calls using acoustic and ultrasonic recording equipment
  - targeted conservation significant flora searches in areas of preferred habitat
- a comprehensive assessment report that includes:
  - desktop and field survey methodology
  - field survey results
  - discussion
- preparation of digital data to Fortescue's standards.

1.4 COMPLIANCE

This environmental assessment was conducted in accordance with Commonwealth and State legislation and guidelines:

- Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)
- Western Australian *Environmental Protection Act 1986* (EP Act)
- Western Australian *Biodiversity Conservation Act 2016* (BC Act)
- Western Australian *Biodiversity Conservation Regulations 2018*
- Western Australian *Animal Welfare Act 2002*
- Department of Environment, Water, Heritage and the Arts (DEWHA 2009) *Matters of National Environmental Significance. Significant impact guidelines 1.1 - Environment Protection and Biodiversity Conservation Act 1999*
- Department of Sustainability Environment Water Population and Communities (DSEWPaC 2011a) *Survey guidelines for Australia's threatened mammals*
- DSEWPaC (2011b) *Survey guidelines for Australia's threatened reptiles*
- DEWHA (DEWHA 2010a) *Survey guidelines for Australia's threatened bats*
- DEWHA (DEWHA 2010b) *Survey guidelines for Australia's threatened birds*
- Threatened Species Scientific Committee (TSSC 2005) *Commonwealth Listing Advice on Northern Quoll (Dasyurus hallucatus)*
- Commonwealth of Australia (2016) *EPBC Act referral guidelines for the endangered Northern Quoll Dasyurus hallucatus*

- Department of Parks and Wildlife (DPaW 2017) *Interim Guideline for Preliminary Surveys of Night Parrot (Pezoporus occidentalis) in Western Australia.*

Summaries of the key legislation under which this assessment was conducted, and related criteria and definitions, are available in **Appendix One**.

As well as those listed above, the assessment complied with Environmental Protection Authority (EPA) requirements for environmental survey and reporting in Western Australia, as outlined in:

- EPA (2020a) T*echnical Guidance – Terrestrial vertebrate fauna surveys for environmental impact assessment*, known herein as the Fauna Technical Guidance
- EPA (2016) *Technical Guidance – Flora and Vegetation Surveys for Environmental Impact Assessment*, known herein as the Flora and Vegetation Technical Guidance
- EPA (2020b) *Statement of Environmental Principles, Factors and Objectives*.

Additional details (definitions and criteria) relevant to these works are available in **Appendix One**.

Fortescue's internal management Guidelines and Procedures were also complied with including:

- *Flora and Vegetation Assessment Guidelines* (100-GU-EN-0005)
- *Terrestrial Vertebrate Fauna Assessment Guidelines* (100-GU-EN-0005)
- *Environmental Datasets – Data Governance Guidelines* (100-GU-EN-0020)
- *Geographic Information Systems and Raw Data Guideline* (100-GU-EN-0009)
- *Environmental Document Standard Terminology* (100-GU-EN-002)
- *Environment Sample Point Naming Convention Guideline* (100-GU-EN-0041)
- *Proposal and Project Management Guidelines* (100-GU-EN-0010).

2 DESKTOP ASSESSMENT

2.1 PHYSICAL ENVIRONMENT

2.1.1 CLIMATE

The survey area is located within the Pilbara region, which includes two broad climatic zones. Coastal areas, as well as some higher rainfall inland areas, have a semi-desert tropical climate which experience 9 to 11 months of dry weather, with hot humid summers and warm winters. Inland areas have a dry desert climate, typically with higher temperatures and lower rainfall, and often experience up to 12 months of dry weather, with hot dry summers and mild winters (Leighton 2004). The survey area is within the dry inland area.

According to the Köppen-Geiger climate classification, the survey area has a hot arid desert climate (Class BWh) (Peel, Finlayson & McMahon 2007),where annual rainfall is generally less than 200 mm or the region loses more water via evapotranspiration than it receives as rain. The mean average temperature exceeds 18°C, and summer temperatures are frequently over 40°C.

Annual rainfall in the Pilbara has substantial yearly variation, but generally follows an inland to coastal and southern to northern increasing trend (Leighton 2004). Tropical cyclones, many of which originate in the Timor Sea, along with local thunderstorms, produce much of the summer and early autumn rainfall. The driest months are in spring (September to October), and winter rainfall is highly variable, generally decreasing from the coast through to inland areas (Leighton 2004).

The mean annual rainfall is 335.3 mm with 65.59% falling during the summer period from January to March (BoM 2021a - Indee weather station). The rainfall in the six months prior to survey was above average with 130.6% of the long-term mean for December to May.

March is the hottest month with a mean maximum temperature of 36.8° and minimum of 24.6°. July is the coldest month with a mean maximum of 27.3° and minimum of 12.5° (BoM 2021a – Port Hedland Airport weather station).

Figure 2 shows the average rainfall and temperatures of the survey area, with rainfall for the year preceding the field survey.

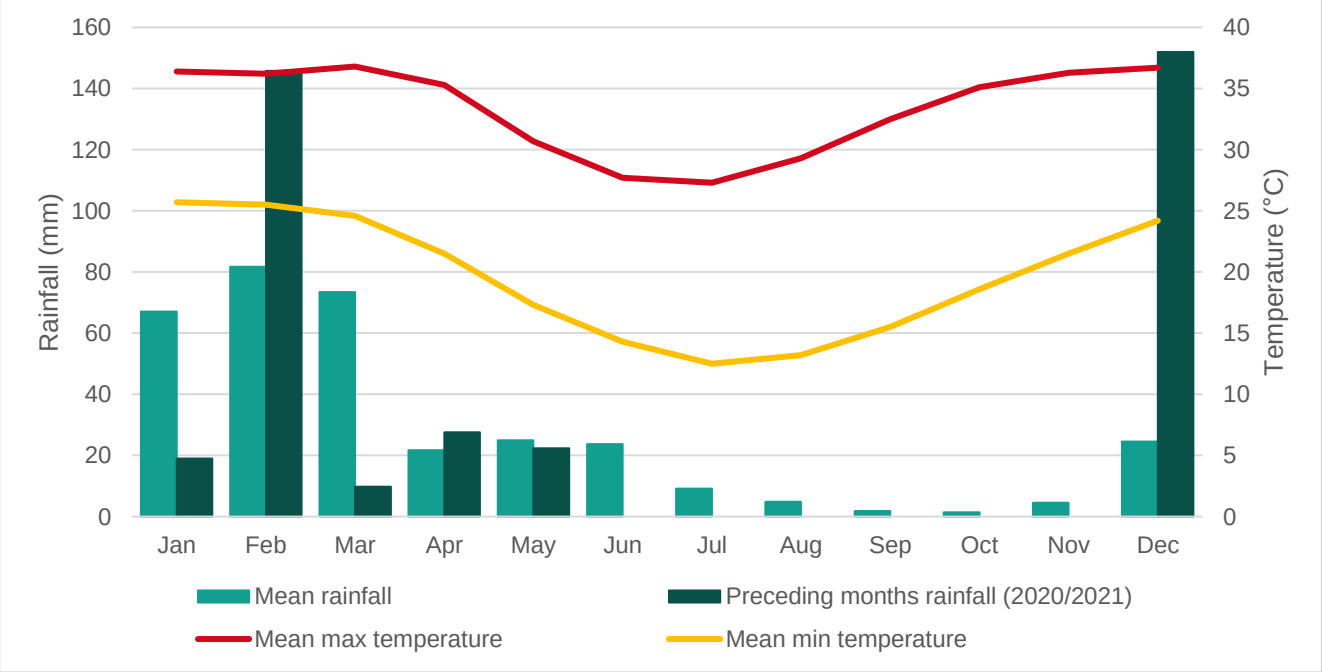

Figure 2: Rainfall and temperature data for the survey area (BoM 2021a)

2.1.2 LAND SYSTEMS

According to the Department of Primary Industries and Regional Development (DPIRD 2020) soil landscape mapping, there are three land systems that intersect the survey area with the Macroy System occupying the majority (**Table 2** and **Map 1**).

Table 2: Land systems (DPIRD 2020)

Mapping unit	Land system	Description	Extent (ha)	%
283Bo	Boolaloo	Granite hills, domes, tor fields and sandy plains supporting spinifex grasslands with scattered shrubs.	59.66	5.83
283Mc	Macroy	Stony plains and occasional tor fields based on granite supporting hard and soft spinifex shrubby grasslands.	952.97	93.15
283Ri	River	Narrow, seasonally active flood plains and major river channels supporting moderately close, tall shrublands or woodlands of acacias and fringing communities of eucalypts sometimes with tussock grasses or spinifex.	10.42	1.02

2.1.3 WETLANDS AND DRAINAGE

The survey area is in the Turner River catchment (Landgate 2021) and intersects tributaries of the Turner River along the eastern boundary, with overall drainage towards the north. The survey area is partly within the River land system which is characterised by major river channels and seasonally active flood plains.

2.1.4 GROUNDWATER DEPENDENT ECOSYSTEMS

The Groundwater Dependent Ecosystems Atlas (BoM 2021b) indicates that the survey area is considered as low potential for terrestrial GDEs to occur, with an Inflow Dependent Ecosystem (IDE) likelihood of 5.

2.1.5 ENVIRONMENTALLY SENSITIVE AREAS

The survey area does not intersect any mapped Environmentally Sensitive Areas (ESAs) (Landgate 2021). The nearest ESA is 55 km away, corresponding with Mungaroona Range Nature Reserve.

The proposed works are not anticipated to impact any ESAs.

2.1.6 CONSERVATION LANDS

The survey area does not correspond with any conservation lands i.e., any Nature Reserves, National Parks or other areas vested for conservation. The nearest conservation estate is Mungaroona Range Nature Reserve which is approximately 55 km southwest of the survey area at its closest point.

2.1.7 LAND USE HISTORY

The survey area has a history of grazing and overlies the Kangan pastoral lease.

2.2 BIOLOGICAL ENVIRONMENT

2.2.1 BIOGEOGRAPHIC REGION

Biogeographic regions are delineated on the basis of similar climate, geology, landforms, vegetation and fauna and are defined in the Interim Biogeographical Regionalisation for Australia (IBRA) (Department of Agriculture Water and the Environment 2020).

The survey area, located in the Pilbara IBRA region and in the Chichester subregion, is described as:

> *Undulating Archaean granite and basalt plains include significant areas of basaltic ranges. Plains support a shrub steppe characterised by Acacia inaequilatera over Triodia wiseana (formerly Triodia pungens) hummock grasslands, while Eucalyptus leucophloia tree steppes occur on ranges. The climate is Semi-desert-tropical and receives 300mm of rainfall annually. Drainage*

occurs to the north via numerous rivers (e.g. De Grey, Oakover, Nullagine, Shaw, Yule, Sherlock). Subregional area is 9,044,560 h (Kendrick & McKenzie 2001).

2.2.2 PRE-EUROPEAN VEGETATION

During the 1970s, John Beard and associates conducted a systematic survey of native vegetation, describing the vegetation systems in Western Australia at a scale of 1:250 000 in the south-west and at a scale of 1:1,000,000 in less developed areas.

Beard's vegetation maps predicted the native vegetation at the time of settlement, which is known as the pre-European vegetation type and extent. Beard's vegetation maps have since been developed in digital form by Shepherd, Beeston & Hopkins (2002) and updated by DPIRD (2019). Extents are updated every two years by the Department of Biodiversity, Conservation and Attractions (DBCA 2019a). This mapping indicates that the survey area intersects a single pre-European vegetation unit: Association 93: *Hummock grasslands, shrub steppe; kanji over soft spinifex*.

The pre-European vegetation association identified from the survey area (DPIRD 2019) and its pre-European and current extents are listed in **Table 3** (DBCA 2019a).

Table 3: Pre-European vegetation association representation (DBCA 2019a)

Region	Vegetation association	Original extent (ha)	Current extent (ha)	% remaining
Western Australia	93	3,044,309.52	3,040,640.98	99.88
IBRA biogeographic region (Pilbara)	93	3,042,114.27	3,038,471.67	99.88
IBRA biogeographic sub-region (Chichester)	93	2,940,348.04	2,936,731.54	99.88
LGA (Town/City of Port Hedland)	93	1,015,339.22	1,014,599.99	99.93

2.2.1 PREVIOUS VEGETATION MAPPING

The vegetation of the entire survey area has been mapped during previous surveys commissioned by Fortescue or Iron Bridge Operations (IBO) including:

- Biota Environmental Sciences (2004a) Vegetation and Flora Survey of the Proposed FMG Stage A Rail Corridor. This assessment included vegetation mapping across the majority of the survey area.
- Ecologia Environment (2012a) *North Star Vegetation and Flora Assessment*. This assessment included vegetation mapping across the entire survey area.

The most recent mapping that encompasses the entire survey area (Ecologia Environment 2012a) indicates the following vegetation types occur (**Map 2**):

- EvCc* - *Eucalyptus victrix*, *Eucalyptus camaldulensis* open mid woodland over **Cenchrus ciliaris* tussock grassland
- GwTp - *Grevillea wickhamii* sparse tall shrubland over *Triodia pungens* open hummock grassland and isolated *Eragrostis cumingii* tussock grasses *Cyperus squarrosus* sedges and *Stemodia viscosa* herbs
- ImTp - *Indigofera monophylla* and *Solanum phlomoides* sparse open shrubland over *Triodia pungens* and *Triodia basedowii* sparse hummock grassland with *Mollugo molluginea* and *Bonamia linearis* isolated herbs
- PfTp - *Pluchea ferdinandi-muelleri* open low shrubland over *Triodia pungens* sparse hummock grassland and **Cenchrus ciliaris*, *Eriachne lanata* and *Chrysopogon fallax* open tussock grassland
- Tp - *Triodia pungens* open hummock grassland.

2.2.2 THREATENED AND PRIORITY ECOLOGICAL COMMUNITIES

Threatened and Priority Ecological Communities (TECs and PECs) intersecting the survey area and nearby were identified by a *Protected Matters Search Tool* (PMST) search (DAWE 2021a, search reference JEFK4P using a 50 km buffer) that did not identify any EPBC-listed TECs.

A DBCA database search (search reference 25-0620EC using a 50 km buffer) identified one known PEC within the search area, *Gregory Land System* (Priority 3). This PEC is characterised by 'linear dunes and restricted sandplains supporting shrubby hard spinifex (and occasionally soft spinifex) grasslands' (Species and Communities Program, DBCA 2021). The nearest occurrence of this PEC is approximately 14 km west of the survey area.

2.2.3 THREATENED AND PRIORITY FLORA

The PMST search (as above) identified one EPBC-listed Threatened Flora (TF) species (*Pityrodia* sp. Marble Bar (G.Woodman & D.Coultas GWDC Opp 4) as a 'species or habitat known to occur within area'. This species has been formally named as *Quoya zonalis*.

A search of the DBCA databases (search reference 25-0620EC) was conducted using a 40 km buffer around the survey area. The results incorporate the TPFL List, taken from Threatened and Priority Flora Report Forms and DBCA surveys, and WA Herb, taken from vouchered specimens held in the Western Australian Herbarium. The DBCA database searches identified 20 conservation listed flora taxa consisting of one TF, one P1, 15 P3 and three P4 taxa. **Map 3** shows the locations of conservation-listed flora identified by the DBCA database search in relation to the survey area. None of the DBCA database records are located within the survey area.

Fortescue/IBO maintains a database of conservation listed flora and other flora of conservation interest associated with its operational and exploration tenements. This database consists of DBCA database search results requested for flora and vegetation assessments and the results of field surveys it has commissioned. The resultant list, and associated location data, provides a comprehensive understanding of the conservation significant flora and other flora of conservation interest (e.g., significant range extensions, unusual forms) within and close to Fortescue's areas of interest. Fortescue's significant flora database identified no additional TF or PF taxa, though additional locations of those taxa identified by the DBCA database searches are presented in on **Map 3**. Based on the Fortescue database, there are six PF that have been previously recorded

within the survey area including *Gomphrena leptophylla*, *Gymnanthera cunninghamii*, *Heliotropium muticum*, *Nicotiana umbratica* (P3), *Bulbostylis burbidgeae* and *Goodenia nuda* (P4).

The combined database searches identified 20 conservation-listed flora taxa, listed in **Table 19** in **Appendix Three**.

2.2.3.1 Threatened and Priority Flora Likelihood Assessment

Ecoscape conducted a likelihood assessment to identify the TF and PF species that have potential to occur within the survey area. Information to assess the likelihood of a species occurring includes the following sources: ecology as listed on *FloraBase* (WAH 1998-2021; 2021, including specimen collection information), in more detailed documents, and information from recent nearby surveys incorporating an assessment of habitats likely to be present in the survey area.

The attributes taken into consideration were:

- broad soil type usually associated with the species
- broad landform usually associated with the species
- usual vegetation (characteristic species) with which the species is usually associated
- species having previously been recorded from within approximately 20 km of the survey area (considered as 'nearby') taking locational accuracy into consideration
- time since recorded (i.e., within the previous 25 years), taking into consideration land use changes since collection
- reliability of record: species identified by only a TPFL record, without an accompanying verified vouchered specimen, may have been incorrectly identified or been subject to taxonomic updates since the record was entered
- number of records for the species
- if the record is for a not naturally occurring population (planted).

The likelihood rating is assigned using the categories listed in **Table 4**.

Table 4: Categories for likelihood of occurrence of TF and PF

Likelihood	Category
Recorded	Species recorded within the survey area.
Possible	May occur within the survey area (but has not been recorded); broadly, 2-4 of the first-listed attributes (but always including natural records from nearby) are present in the survey area.

Unlikely	Could occur but is not expected; 1-3 of the first-listed attributes are present in the survey area but:
	• it is not known from nearby, or
	• it is known from nearby but has no other required attributes, or
	• it is known from nearby but has at least one well-defined attribute that does not occur in the survey area (e.g. it is associated with a specific landform or soil type that does not occur in the survey area), or
	• it is known from nearby but:
	  ○ the record is old (>25 years), or
	  ○ the locational data is highly likely to be inaccurate, or
	  ○ the area has been significantly cleared at and around the location of the record and survey area and as such the habitat almost certainly no longer occurs within the survey area
	  ○ the record is unlikely to be naturally occurring (i.e. planted).

Highly unlikely	The species characteristics include only one or none of the first-listed attributes of soil, landform, associated vegetation and having previously been recorded nearby, or a critical element (often landform) is not within the survey area and as such it almost certainly does not occur.

The likelihood assessment is available in **Table 19** in **Appendix Three**. Six have been previously recorded from within the survey area: *Gomphrena leptophylla*, *Gymnanthera cunninghamii*, *Heliotropium muticum*, *Nicotiana umbratica* (P3), *Bulbostylis burbidgeae* and *Goodenia nuda* (P4). The recorded PF taxa are from relatively recent surveys and are considered likely to be accurate. One P1 and six P3 were identified as having a Possible likelihood of occurring based on the information available during the desktop assessment. These were considered the most likely to occur and were prioritised for the field survey.

The likelihood of occurrence was re-evaluated following the field survey when actual survey area characteristics (vegetation types, vegetation condition, visibility for individual species) were better understood, and the level of survey effort was considered. The post-survey likelihood is also incorporated into this table and discussed further in **Section 5.1.1.2**.

2.2.4 THREATENED AND PRIORITY FAUNA

Combined database search results are incorporated into **Table 20** in **Appendix Three**.

One species identified by the Fortescue database search has been excluded from the field survey and further assessments (including likelihood assessments). *Dasycercus cristicauda* (Crest-tailed Mulgara) has been excluded due to a taxonomic change with records of this species now treated as *Dasycercus blythi* Brush-tailed Mulgara) (Woolley 2005; Woolley, Haslem & Westerman 2013).

2.2.4.1 EPBC-listed Threatened Fauna

The PMST search (DAWE 2021, search reference JEFK4P using a 50 km buffer), identified the following as having been recorded or having potential to occur within the search area buffer:

- four mammals: three ‘species or species habitat known to occur within area’, one ‘breeding likely to occur within area’
- 20 birds: two ‘species or species habitat known to occur within area’, three ‘species or species habitat likely to occur within area’, 15 ‘species or species habitat may occur within area’
- one reptile: one ‘species or species habitat likely to occur within area’.

2.2.4.2 NatureMap

NatureMap (DBCA 2007-2021) is maintained collaboratively by the DBCA and the Western Australian Museum. These records represent a combination of vouchered museum specimens and records obtained via the Fauna Survey Returns Database which are maintained by the DBCA.

The *NatureMap* search identified 328 vertebrate fauna species that have been recorded within the applied 40 km buffer area. Of these, 21 (11 mammals, seven birds, and three reptiles) are conservation-listed.

2.2.4.3 DBCA Database Search

A search of the DBCA databases was conducted (search reference: Pannell6361) using a 50 km buffer around the provided shapefiles of the survey area. Seventeen conservation-listed species were identified as having previously been recorded from within the search area buffer, consisting of ten mammals, five birds and two reptiles.

2.2.4.4 Fortescue Database Search

No additional taxa were identified from Fortescue’s database search results (Map 4). The full list of Threatened and Priority fauna is incorporated in **Table 20** in **Appendix Three**.

2.2.4.5 Threatened and Priority Fauna Likelihood Assessment

The likelihood of conservation-listed fauna species, as identified by the database and literature searches, occurring within the survey area was assessed using the following criteria:

- suitability of habitat types likely to be present
- distance between previous record of conservation-listed species and the survey area

- frequency and number of records in the region
- date of record of conservation-listed species (recent or historical)
- the record is naturally occurring (not from a sanctuary or translocated population).

The following were also taken into consideration during the assessment:

- sufficiency of information
- behavioural and ecological characteristics such as cryptic behaviours, size and mobility of species
- record certainty.

The categories of likelihood of occurrence, assessed using the above criteria, are shown in **Table 5**.

Table 5: Categories for likelihood of occurrence of conservation-listed fauna

Likelihood	Category
Recorded	Species recorded within the survey area within a reasonable timeframe (0-25 years).
High	Species recorded in close proximity to the survey area (<10 km) within the past 25 years. Suitable habitat occurs within the survey area.
Medium	Species recorded within 20km of the survey area or within close proximity (<10km) but more than 25 years ago. However, suitable habitat may exist within the survey area.
Low	Species not recorded in the proximity of the survey area (<10 km) or rarely recorded within 20 km of the survey area. Suitable habitat unlikely to occur within the survey area.
Very Low	Species not recorded by multiple surveys/databases within 50 km of the survey area and suitable habitat does not occur within the survey area, however, species or suitable habitat is listed as potentially occurring in the wider region

The likelihood of species occurring within the survey area are indicated in **Table 20** in **Appendix Three**. Ten species were assessed as having a High likelihood of occurring within the survey area. Three conservation-listed fauna species have been previously recorded from within the survey area.

Likelihood of occurrence does not take into consideration factors such as frequency that a species occurs (or may occur), the duration that such species occupies (or may occupy) the survey area or dependence on habitat or resources within the survey area. Highly mobile species potentially only occur within (or for birds, overflying) the survey area for very brief periods and/or on very infrequent intervals. If a previous observation included in the database search records corresponds with this event it is listed as 'Recorded', however, if such a transient visitation is possible in the future the likelihood of such species occurring is likely listed as 'High'.

Following the field survey, when actual survey area characteristics were better understood and the level of survey effort was considered, the likelihood of occurrence was re-evaluated. The post-survey likelihood is also incorporated into this table and discussed further in **Section 5.3.4**, including providing an indication of dependence of species on the habitat and resources available within the survey area.

2.2.5 FAUNA HABITAT

The entire survey area has been subject to previous fauna assessments and habitat mapping. The Ecologia (Ecologia Environment 2012b) previous Level 2 terrestrial vertebrate fauna assessment reported two fauna habitat types that correspond to the survey area. The habitats were described as 'Sandy plains with spinifex' and 'Scattered granites and Creeklines'. These were used as the basis for ground truthing during the field survey.

2.3 LITERATURE REVIEW

2.3.1 PREVIOUS SURVEYS

The following previous surveys have been conducted in areas overlying all, or part of the survey area:

2.3.1.1 Flora and Vegetation

- Ecologia Environment (2015a); *North Star Slurry and Infrastructure Corridors Conservation Significant Flora and Vegetation Assessment*. Targeted flora and vegetation survey conducted within the infrastructure corridor connecting Port Hedland and the North Star Hematite project, which overlies the survey area.
- Ecologia (2012a); *North Star Vegetation and Flora Assessment*. A baseline flora and vegetation assessment as part of the environmental approvals processes for the North Star mine. The assessment includes the entire extent of the North Star Junction survey area. There were 472 flora taxa recorded (eight conservation-listed) from a large-scale survey that included the sampling of 272 quadrats. There were 33 vegetation types mapped and described, none conservation-listed.
- Coffey Environments (2007); *Supplementary Vegetation and Flora Surveys of the Port Hedland to Cloudbreak Rail Corridor and Associated Borrow Pits and Infrastructure – Volume 1: Main Report and Figures*. A flora and vegetation survey of Fortescue's rail corridor, including a section of rail corridor that partially intersects the survey area on the western boundary.
- Biota (2004a); *Vegetation and Flora Survey of the Proposed FMG Stage A Rail Corridor*. A baseline botanical survey of the Fortescue rail corridor. The majority of the North Star Junction survey area falls within this survey area

2.3.1.2 Fauna

- Ecologia (2012b); *North Star Project Level 2 Terrestrial Vertebrate Fauna Assessment*. A baseline Level 2 vertebrate fauna survey as part of the environmental approvals processes for the North Star mine which partially corresponds with the southern section of the survey area. The eastern portion of this survey's much larger study area wholly encompasses the survey area.
- Ecologia (2011); *Targeted Conservation Significant Fauna Survey*. A targeted conservation significant fauna survey of the North Star Project which partially corresponds with the survey area.
- Biota Environmental Sciences (2004b); *Fauna Habitat and Fauna Assemblage of the Proposed FMG Stage A Rail Corridor*. A Fortescue rail corridor fauna assessment with the majority of the North Star Junction survey area falling within this survey area.

2.3.2 RELEVANT LITERATURE

The following previous surveys have been conducted between 200 m and 36 km from the survey area:

2.3.2.1 Flora and Vegetation

- Ecoscape (Ecoscape (Australia) Pty Ltd 2020a); *Pippingarra and Wodgina Roads: Flora and Fauna Survey*. A Reconnaissance flora and vegetation survey and Basic terrestrial fauna survey of a linear alignment within 200 m of the North Star Junction survey areas at the southern extent. This survey recorded 100 flora taxa, including two conservation-listed (*Heliotropium muticum* and *Triodia chichesterensis*), from nine vegetation types. There were 45 vertebrate fauna species recorded including one conservation-listed (Western Pebble-mound Mouse) and two habitat types.
- Ecoscape (2020b); *North Star Extension Flora and Vegetation Survey*. A consolidated detailed flora and vegetation survey approximately 20 km east of the survey area. There were 201 flora taxa recorded including three conservation-listed. Twelve vegetation types were described and mapped including vegetation potentially representing Groundwater Dependent Vegetation (GDV).

- Ecoscape (2018); *Glacier Valley Extension Flora and Vegetation Survey, North Star Project.* A flora and vegetation survey approximately 20 km east of the survey area. There were 218 flora taxa recorded including three conservation-listed. Eleven vegetation types were described and mapped.
- Ecologia (2016); *Iron Bridge North Star Stage 2 Pityrodia sp. Marble Bar Regional Survey*. Targeted survey for then Priority 1-listed (now Threatened) *Pityrodia* sp. Marble Bar (known named *Quoya zonalis*) within a search area that partially corresponds with the survey area in the south.
- Ecologia Environment (2015b); *North Star Aerodrome Flora Level 2 and Fauna Level 1 Assessment*. Located 4 km southeast of the North Star Junction survey area at its closest point. This survey recorded 221 flora taxa (none conservation-listed) from nine vegetation types. This survey recorded a total of 30 fauna species and four species of conservation significance (Northern Quoll, Rainbow Bee-eater, Western Pebble-mound Mouse and including one species formerly listed as conservation significant, Australia Bustard
- Coffey Environments (2014); *North Star Alternate Access Road Flora and Vegetation Assessment*. The North Star Alternate Access Road survey area was a Level 2 assessment located 10 km north of the survey area at its closest point. This survey recorded 166 flora taxa including two conservation-listed. Ten vegetation types were mapped and described, none that were considered significant.
- Ecologia (2012c); *North Star Access Corridor Flora, Vegetation, Vertebrate Fauna and Fauna Habitat Assessment*. A baseline flora, vegetation and fauna assessment as part of the environmental approvals processes for the North Star mine access corridor, which lies within 2 km of the survey area to the northwest. There were 163 flora taxa recorded including one conservation-listed (*Heliotropium muticum*) and nine vegetation types. There were four vertebrate fauna habitat types identified during the survey. A total of 51 species of vertebrate fauna were observed during the survey including four introduced mammals.
- Ecologia (2012d); *Pityrodia sp. Marble Bar Targeted Flora Survey*. A targeted survey to identify *Pityrodia* sp. Marble Bar (now named *Quoya zonalis*) outside areas covered by the North Star flora and vegetation surveys. Provides regional context on the distribution of the species.

2.3.2.2 Fauna

- Ecoscape (2017); *Conservation Significant Fauna Monitoring 2016/17*. Monitoring of EPBC Act listed threatened fauna species (Northern Quoll, Pilbara Leaf-nosed Bat and Pilbara Olive Python) conducted approximately 20 km east of the survey area.
- Ecoscape (2016); *Conservation Significant Fauna Monitoring 2015/2016: Operations – North Star*. Monitoring of EPBC Act listed threatened fauna species (Northern Quoll, Pilbara Leaf-nosed Bat and Pilbara Olive Python) conducted approximately 20 km east of the survey area.
- Ecoscape (Ecoscape (Australia) Pty Ltd 2015); *North Star Pilbara Olive Python Monitoring 2015*. Monitoring of the EPBC Act listed Pilbara Olive Python as part of the North Star Project, conducted approximately 20 km east of the survey area.
- Ecologia (Ecologia Environment 2014a); *EPBC Listed Threatened Fauna Monitoring Report*. Fauna monitoring for the North Star Project in accordance with legislative requirements, conducted approximately 20 km east of the survey area.
- Ecologia (2014b); *North Star Filtration Plant Relocation Flora and Fauna Desktop Assessment*. A desktop assessment of an area located approximately 7 km from the survey area.
- Ecologia (Ecologia Environment 2013); *North Star Magnetite Project – Environmental Scoping Document. Response to requested terrestrial items*. Provides an assessment on the key ecological attributes of the EPBC listed Northern Quoll, Pilbara Leaf-nosed Bat and Pilbara Olive Python. Discussions on Mulgara, Greater Bilby and Grey Falcon are also provided.

- Ecologia (2012); *Canning Basin Pipeline and Drawdown Area Vertebrate and Short Range Endemic Invertebrate Survey*. A baseline level one fauna survey, invertebrate Short Range Endemic (SRE) survey and a habitat assessment of a study area approximately 36km to the north east of the survey area. Found six fauna habitat types, three conservation significant fauna were observed and secondary evidence of one conservation significant species, the Greater Bilby (*Macrotis lagotis*) was recorded within the project area.

3 METHODS

3.1 SURVEY AIMS

The aims of the survey were to undertake:

- a Reconnaissance flora and vegetation survey
- a Basic terrestrial vertebrate fauna survey.

3.2 GUIDING PRINCIPLES

The flora and vegetation survey was conducted as a Reconnaissance survey according to the Flora and Vegetation Technical Guidance (EPA 2016). The EPA recommends a Reconnaissance survey should:

- provide context and gather broad information
- verify the findings of the desktop assessment
- include low intensity sampling of the flora and vegetation to describe the general vegetation characteristics and condition
- clarify if the area may support any significant flora and vegetation
- identify if a detailed survey is required.

Targeted searches were also conducted in areas of habitat suitable for TF and PF identified during the desktop assessment and previous surveys as having potential to occur.

The fauna and fauna habitat survey was conducted as a Basic survey according to the Fauna Technical Guidance (EPA 2020a). The EPA recommends a Basic survey should:

- be conducted as a low intensity survey to gather broad fauna and habitat information
- verify the adequacy of the desktop assessment
- map, describe and photograph habitats
- record opportunistic fauna observations
- identify possible future survey site locations, access and logistics
- determine if a detailed survey is required.

Targeted surveys were also conducted to gather information on significant fauna and habitats.

3.3 FLORA AND VEGETATION FIELD SURVEY

3.3.1 FIELD SURVEY METHODS

The methods utilised during the field survey followed those outlined in the Flora and Vegetation Technical Guidance (EPA 2016), conducted as a Reconnaissance survey.

Conservation criteria used in this assessment are outlined in **Table 13**, **Table 14** and **Table 15** in **Appendix One**.

Survey method details are outlined below.

3.3.1.1 Floristic Quadrats

Floristic quadrat ('quadrat') locations were selected using aerial photography, environmental values, and field observations to represent the vegetation values existing at the survey area. The unmarked quadrats were 50 m x 50 m in dimension, as required according to the Flora and Vegetation Technical Guidance (EPA 2016). Where the vegetation consisted of a narrow linear corridor, quadrats were linear but of the same overall size i.e., 2,500 m^2.

The following information was collected from within each quadrat:

- observer
- date
- quadrat/site number
- GPS location (GDA94) of the northwest corner
- digital photograph taken from the northwest corner, looking diagonally across the quadrat
- broad soil type and colour
- topography
- list of flora species recorded with the average height and total cover within the quadrat for each species
- vegetation description (as per below)
- vegetation condition.

One quadrat per vegetation type was recorded in accordance with requirements of a Reconnaissance survey. Quadrat locations are displayed on **Map 5**.

3.3.1.2 Targeted Searches

Threatened and Priority Flora identified during the desktop analysis and previous surveys as known or having potential to occur were targeted for searches in areas of potential habitat. Targeted searches were conducted in potentially suitable habitat of target species, with the remainder of the survey area opportunistically searched during site traverses.

The locations of all targeted taxa collected were recorded using a handheld GPS with the following data recorded:

- observer, date and time
- reproductive status and other features such as health of plants, percentage flowering and fruiting
- local abundance/population size and/or population boundary, including outside the development envelopes where possible
- landform
- brief vegetation community description
- representative photos of each species and habitat
- collection of representative specimens.

3.3.1.3 Introduced Species

Introduced species (weeds) were recorded during the collection of the overall flora inventory. The field survey included searches for Weeds of National Significance (WoNS), Declared Pest plants and 'Priority Weeds' as outlined on a list maintained by Fortescue for its management purposes. Their locations and numbers/extents were recorded where noted during the field survey, and each such introduced plant species photographed.

3.3.1.4 Vegetation Description and Classification

Vegetation was described from each of the quadrats using the height and estimated cover of dominant and characteristic species of each stratum based on the National Vegetation Information System (NVIS), recorded at Level V (NVIS Technical Working Group & Department of the Environment and Energy [DotEE] 2017) (**Table 16** and **Table 17** in **Appendix Two**). Up to three species per stratum from each stratum (upper, mid and ground) were used to formulate vegetation descriptions for each quadrat and each vegetation type.

Vegetation type descriptions were created as per Fortescue standards by combining quadrat descriptions and modifying, where necessary, based on the wider vegetation. Vegetation codes were formulated using the first letter of genus and species names of the dominant species of each stratum e.g. **ChAcTe** refers to ***C****orymbia* ***h****amersleyana* low open woodland over ***A****cacia* ***c****olei* tall sparse shrubland over ***T****riodia* ***e****pactia* mid hummock grassland.

3.3.1.5 Vegetation Condition Assessment

Vegetation condition was assessed broadly and continuously throughout the survey area and at each quadrat using the Vegetation Condition Scale for the Eremaean Botanical Province (EPA 2016) (**Table 18** in **Appendix Two**). As quadrats are located in the best condition parts of a vegetation type, the condition rating of the quadrat may not match that of the broader vegetation type due to the scale of mapping.

3.3.1.6 Field Survey Timing

The field survey was conducted during 25 to 28 May 2021 which is within the optimal period for a primary survey within the bioregion according the Flora and Vegetation Technical Guidance (EPA 2016).

3.3.1.7 Adequacy of Sampling

In order to demonstrate adequacy of sampling, a species accumulation curve was generated by the software Species Diversity and Richness IV (Pisces Conservation Ltd 2010) using five random selections of sample order, using quadrat data only. However, for a Reconnaissance survey with low intensity sampling, the species inventory is not anticipated to be comprehensive.

3.4 FAUNA FIELD SURVEY

The methods utilised during the field survey followed those outlined in the Fauna Technical Guidance (EPA 2020a), conducted as a Basic survey.

Conservation criteria used in this assessment are included in **Table 13** and **Table 14** in **Appendix One**..

Survey method details are outlined below.

3.4.1 FAUNA SURVEY METHODS

The Basic fauna survey incorporated a number of survey techniques as per the Terrestrial Fauna Technical Guidance (EPA 2020a) including habitat assessment, active searches (day and night-time), raking of vegetation spoil heaps and leaf litter, searches for secondary evidence such as scats and tracks, as well as opportunistic searches.

Terrestrial vertebrate fauna were the main targets of the field survey. Survey techniques included:

- opportunistic bird observations while moving through the survey area
- turning of surface debris (rocks, logs, vegetation spoil heaps) that reptiles and mammals may shelter beneath
- raking of litter beds to locate fossorial reptile species
- tree hollow inspection to detect arboreal fauna
- motion cameras (Reconyx HC500) to capture evidence of cryptic and nocturnal fauna species
- Songmeter acoustic recorder fitted with ultrasonic microphones to sample for bats.

Fauna species were identified opportunistically based on sightings, calls, remains, diggings and other signs. Dr. Kyle Armstrong of Specialised Zoological provided identification of bat calls recorded on the acoustic recording device. Potential habitats for conservation significant species were identified and evaluated (see **Section 3.4.1.1**) and their likelihood of occurrence re-assessed.

Based on the desktop assessment, the following were considered to have a High likelihood of occurring in the survey area and they, and habitat suitable to support them, were targeted during the field survey:

- Brush-tailed Mulgara, Ampurta (*Dasycercus blythi*)
- Northern Quoll (*Dasyurus hallucatus*)
- Spectacled Hare-wallaby (*Lagorchestes conspicillatus leichardti*)
- Ghost Bat (*Macroderma gigas*)
- Bilby, Dalgyte (*Macrotis lagotis*)
- Western Pebble-mound Mouse (*Pseudomys chapmani*)

- Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia* Pilbara form)
- Fork-tailed Swift (*Apus pacificus*)
- Grey Falcon (*Falco hypoleucos*)
- Peregrine Falcon (*Falco peregrinus*).

3.4.1.1 Fauna Habitat Assessment

The fauna habitats present within the survey areas were identified and mapped. Fauna habitats were described as an area which is distinguishable from its surrounding area by its landform, vegetation and fauna assemblage occupying the area. In addition, its likelihood to harbour specialised fauna species which are not found in adjacent areas was taken into consideration.

The following information was used to identify and map all fauna habitats within the survey area:

- previous fauna habitat mapping
- land systems
- vegetation type and condition mapping
- aerial imagery
- landforms
- soil characteristic
- fauna assemblage information.

The composition and characteristics of each fauna habitat type was recorded, including noting suitability for various fauna suites or conservation-listed species. Habitat types were delineated in the field and digitised upon return from the field survey.

4 FIELD SURVEY RESULTS

4.1 FLORA AND VEGETATION SURVEY

The flora and vegetation survey was conducted by Stephen Kern (Principal Botanist, Flora Collecting Permit FB62000001; Threatened Flora Collecting Permit TFL 74-1920) during 25 to 28 May 2021.

4.1.1 FLORA

4.1.1.1 Flora Inventory

Ten floristic quadrats were recorded from within the survey area. A total of 210 vascular flora were recorded from 115 genera and 48 families from the quadrats, relevés, opportunistic observations and searches for conservation-listed flora. Of these, three were introduced (1.43%) and two (0.95%) could not be identified to species level due to insufficient diagnostic reproductive material.

The most commonly represented families were Fabaceae (40 taxa), Poaceae (34, one introduced) and Malvaceae (20). The most commonly represented genera were *Acacia* with 14 taxa, *Senna* (seven) and *Cyperus* and *Triodia* (six each).

The number of species per quadrat ranged from three in quadrat NJ2109 to 61 in quadrats NJ2101 and NJ2106, with an average species diversity per quadrat of 26.8. The most commonly recorded species were *Triodia epactia* recorded from eight quadrats, *Eriachne obtusa* (seven quadrats), *Acacia maitlandii*, *Acacia orthocarpa*, *Corchorus parviflorus*, *Fimbristylis dichotoma*, *Grevillea wickhamii* and *Trigastrotheca molluginea* (five quadrats each).

The combined flora inventory is presented in **Table 21** in **Appendix Four**. Quadrat data is presented in **Appendix Five**.

4.1.1.2 Conservation-listed Flora

Threatened Flora

No Commonwealth EPBC Act or Western Australian BC Act-listed TF were recorded during the field survey.

Priority Flora

Nine PF were recorded during the field survey:

- P3
  - *Gomphrena leptophylla*
  - *Gymnanthera cunninghamii*
  - *Heliotropium muticum*
  - *Nicotiana umbratica*
  - *Phyllanthus hebecarpus*
  - *Rothia indica* subsp. *australis*
  - *Triodia chichesterensis*
- P4
  - *Bulbostylis burbidgeae*
  - *Goodenia nuda.*

Locations of PF are indicated on **Map 5** and described in more detail in **Table 6**.

Table 6: PF recorded during the field survey

***Gomphrena leptophylla* (P3)**	
Description: Spreading annual herb to 0.15 m high with white flowers. This species has been recorded from a variety of landform types including sandy creek beds, open flats, edges of salt pans/marshes and stony hillsides.(WAH 1998-2021; 2021). 	**Habitat:** Recorded from sandy minor drainage lines within the ChAcTe vegetation type. **Location:** various locations **Survey results**: 11 records within the survey area totalling at least 200 plants **Populations:** Two populations **Known records and distribution**: According to *NatureMap* (DBCA 2007-2021) there are eight records of this species within Western Australia. However, *Gomphrena leptophylla* is widespread in the Northern Territory and Queensland (ALA 2021).
***Gymnanthera cunninghamii* (P3)**	
Description: Erect shrub to 2 m high with cream-coloured flowers (WAH 1998-2021; 2021). 	**Habitat:** recorded from sandy drainage lines associated with the ChAcTe and MaAtCc vegetation types. **Location:** isolated locations corresponding with drainage lines **Survey results**: six records in survey area totalling 10 plants that were observed **Populations:** two populations **Known records and distribution**: According to *NatureMap* (DBCA 2007-2021) there are 73 records of this species within Western Australia. However, the distribution of *Gymnanthera cunninghamii* extends across the Northern Territory and into Queensland (ALA 2021)

***Heliotropium muticum* (P3)**	
Description: Ascending to spreading perennial herb to 0.3 m high with white flowers (WAH 1998-2021; 2021). 	**Habitat:** Sandy plains/flats typically associated with the **AoTl** vegetation type. **Location:** recorded from the northern portion of the survey area. This species has been extensively recorded within the survey area previously **Survey results**: two records in survey area and an additional location outside. **Populations:** likely a single continuous population **Known records and distribution**: According to *NatureMap* (DBCA 2007-2021) there are 73 records of this species from Pilbara bioregions, with an overall distribution of approximately 150 km (north-south) around the Port Hedland area.
***Nicotiana umbratica* (P3)**	
Description: Erect, short-lived annual or perennial herb to 0.7 m high with white flowers (WAH 1998-2021; 2021). 	**Habitat:** Typically growing amongst granite boulders within the **AtTe** vegetation type. **Location:** isolated occurrences throughout the survey area. **Survey results**: 9 records in survey area with at least 38 plants **Populations:** estimated five populations **Known records and distribution**: According to *NatureMap* (DBCA 2007-2021) [or Atlas of Living Australia (ALA 2021)] there are 24 records of this species from Pilbara bioregion, with an overall distribution of approximately 160 km (north-south) by 300 km (east-west), largely south of Port Hedland.

***Phyllanthus hebecarpus* (P3)**	
Description: An upright shrub to 1 m tall (WAH 1998-2021; 2021). 	**Habitat:** recorded from an isolated granite outcrop. **Location:** near the western boundary of the survey area adjacent to the rail access road. **Survey results**: two records in survey area with 15 plants **Populations:** one population **Known records and distribution**: According to *NatureMap* (DBCA 2007-2021) there are seven records of this species from the Pilbara bioregion, all from a restricted distribution south of Port Hedland. This species is widespread in the Northern Territory, Queensland and New South Wales (ALA 2021).
***Rothia indica* subsp. *australis* (P3)**	
Description: Prostrate annual herb to 0.3 m high, densely covered in spreading hairs. (WAH 1998-2021; 2021). 	**Habitat:** recorded from a drainage line associated with the **MaAtCc** vegetation type. **Location:** near the eastern boundary of the survey area. **Survey results**: one record in survey area with one plant **Populations:** one population **Known records and distribution**: According to *NatureMap* (DBCA 2007-2021) there are 21 records of this taxon within Western Australia, though its distribution extends across the Northern Territory and Queensland (ALA 2021)

***Triodia chichesterensis* (P3)**	
Description: A hummock grass to 0.6 m high (WAH 1998-2021; 2021)**.** 	**Habitat:** recorded from stony rises associated with the **AiTw** vegetation type. **Location:** the eastern half of the survey area] **Survey results**: 10 records in survey area with an estimated 3,800 plants. **Populations:** two populations **Known records and distribution**: According to *NatureMap* (DBCA 2007-2021) there are 13 records of this species from the Pilbara bioregion to the south of Port Hedland, with an overall distribution of approximately 90 km (north-south).
***Bulbostylis burbidgeae* (P4)**	
Description: Tufted annual sedge to 0.25 m high (WAH 1998-2021; 2021). 	**Habitat:** recorded from amongst granite boulders **Location:** recorded from the northwestern corner of the survey area during 2021 and has been recorded elsewhere previously. **Survey results**: two records in survey area during 2021 with at least 40 plants **Populations:** two populations **Known records and distribution**: According to *NatureMap* (DBCA 2007-2021) there are 45 records of this species from the Pilbara bioregion, with an overall distribution of approximately 450 km (east-west).

***Goodenia nuda* (P4)**	
Description: Erect to ascending herb to 0.5 m high with yellow flowers (WAH 1998-2021; 2021). 	**Habitat:** recorded from a drainage line within the **ChAcTe** vegetation type **Location:** combined surveys indicate this taxon is scattered across the survey area. **Survey results**: one location recorded during the 2021 survey **Populations:** likely one scattered population **Known records and distribution**: According to *NatureMap* (DBCA 2007-2021) there are 126 records of this species that is extensively documented from the entire Pilbara bioregion and into adjacent areas.

4.1.1.3 Other Significant Flora

No flora taxa having other significance according to the Flora and Vegetation Technical Guidance (EPA 2016) were recorded during the field survey.

4.1.1.4 Flora of Taxonomic Interest

An *Amaranthus* species was opportunistically collected that was sent for confirmation by the Western Australian Herbarium as it did not clearly align with other *Amaranthus* taxa known from the region. The Herbarium considers this collection unusual and potentially representing an undescribed species. It was a low herb with long, narrow bracts, bracteoles and sepals collected from amongst granite boulders. The collection was made from the southern portion of the survey area, south of the main access road.

Image 1: *Amaranthus* sp.

4.1.1.5 Introduced Flora

Three introduced flora species (weeds) were recorded during the field survey, representing 1.43% of the overall flora inventory:

- **Cenchrus ciliaris* (Buffel Grass); recorded from six locations, this weed was dominant within the **MaAtCc** vegetation type and a major contributor to the vegetation condition assessment of that vegetation.
- **Flaveria trinervia* (Speedy Weed); recorded from two locations at low density (<1% cover)
- **Portulaca pilosa* (Djanggara); recorded from two locations at low density (<1% cover).

None of the introduced flora have any specific significance i.e., none are Declared Pest plants or WoNS species.

Image 2: *_Cenchrus ciliaris_ (Buffel Grass)

Image 3: *_Flaveria trinervia_ (Speedy Weed)

Image 4: *_Portulaca pilosa_ (Djanggara)

4.1.2 VEGETATION

4.1.2.1 Vegetation Types

Eight vegetation types were recorded from within the survey area (**Table 7**, **Map 5**) based on a combination of structural vegetation type as identified in the field and subsequent desktop review.

The vegetation types within the survey area, grouped broadly based on landform types, were:

- Drainage lines: two vegetation types
- Granite Outcropping: one vegetation type
- Plains: five vegetation types.

Table 7: Vegetation types

Landform	Mapping unit	Vegetation type	Floristic quadrats	Representative photograph	Area (ha) and extent (%)
Plains	**AaTw**	*Acacia acradenia* tall open shrubland over *Triodia wiseana* and *T. epactia* low hummock grassland	**NJ2107**		6.78 ha 0.66%
Plains	**AiTw**	*Acacia inaequilatera* and *A. bivenosa* tall sparse shrubland over *Triodia wiseana* and *T. chichesterensis* low hummock grassland	**NJ2103** NJ2108		45.47 ha 4.44%
Plains	**AoTl**	*Acacia orthocarpa* and *Grevillea wickhamii* tall open shrubland over *Triodia lanigera* and *Acacia stellaticeps* low hummock grassland/shrubland	**NJ2102** NJ2110		570.66 ha 55.78%

Landform	Mapping unit	Vegetation type	Floristic quadrats	Representative photograph	Area (ha) and extent (%)
Granite Outcropping	**AtTe**	*Acacia tumida* var. *pilbarensis* tall sparse shrubland over *Triodia epactia* mid open hummock grassland	NJ2104		111.68 ha 10.92%
Drainage lines	**ChAcTe**	*Corymbia hamersleyana* low open woodland over *Acacia colei* var. *colei* tall sparse shrubland over *Triodia epactia, T. longiceps* and *Chrysopogon fallax* mid hummock/tussock grassland	NJ2106		36.31 ha 3.55%
Drainage lines	**MaAtCc**	*Melaleuca argentea* and *Eucalyptus camaldulensis* subsp. *refulgens* open woodland over *Acacia tumida* var. *pilbarensis* and *A. trachycarpa* tall open shrubland over **Cenchrus ciliaris* and *Triodia epactia* low tussock/hummock grassland	NJ2101		20.01 ha 1.96%
Plains	**Tl**	*Triodia longiceps* and *T. epactia* low hummock grassland	NJ2105		223.28 ha 21.82%

Landform	Mapping unit	Vegetation type	Floristic quadrats	Representative photograph	Area (ha) and extent (%)
Plains	**Ts**	*Triodia secunda* low hummock grassland	NJ2109		8.86 ha 0.87%
		TOTAL EXTENT			**1023.05 ha 100%**

4.1.2.2 Vegetation Significance

TECs and PECs

No vegetation recorded from the survey area was assessed as being representative of any currently described TEC or PEC.

Other Significant Vegetation

According to the criteria outlined in the Flora and Vegetation Technical Guidance (EPA 2016), the **MaAtCc** vegetation type is considered significant as representative of GDV since it is characterised/dominated by *Melaleuca argentea* and *Eucalyptus camaldulensis*.

4.1.2.3 Vegetation Condition

The vegetation condition within the survey area ranged from Good to Excellent condition, with the majority in Excellent condition with minimal evidence of disturbance (**Table 8**, **Map 6**). Vegetation in Very good condition corresponded with vegetation type **ChAtTe** (minor drainage lines) with minor evidence of cattle and weed invasion. Vegetation in Good condition was mapped in the major drainage line corresponding with vegetation type **MaAtCc**, impacted by weed invasion (particularly **Cenchrus ciliaris*) and cattle grazing.

Table 8: Vegetation condition

Vegetation condition	Extent (ha)	Proportion (%)
Excellent	966.73	94.49
Very Good	34.02	3.33
Good	22.31	2.18
Poor	-	-
Degraded	-	-
Completely Degraded	-	-

4.1.2.4 Adequacy of Survey

Adequacy of survey can be demonstrated using a species accumulation curve; if the curve has reached (or almost reached) an asymptote it is considered that most species are likely to have been recorded from the

survey area. However, it should not be expected that a Reconnaissance flora and vegetation survey would record a complete flora inventory.

A species accumulation curve was generated using quadrat data (**Figure 3**). Opportunistic observations, which increase the number of species recorded, are not included in the analysis.

The species accumulation curve suggests that additional sampling would record more flora taxa. However, the Bootstrap estimate of species richness is 173.8 which, when taking opportunistic records into account, is below the actual total recorded (210). This indicates that the overwhelming majority of flora taxa likely to be present would have been recorded.

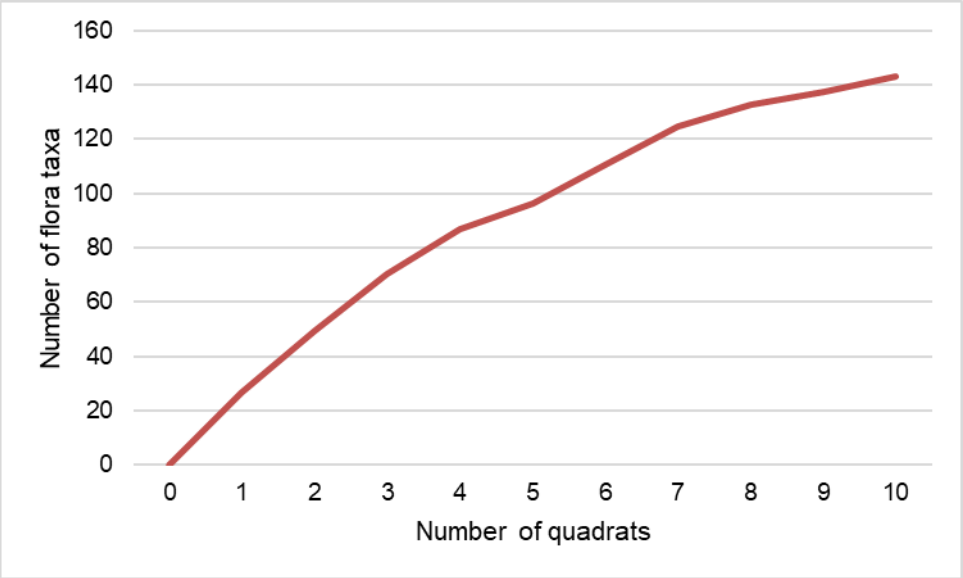

Figure 3: Species accumulation curve

4.1.3 BOTANICAL LIMITATIONS

Survey design: Single phase, quadrat-based flora and vegetation survey with extensive traverses searching for conservation significant flora. Results from previous surveys were considered as part of survey design and the desktop assessment.

Survey type: Reconnaissance flora and vegetation survey with extensive searches for significant flora searches conducted over a single phase. All areas were adequately surveyed through the use of floristic quadrats to sample vegetation types, and targeted searches for conservation significant flora.

Type of vegetation classification system: Vegetation classified at NVIS Level V (NVIS Technical Working Group & DotEE 2017) using largely structural vegetation types defined using dominant and characteristic species and vegetation structure as recorded during the field surveys.

A full summary of botanical limitations is presented in **Table 9**.

Table 9: Botanical limitations

Possible limitations	Constraints (yes/no): Significant, moderate or negligible	Comment
Availability of contextual information at a regional and local scale	No	Two previous surveys have been incorporated the survey area. Numerous other reports are available from surrounding areas as outlined in **Section 2.3.1**
Competence/experience of the team conducting the survey, including	No	The lead botanist conducting the field survey has over 15 years' experience undertaking flora and vegetation

Possible limitations	Constraints (yes/no): Significant, moderate or negligible	Comment
experience in the bioregion surveyed		surveys within Western Australia including extensive experience in the Pilbara bioregion.
Proportion of the flora recorded and/or collected, and any identification issues	No	210 vascular flora taxa were recorded during the field survey of which 0.95% could not be identified with certainty to species level due to the lack of diagnostic reproductive material. None of the unidentified taxa are considered likely to represent any conservation-listed flora from the region.
Was the appropriate area fully surveyed (effort and extent)	No	The area was sampled sufficiently for the purpose of a Reconnaissance flora and vegetation survey with all vegetation types assessed and targeted searches undertaken during traverses on foot.
Access restrictions within the survey area	No	The entire survey area was accessible on foot.
Survey timing, rainfall, season of survey	No	The field survey was conducted during May, during the optimal season for primary survey in the Pilbara bioregion. The rainfall in the six months prior to the field survey was above the mean for this period (**Figure 2**), also indicated by the rainfall (**Figure 4**). Consequently the timing of field survey was ideal to detect the majority of flora species.
Disturbance that may have affected the results of the survey e.g. fire, flood, clearing	No	There were no recent disturbances that would have affected the results of the survey significantly. The majority of the survey area had not been recently burnt.

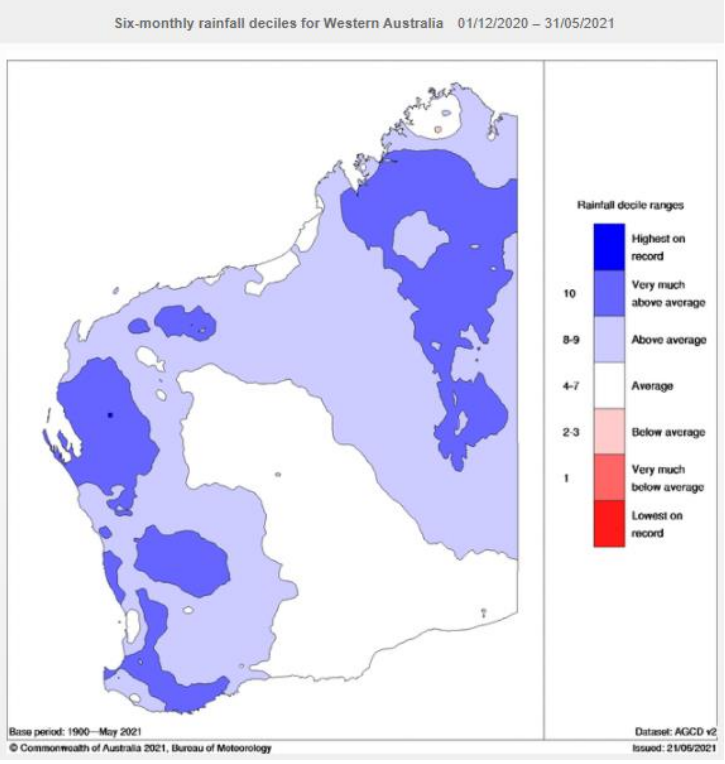

Figure 4: Rainfall deciles for the 6 months prior to the field survey (BoM 2021c)

4.2 VERTEBRATE FAUNA SURVEY

The fauna survey was conducted by Hugh Osborn (Zoologist) during 25 to 28 May 2021.

The survey was conducted in accordance with the requirements for a Basic survey as outlined in the Fauna Technical Guidance (EPA 2020a).

Five trail cameras, also known as motion cameras, were deployed in representative habitat and on habitat suitable for significant fauna species features such as Brush-tailed Mulgara (*Dasycercus blythi*) burrows (**Map 7**).

One ultrasonic recording unit (SM4-01147, **Map 7**) was deployed nearby to a previous conservation significant bat detection (*Rhinonicteris aurantia* – Pilbara, shown on **Map 4**) within the survey area for the detection of Bat species.

The entire survey area was traversed on foot and all habitats were assessed for quality and capability of supporting both locally common and significant fauna species. Habitat assessment points, motion camera and ultrasonic recorder locations, and locations of significant observations are indicated on **Map 7**.

4.2.1 FAUNA HABITAT

Three fauna habitat types were recorded within the survey area (**Table 10**):

- Hummock Grasslands
- Creeklines
- Granite Outcrops.

The Hummock Grasslands are often associated with *Acacia* shrubs. Fire within the last approximately 12 months had affected the southwestern section of this habitat type, removing the ground cover used by fauna usually provided by larger spinifex clumps. All habitats are also subject to degradation by introduced weeds, road clearing, drainage construction, cattle presence and maintenance activity.

Fauna habitats were assessed from 15 habitat assessment points and five motion camera deployments across the survey area (**Table 22, Table 23, Map 7**). Habitat quality varied from degraded to moderate dependent on the level of disturbance from clearing, fire history, and trampling by Cattle.

Habitat quality is based on the level of disturbance due to weeds, road/tracks, clearing or other human disturbances, and the context of the habitat with the surrounding landscape.

Table 10: Fauna habitat types

Habitat type	Description	Fauna Habitat Assessment Points	Photograph
Hummock Grassland	**Spinifex grasslands with scattered granites on sandy and clay soils** Conservation-listed species such as Brush-tailed Mulgara (*Dasycercus blythi*) and Bilby (*Macrotis lagotis*) are likely to use suitable sandy areas for burrows. Pebble-mound Mouse (*Pseudomys chapmani* P4) may use suitable areas with a stony surface within this habitat. **Extent**: 859.27 ha; 83.99%	HA01; HA02; HA05; HA06; HA09; HA10; HA12;HA13, HA15	
Creeklines	**Riparian vegetation consisting of tall Eucalypts over *Acacia* and mixed shrubs over grasses.** This habitat type is an important seasonal water source for many species. Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia* Pilbara form) could utilise large Eucalypt trees to roost during the wet season. **Extent**: 52.10 ha; 5.09%	HA03; HA07; HA11	

Habitat type	Description	Fauna Habitat Assessment Points	Photograph
Granite Outcrops	**Granite outcrops surrounded by spinifex grasslands** Granites surrounded by spinifex grassland provide potential habitat for *Ctenotus nigrilineatus.* Suitable granite outcrops may provide habitat for North Quoll (*Dasyurus hallucatus*). **Extent**: 111.68 ha; 10.92%	HA04; HA08; HA14	

4.2.1.1 Hummock Grassland

This habitat type was the most common habitat type within the survey area (83.99%). The vegetation consisted primarily of various *Triodia* spp., with various shrubs including *Acacia stellaticeps* on soil ranging between clay and sand. Exposed granite slabs consisting of flat areas of less significant size than the Granite outcroppings were intermittent within this habitat type and provide additional structure for a variety of fauna species. The flat spinifex plains are suitable for conservation significant species such as Brush-tailed Mulgara (*Dasycercus blythi*) and Bilby (*Macrotis lagotis*) which can burrow and forage within the various soils which ranged from sand to sandy clay, mostly without gravel or stones but some areas covered by pebbles. This area provides connectivity within the landscape to the resources provided by this and other habitats.

4.2.1.2 Creeklines

Creeklines support riparian vegetation such as tall Eucalypts, *Acacia* spp. and a variety of shrubs, herbs and grasses. Bird species benefit from the abundance and diversity of plants and the close proximity to seasonal water sources. The increase in availability of water supports species which require more mesic areas and are not considered as arid zone specialists such as Yellow-throated Miner, Cockatiel, and various Honeyeater species. When water is absent this habitat creates avenues for the movement of feral species such as Cattle, Feral Cats, and Wild Dogs through the survey area.

4.2.1.3 Granite Outcrops

These rocky outcrops surrounded mostly by hummock grassland habitat and range in structure from crumbling boulder piles to extensive gently sloping slabs. The diversity of rocky structures has the potential to provide den sites and shelter for conservation significant species such as the Northern Quoll (*Dasyurus hallucatus*).

4.2.2 FAUNA ASSEMBLAGE

Thirty-nine vertebrate fauna species were recorded during the survey (**Table 11**) consisting of:

- 11 mammals (two introduced)
- 20 birds (one introduced)
- eight reptiles.

Of these, three are conservation-listed:

- Bilby (*Macrotis lagotis*); VU EPBC status; VU BC status, observed via unconfirmed secondary evidence in the form of diggings within Hummock Grasslands habitat next to a small outcrop of granite.
- Brush-tailed Mulgara, Ampurta (*Dasycercus blythi*); P4 DBCA status, observed via secondary evidence in the form of burrows in the Hummock Grasslands.
- Western Pebble-mound Mouse (*Pseudomys chapmani*); P4 DBCA status, observed via secondary evidence of two mounds within the Hummock Grasslands on sandy loam soil with pebbles.

One species could not be identified from the remote camera data (MC014) and was captured in only one frame (**Figure 5**). Although unconfirmed, the image is likely to be of the Common Rock Rat *(Zyzomys argurus*) that occupies a range of habitats but is commonly associated with rocky outcrops, particularly sandstone formations, but occasionally is found on igneous, lateritic or limestone scree slopes (Van Dyck & Strahan 2008). This record is not included in the species list (**Table 11**).

Figure 5: Common Rock Rat *(Zyzomys argurus*) unconfirmed image

Table 11: Recorded fauna species

Family	Species	Common name	EPBC Act status	Western Australian status
Mammals				
Canidae	**Canis familiaris familiaris*	Dog	-	-
Dasyuridae	*Dasycercus blythi*	Brush-tailed Mulgara, Ampurta	-	P4
Emballonuridae	*Taphozous georgianus*	Common Sheath-tailed Bat	-	-
Felidae	**Felis catus*	Cat	-	-
Macropodidae	*Osphranter robustus erubescens*	Euro, Biggada	-	-
Molossidae	*Chaerephon jobensis*	Greater Northern Free-tailed Bat	-	-
Muridae	*Pseudomys chapmani*	Western Pebble-mound Mouse	-	P4
Thylacomyidae	*Macrotis lagotis*	Bilby, Dalgyte	VU	VU
Vespertilionidae	*Chalinolobus gouldii*	Gould's Wattled Bat	-	-
Vespertilionidae	*Scotorepens greyii*	Little Broad-nosed Bat	-	-
Vespertilionidae	*Vespadelus finlaysoni*	Finlayson's Cave Bat	-	-
Birds				
Accipitridae	*Circus assimilis*	Spotted Harrier	-	-
Alcedinidae	**Dacelo leachii*	Blue-winged Kookaburra	-	-
Artamidae	*Artamus cinereus*	Black-faced Woodswallow	-	-
Campephagidae	*Coracina novaehollandiae*	Black-faced Cuckoo-shrike	-	-
Campephagidae	*Lalage tricolor*	White-winged Triller	-	-
Columbidae	*Geophaps plumifera*	Spinifex Pigeon	-	-
Columbidae	*Ocyphaps lophotes*	Crested Pigeon	-	-
Corvidae	*Corvus bennetti*	Little Crow	-	-
Cracticidae	*Cracticus nigrogularis*	Pied Butcherbird	-	-
Estrildidae	*Emblema pictum*	Painted Finch	-	-
Estrildidae	*Taeniopygia guttata*	Zebra Finch	-	-
Falconidae	*Falco berigora*	Brown Falcon	-	-
Falconidae	*Falco cenchroides*	Australian Kestrel (Nankeen Kestrel)	-	-
Hirundinidae	*Hirundo neoxena*	Welcome Swallow	-	-
Maluridae	*Malurus leucopterus*	White-winged Fairywren	-	-
Meliphagidae	*Ptilotula penicillata*	White-plumed Honeyeater	-	-
Monarchidae	*Grallina cyanoleuca*	Magpie-lark	-	-
Psittacidae	*Melopsittacus undulatus*	Budgerigar	-	-
Rhipiduridae	*Rhipidura leucophrys*	Willie Wagtail	-	-
Turnicidae	*Turnix velox*	Little Buttonquail	-	-
Reptiles				
Agamidae	*Ctenophorus caudicinctus*	Western Ring-tailed Dragon	-	-
Agamidae	*Ctenophorus isolepis isolepis*	Central Military Dragon	-	-
Agamidae	*Gowidon longirostris*	Long-nosed Dragon	-	-
Diplodactylidae	*Lucasium stenodactylum*	Sand-plain Gecko	-	-
Elapidae	*Pseudonaja nuchalis*	Gwardar; Northern Brown Snake	-	-
Gekkonidae	*Heteronotia binoei*	Bynoe's Gecko	-	-
Scincidae	*Ctenotus* sp.		-	-
Varanidae	*Varanus gouldii*	Bungarra or Sand Goanna	-	-

The bat call analysis report is included in **Appendix Seven**. No conservation-listed bats were recorded.

Survey sites are listed in **Table 22** in **Appendix Four**.

4.2.3 SIGNIFICANT FAUNA AND ASSOCIATED HABITAT

The significant fauna species observed during the field survey are discussed below with respect to each species' habitat requirements, taking into consideration the findings of the field survey and survey effort.

Bilby (*Macrotis lagotis*) – VU EPBC status; VU BC status

Diggings most likely attributable to Bilby were recorded (site FS04) in Hummock Grassland habitat near a small granite outcrop (**Image 5**).

Bilbies had previously been recorded from the western edge of the survey area (Fortescue data) and from scattered locations nearby (DBCA database records and Fortescue data).

Image 5: Bilby diggings (all FS04)

Brush-tailed Mulgara, Ampurta (*Dasycercus blythi*) – P4 BC status

Brush-tailed Mulgara burrows were recorded from four locations (FS06, FS07, FS08 and FS09; **Image 6**-**Image 8**) in Hummock Grassland habitat.

Brush-tailed Mulgara have previously been recorded from the western edge of the PEC solar survey area (Fortescue data) and from scattered locations nearby (DBCA database records and Fortescue data).

Image 6: Brush-tailed Mulgara diggings (FS07)

Image 7: Brush-tailed Mulgara diggings (FS08)

Image 8: Brush-tailed Mulgara diggings (FS09)

Western Pebble-mound Mouse *(Pseudomys chapmani*) – P4 BC status

Mounds of the Western Pebble-mound Mouse (*Pseudomys chapmani*) were recorded from two locations (FS01 and FS02, **Map 7**) although it could not be determined if the mounds were active or not. Both mounds (**Image 9**, **Image 10**) were in the Hummock Grassland habitat type in close proximity to areas of Creekline fauna habitat.

The Western Pebble-mound Mouse has not been previously recorded from within the survey area.

Image 9: Western Pebble-mound Mouse mound (FS01)

Image 10: Western Pebble-mound Mouse mound (FS02)

4.2.4 FAUNA SURVEY LIMITATIONS

Table 12: Fauna survey limitations

Possible limitations	Constraints (yes/no): Significant, moderate or negligible	Comment
Availability of data and information	No	There are fauna survey reports available from nearby to provide context.
Competency/experience of the survey team, including bioregion experience	No	The zoologist conducting the field survey has over 5 year's experience conducting fauna surveys in Western Australia.
Scope of survey e.g. excluded fauna groups	No	The survey was conducted as a Basic level assessment which provides confirmation of habitat values present within the survey area and records opportunistic observations of fauna. It is not expected to provide a comprehensive inventory of species present.
Timing, weather, season	No	The field survey was conducted during May when most species would have been present.
Disturbances that may have affected results	No	No significant disturbances were recorded.
Proportion of fauna identified, recorded, or collected	No	The fauna inventory is comparable to other Basic fauna surveys.
Adequacy of survey intensity and proportion of survey achieved	No	The survey area was adequately traversed with multiple observation points throughout. Trail cameras and ultrasonic acoustic recorders were positioned to confirm previous records of significant species.
Access	No	There were no access constraints
Data and analysis issues including sampling biases	No	The survey was adequate for a Basic level assessment.

5 DISCUSSION

5.1 FLORA SIGNIFICANCE

A total of 210 vascular flora species were recorded from 10 floristic quadrats and opportunistic observations, including during searches for conservation-listed flora. A small proportion of the total flora inventory (three species, 1.43%) were introduced species reflecting the relatively low level of disturbance in the survey area with the exception of drainage lines. The average species diversity per quadrat was 26.8 and the species accumulation curve and richness estimate indicate the majority of species present would have been recorded.

The number of flora species recorded is relatively high compared with other nearby areas despite the small survey area size and Reconnaissance level of intensity. For example, many surveys of larger size and intensity have recorded a similar number of flora species or less (Coffey Environments 2014; Ecologia Environment 2015b; Ecoscape 2020b, Ecoscape 2018). This is considered likely indicative of the above average seasonal conditions during the survey timeframe.

The high number of flora taxa recorded and comparison with species richness estimate confirm a suitable adequacy of survey, particularly considering it was undertaken at Reconnaissance level.

5.1.1 LOCAL AND REGIONAL ASSESSMENT OF FLORA SIGNIFICANCE

5.1.1.1 Conservation-listed Flora

Threatened Flora

No TF species listed for protection under the Commonwealth EPBC Act or Western Australian BC Act were recorded. None of the unidentified taxa resemble any currently described TF.

Priority Flora

There were nine PF recorded during the field survey:

- *Gomphrena leptophylla* (P3); this species was recorded from two populations with at least 200 plants. Suitable habitat extends outside the survey area and it has been recorded nearby. Impact to this species from Fortescue's activities is not considered significant.
- *Gymnanthera cunninghamii* (P3); this species was recorded from two populations of at least 10 plants combined, with scattered individuals along drainage lines. Considering the low number of plants that may be impacted and relatively widespread distribution in Western Australia and across northern Australia, impact to *Gymnanthera cunninghamii* is not likely to be significant.
- *Heliotropium muticum* (P3); this species was only observed from two locations, though previous records are abundant. Despite traverses on foot through the previously documented populations, few plants were recorded. Previous surveys undertaken by Ecoscape have recorded *Heliotropium muticum* to be abundant from disturbed of burnt areas indication it is likely to be a disturbance opportunist. Previous surveys that documented this species may have followed a bushfire event. Despite the relatively small distribution of this species, Ecoscape considers impact will not be significant to *Heliotropium muticum* on the basis that it is locally abundant from many locations south of Port Hedland.
- *Nicotiana umbratica* (P3); this species was observed from several isolated locations, typically growing amongst granite boulders. Suitable habitat for this species exists outside of the survey area and it has been recorded from nearby also. Considering the low number of plants located within the survey area, impact is not likely to be significant.
- *Phyllanthus hebecarpus* (P3); a single, isolated population was recorded from adjacent to the rail access road with at least 15 plants present. This species has a restricted geographical range within Western Australia, though is widespread across northern Australia. Suitable habitat for this species (granite outcrops) is widespread outside of the survey area and impact is considered unlikely to be significant.

- *Rothia indica* subsp. *australis* (P3); a single plant of this taxon was observed and collected. Considering the low number of plants within the survey area and widespread distribution of this taxon, impact to this taxon is unlikely to be significant.
- *Triodia chichesterensis* (P3); Two populations were recorded with a large number of plants (at least 3,800) and it was frequently a dominant component of the **AiTw** vegetation type. This species has a restricted distribution within the Pilbara bioregion, however is relatively abundant within this range. *Triodia chichesterensis* is known to occur nearby and impact to this species is considered unlikely to be significant.
- *Bulbostylis burbidgeae*. (P4); one population of *Bulbostylis burbidgeae* was recorded with other locations previously documented from amongst granite outcrops and boulders. This species is known from nearby adjacent areas where plenty of suitable habitat exists. Impact to *Bulbostylis burbidgeae* is unlikely to be considered significant.
- *Goodenia nuda* (P4); one individual plant was recorded from a minor drainage line with other locations previously documented at various locations within the survey area. This species is known from nearby adjacent areas where plenty of suitable habitat exists. Impact to *Goodenia nuda* is unlikely to be considered significant, particularly considering the widespread distribution of this species throughout the Pilbara region.

5.1.1.2 Post-survey Likelihood Assessment

The likelihood of conservation significant flora occurring in the survey area was revised following the field survey. This revised likelihood, that took into account vegetation condition, grazing and other disturbances, actual habitat availability and search effort, is included in **Table 19** in **Appendix Three**. Two flora taxa were identified are considered to have a Possible likelihood of occurring based on the post-survey likelihood assessment:

- *Abutilon* sp. Pritzelianum (S. van Leeuwen 5095) (P3); this taxon is a spindly, upright shrub to 2 m tall that is most commonly recorded from roadsides or other disturbed areas. It remains a possible likelihood of occurring on the basis that majority of the survey area had not been recently disturbed and it is known from nearby areas.
- *Euphorbia clementii* (P3); this species is an upright shrub to 0.6 m high. It has been recorded from nearby areas of similar habitat (flats) and is relatively inconspicuous, making it potentially difficult to detect without more intensive survey, therefore remains a possible likelihood of occurring.

5.1.1.3 Other Significant Flora

An *Amaranthus* species was opportunistically collected that may be of taxonomic interest based on confirmation by the Western Australian Herbarium. This taxa was collected opportunistically from amongst granite boulders. The Herbarium considers this collection unusual and potentially representing an undescribed species. However, additional collections would be required for a more definitive verification.

5.1.1.4 Introduced Flora

Three introduced flora species were recorded during the field survey, representing 1.43% of the overall flora inventory. **Cenchrus ciliaris* was recorded a high density within the **MaAtAc** vegetation type and was a major contributor to the vegetation condition assessment. Other introduced flora species were recorded at low densities within the survey area.

None of the introduced flora have any specific significance i.e., none are identified as Declared Pest plants or WoNS species.

5.2 VEGETATION SIGNIFICANCE

Eight vegetation types were recorded from the survey area:

- **Plains/flats:**
  - **AaTw**: *Acacia acradenia* tall open shrubland over *Triodia wiseana* and *T. epactia* low hummock grassland

- **AiTw**: *Acacia inaequilatera* and *A. bivenosa* tall sparse shrubland over *Triodia wiseana* and *T. chichesterensis* low hummock grassland
- **AoTl**: *Acacia orthocarpa* and *Grevillea wickhamii* tall open shrubland over *Triodia lanigera* and *Acacia stellaticeps* low hummock grassland/shrubland
- **Tl**: *Triodia longiceps* and *T. epactia* low hummock grassland
- **Ts**: *Triodia secunda* low hummock grassland

- **Granite outcropping:**
  - **AtTe**: *Acacia tumida* var. *pilbarensis* tall sparse shrubland over *Triodia epactia* mid open hummock grassland
- **Drainage lines**
  - **ChAcTe**: *Corymbia hamersleyana* low open woodland over *Acacia colei* var. *colei* tall sparse shrubland over *Triodia epactia*, *T. longiceps* and *Chrysopogon fallax* mid hummock/tussock grassland
  - **MaAtCc**: *Melaleuca argentea* and *Eucalyptus camaldulensis* subsp. *refulgens* open woodland over *Acacia tumida* var. *pilbarensis* and *A. trachycarpa* tall open shrubland over **Cenchrus ciliaris* and *Triodia epactia* low tussock/hummock grassland.

Broadly, these vegetation types are considered similar to those documented by other surveys of the surrounding region (**Section 2.3.1**).

5.2.1 THREATENED AND PRIORITY ECOLOGICAL COMMUNITIES

Based on species composition and landform, none of the vegetation types recorded from the survey area are considered to have potential to represent any known TEC or PEC from the region.

5.2.2 LOCAL AND REGIONAL ASSESSMENT OF VEGETATION SIGNIFICANCE

The flora and vegetation survey was undertaken at a Reconnaissance level of intensity, therefore limited data is available to assess local and regional significance. The **MaAtCc** vegetation type is considered to represent GDV as it is dominated by *Melaleuca argentea* and *Eucalyptus camaldulensis*. These species are considered phreatophytic and groundwater dependant (see **Appendix One**). Changes to hydrology (groundwater and surface water) has the potential to impact this vegetation type.

5.2.3 VEGETATION CONDITION

The vegetation condition within the survey area ranged from Good to Excellent condition, with the majority in Excellent condition. Vegetation from drainage lines (**MaAtCc** and **ChAtTe**) were typically in lesser vegetation condition with weed invasion and cattle grazing more evident than other vegetation types.

5.3 FAUNA SIGNIFICANCE

5.3.1 FAUNA HABITAT TYPES

Three fauna habitat types were recorded during the field survey (**Section 4.2.1**):

- Hummock Grassland
- Creeklines
- Granite Outcrops.

5.3.2 FAUNA ASSEMBLAGE

Thirty-nine vertebrate fauna species were recorded during the field survey, three of which are conservation-listed and have been previously recorded from within the survey area or within close proximity (approximately 2 km). As suitable habitat for these species (*Macrotis lagotis*; Bilby (VU), *Dasycercus blythi*; Brush-tailed Mulgara (P4) and *Pseudomys chapmani*; Western Pebble-mound Mouse (P4)), all of which are known to inhabit areas of Hummock Grasslands, occurs throughout the survey area they are likely to occur sparsely throughout in this habitat type.

Rhinonicteris aurantia Pilbara form (Pilbara Leaf-nosed Bat) has previously been recorded from the eastern side of the survey area. Identification of bat species from full spectrum WAV-format recordings of their echolocation calls was based on measurements of characteristic frequency, observation of pulse shape, and the pattern of harmonics (**Appendix Seven**), however, this species was not recorded during this survey. Five bat species were unambiguously recorded, none of them conservation-listed,

Seasonal conditions were above average and have had no appreciable significance in relation to the species expected or recorded.

5.3.3 RECORDED CONSERVATION-LISTED SPECIES

Macrotis lagotis (Bilby) – VU EPBC status; VU BC status

Diggings most likely attributable to Bilby were recorded in Hummock Grassland habitat near a small granite outcrop. The habitat type where recorded is as anticipated, based on the habitat types listed for this species (open tussock grasslands on uplands and hills, hummock grasslands on plains and alluvial areas, and Mulga shrublands (TSSC 2016a)).

Bilbies are a solitary species that shelter in burrows, with each individual occupying several burrows concurrently (TSSC 2016a). The burrows are open ended, do not contain nesting material and are often located against a termite mound, spinifex tussock or small shrubs (Van Dyck & Strahan 2008). Prior to European settlement Bilbies occupied approximately 70% of the Australian continent, however, their range has reduced significantly, and continues to decline, and they are now known from only approximately 20% of their former range, most of which is in Western Australia (TSSC 2016a).

Bilbies are omnivores that primarily dig for food that includes invertebrates, seeds, bulbs and fungi (TSSC 2016a). When digging Bilbies fling soil from all sides and form excavations to 25 cm deep, usually over numerous scattered excavations (Van Dyck & Strahan 2008).

Bilbies have previously been recorded from the western edge of the PEC solar survey area (Fortescue data) and from scattered locations nearby (DBCA database records and Fortescue data). The location of this record (FS04) is close to the location of the previous record from Fortescue's database from 2020. Due to the availability of suitable habitat, Bilbies are likely to occur sparsely throughout and be resident within the survey area.

Dasycercus blythi (Brush-tailed Mulgara, Ampurta) – P4 DBCA status

Brush-tailed Mulgara burrows were recorded from four locations within the Hummock Grassland habitat type. They live in burrows in Spinifex grasslands, matching the habitat type they were recorded from. Brush-tailed Mulgara are generally solitary except during mating season and occupy several burrows within their home range. Mulgara burrows can have several entrances and pop holes (Van Dyck & Strahan 2008). They occur in Western Australia, the Northern Territory and western Queensland, and previously in South Australia.

Brush-tailed Mulgara have previously been recorded from the western edge of the PEC solar survey area (Fortescue data) and from scattered locations nearby (DBCA database records and Fortescue data). The records from this survey are all from within 1 km of the previous Fortescue record's location.

Brush-tailed Mulgara are likely to occur sparsely through areas and be resident within suitable habitat within the survey area.

Pseudomys chapmani (Western Pebble-mound Mouse) – P4 DBCA status

Mounds of the Western Pebble-mound Mouse (*Pseudomys chapmani*) were recorded from two locations although it could not be determined if the mounds were active or not. Both mounds were in the Hummock Grassland habitat type in close proximity to areas of Creekline fauna habitat.

Western Pebble-mound mice typically occur on gentle slopes, ridges and undulating plains with a mantle of stony soil (Start, Anstee & Endersby 2000). Like other pebble-mound mice, the Western Pebble-mound Mouse creates its own microhabitat by scattering a mound of pebbles around its burrows (Dunlop & Pound 1981). Its

preferred habitat is hummock grasslands of 'hard Spinifex', usually *Triodia basedowii* or *Triodia wiseana,* with trees, mallees and shrubs including *Acacia* and *Senna* species (Start, Anstee & Endersby 2000).

The Western Pebble-mound Mouse has not been previously recorded from within the survey area with the nearest record located approximately 2 km away. However, there are records of this species in most directions from the survey area indicating its presence is not unexpected.

As suitable habitat for the Western Pebble-mound Mouse occurs frequently within the survey area, colonies of this species are anticipated to occur sparsely in areas of suitable substrate.

5.3.4 POST-SURVEY LIKELIHOOD ASSESSMENT

The post-survey likelihood assessment is incorporated into **Table 20** in **Appendix Three**.

Conservation-listed fauna species identified during the desktop assessment as having a High or Medium likelihood of occurring that were not recorded during the field survey are discussed below with respect to each species' habitat requirements, taking into consideration the findings of the field survey and survey effort. Previously recorded species that were not recorded during this survey are also included in the discussion.

High Likelihood Species

Dasyurus hallucatus (Northern Quoll) – EN EPBC status; EN BC status

Northern Quolls are carnivorous, primarily nocturnal marsupials that occur in the northern parts of Australia. They do not have highly specific habitat requirements, occurring over a range of habitat types. They occupy daytime dens that include rocky outcrops, tree hollows, hollow logs, termite mounds, goanna burrows and human structures (Hill & Ward 2010). Within Western Australia Northern Quoll are confined to the Pilbara and Kimberley regions where Cane Toads are considered to represent the main threat to this species' population (TSSC 2005).

As a habitat generalist Northern Quolls are likely to be present within the survey area (i.e. have a High post-survey likelihood). Although they have not been previously recorded from within the survey area, they have been recorded from within 1 km and are highly likely to occur in the Granite Outcrop habitat type where suitable den sites may occur, the Creekline habitat type where hollow logs may be used for shelter, and within the Hummock Grassland habitat type for foraging activities.

Macroderma gigas (Ghost Bat) – VU EPBC status; VU BC status

The Ghost Bat occurs in Western Australia, the Northern Territory and Queensland where it occupies a range of habitats. Daytime roosts have been recorded in caves, rock crevices and old mines with night roosts being permanent in deep natural caves or disused mines. Ghost Bats are carnivorous, foraging by ambushing prey in the air or on the ground or surface gleaning along the ground. Their prey is mostly large invertebrates although vertebrates including birds, bats, rats and mice are also consumed (TSSC 2018).

No suitable roosting habitat (day or night roosts) was recorded; thus, Ghost Bats are highly unlikely to be resident within the survey area. If suitable roosting habitat is available nearby this species may forage within the survey area but is unlikely to be dependent on the survey area for any resources. No evidence of Ghost Bat feeding sites (rock overhang or small cave identified by prey remnants; Van Dyck & Strahan 2008) was recorded.

The post-survey likelihood of Ghost bat occurring within the survey area is High (foraging) and Very Low for residence and dependence on the habitat and resources, including roost sites and food sources, available within the survey area.

Rhinonicteris aurantia Pilbara form (Pilbara Leaf-nosed Bat) – VU EPBC status; VU BC status

The Pilbara Leaf-nosed Bat is confined to Western Australia, primarily within the Pilbara bioregion. It is insectivorous and relies on warm, humid underground roosts including deep caves and abandoned mine

shafts. Foraging habitat includes gorges with pools; gullies; rocky outcrops with exposed rocks, caves and overhangs or boulder piles; major watercourses and open grassland and woodland (TSSC 2016b).

No habitat suitable for roosting was recorded; thus, Pilbara Leaf-nosed Bats are highly unlikely to be resident within the survey area. As they are known to forage in open grassland and woodland, in rocky areas and along major watercourses much of the survey area is therefore potentially suitable for foraging. They have been previously recorded from the watercourse on the eastern side of the survey area (Fortescue data), with an ultrasonic recorder located near the previous recording site during this survey, although the bats were not recorded on this occasion, and the western side near the railway.

The post-survey likelihood of the Pilbara Leaf-nosed Bat is therefore considered to be High for foraging activities and Very Low for dependence on the resources available within the survey area including roost sites and food sources. It is likely that they forage within the survey area on occasion and perhaps frequently.

Apus pacificus (Fork-tailed Swift) – Marine, Migratory EPBC Act

Fork-tailed Swifts occur over much of Australia in a variety of habitats (Simpson & Day 2004). It is protected under international agreements as a migratory species, however, it is not conservation-listed in any State or Territory of Australia (ALA 2021).

As a wide-ranging species Fork-tailed Swifts may on occasion occur within the survey area (i.e., have a High likelihood of occurring), however, they are unlikely to be resident within or be dependent on any resource available within the survey area.

Falco hypoleucos (Grey Falcon) – VU EPBC status; VU BC status

The Grey Falcon's distribution is over much of Australia, occurring at low densities across inland Australia. The main habitat is timbered lowland plains, Acacia shrublands and tree-lined watercourses although it has also been recorded as hunting in treeless areas including tussock grassland, as well as open woodlands. Its prey is usually other bird species although small mammals and occasional reptiles have been recorded (TSSC 2020).

As a wide-ranging species known to hunt in habitat similar to that of the survey area it has a High likelihood of occurring, although it is unlikely to be dependent on any resources present within the survey area.

Falco peregrinus (Peregrine Falcon) – OS DBCA status

The Peregrine Falcon is a habitat generalist known from throughout Australia although not regarded as common anywhere. It feeds on small and medium-sized birds and small mammals and nests in recesses of cliff faces, tree hollows, abandoned nests of other birds and artificial structures (Australian Museum 2021).

Species listed as OS are considered in need of special protection to ensure their conservation.

As a habitat generalist this species has a High likelihood of occurring within the survey area, however, nest sites are not likely to be common and food sources would be widespread. Therefore, it would be unlikely that Peregrine Falcon would be dependent on resources available within the survey area.

Lagorchestes conspicillatus leichardti (Spectacled Hare-wallaby)– P3 DBCA status

The Spectacled Hare-Wallaby *sens. lat.* occurs over much of northern Australia; in the Pilbara it has been recorded as inhabiting Spinifex grasslands, requiring large grass hummocks for shelter. It is considered to have declined in population in the Pilbara with the likely causes attributed as being from fox predation and loss of suitable habitat due to frequent burning (Van Dyck & Strahan 2008).

Suitable long unburnt habitat may occur within the survey area and as such it has a High likelihood of occurring. If it does occur it would be dependent on the habitat available, although there are no records from within the survey area.

Medium Likelihood Species

Liasis olivaceus barroni (Pilbara Olive Python) – VU EPBC status; VU BC status

The Pilbara Olive Python occurs only in the Pilbara region of Western Australia where it prefers rocky outcrops, deep gorges and waterholes, although in cooler months they may be less dependent on water sources (DEWHA 2008).

Although there is a significant watercourse within the survey area, permanent water (i.e., waterholes) were not recorded thus it is unlikely to occur within the survey area as suitable habitat is not present (Low post-survey likelihood of occurring).

Merops ornatus (Rainbow Bee-eater) – MA EPBC status, IA BC status

The Rainbow Bee-eater and has an almost Australia-wide distribution (DAWE 2021b). It is listed as a Marine species under the EPBC Act and as protected under international agreements under both the EPBC and BC Acts, but is not conservation-listed in any State or Territory of Australia (ALA 2021).

Rainbow Bee-eaters are aerial insectivores and nest in colonies, building tunnels into sloping soil or cliff faces (Boland 2004).

As a habitat generalist it is possible that Rainbow Bee-eaters will, on occasion, occur within the survey area for foraging or breeding although it is unlikely they would be dependent on any resources available within it. There are no records of this species from within 50 km of the survey area (DBCA and Fortescue data), thus it remains as a Medium likelihood of occurring.

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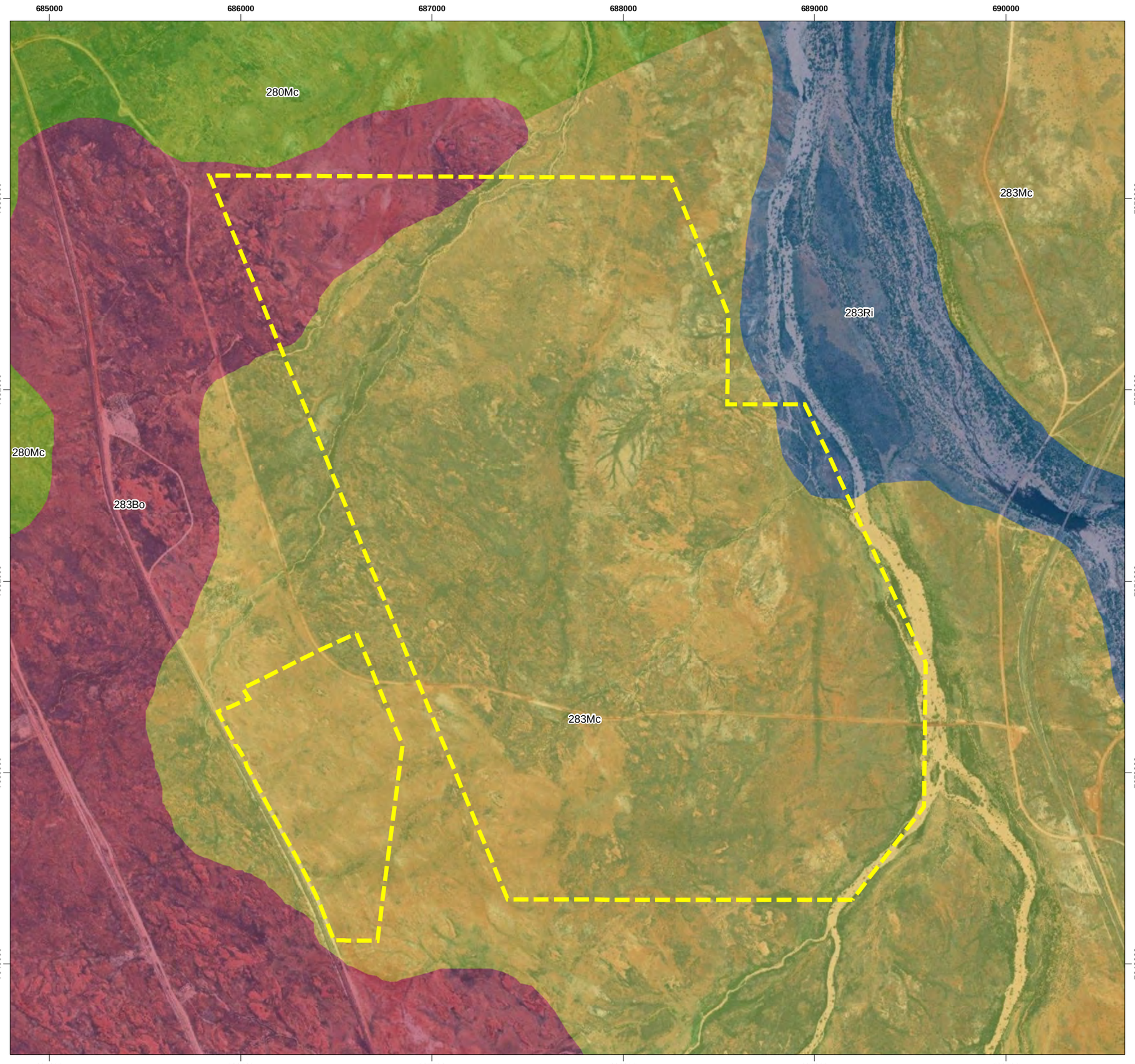
MAPS



LEGEND

Survey Area

Soil Land Systems (DPIRD 2018)

- 280Mc: Stony plains and occasional tor fields based on granite supporting hard and soft spinifex shrubby grasslands.
- 283Bo: Granite hills, domes, tor fields and sandy plains supporting spinifex grasslands with scattered shrubs.
- 283Mc: Stony plains and occasional tor fields based on granite supporting hard and soft spinifex shrubby grasslands.
- 283Ri: Narrow, seasonally active flood plains and major river channels supporting moderately close, tall shrublands or woodlands of Acacias and fringing communities of Eucalypts sometimes with tussock grasses or spinifex.

DATA SOURCES :
SOURCE DATA: SOIL LANDSCAPE DATA DPIRD 2018
AERIAL: ESRI BASEMAP 2018-2019
BASEMAP: GEOSCIENCE AUSTRALIA
SERVICE LAYERS: SOURCE: ESRI, MAXAR, GEOEYE, EARTHSTAR GEOGRAPHICS, CNES/AIRBUS DS, USDA, USGS, AEROGRID, IGN, AND THE GIS USER COMMUNITY

ecoscape

LAND SYSTEMS

NORTH STAR JUNCTION
FLORA AND FAUNA SURVEY

Fortescue
The New Force in Iron Ore

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

N

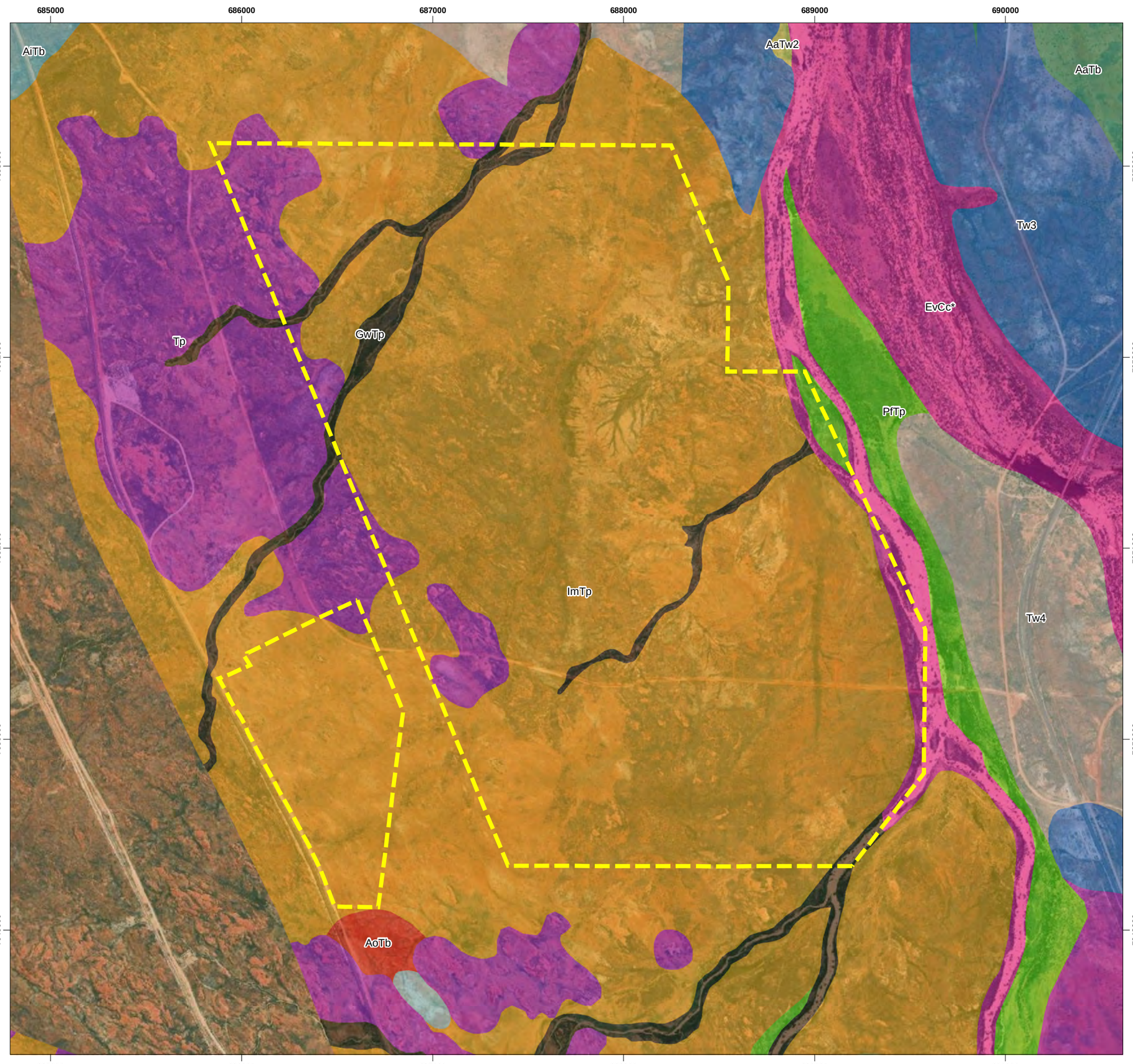
SCALE: 1:20,000 @ A3

0 0.15 0.3 0.45 0.6 0.75 km

PROJECT NO: 4641-21

REV	AUTHOR	APPROVED	DATE
00	LC	XX	14/07/2021

MAP
01



LEGEND

Survey Area

Vegetation Mapping (Ecologia 2012)

- AaTb: *Petalostylis labicheoides* and *Acacia acradenia* sparse mid shrubland over *Corchorus laniflorus* sparse low shrubland over *Chrysopogon fallax* sparse tussockgrassland and *Triodia basedowii* sparse hummock grassland
- AaTw2: *Acacia acredinia* open mid shrubland over *Triodia wiseana* hummock grassland
- AiTb: *Acacia inaequilatera* and *Grevillea wickhamii* sparse tall shrubland over *Acacia acradenia* sparse mid shrubland over *Triodia basedowii* and *Triodia wiseana* hummock grassland
- AoTb:*Acacia orthocarpa* open mid shrubland over *Indigofera monophylla* sparse low shrubland over *Triodia basedowii* open hummock grassland
- EvCc*: *Eucalyptus victrix*, *Eucalyptus camaldulensis* open mid woodland, over **Cenchrus ciliaris* tussock grassland
- GwTp: *Grevillea wickhamii* sparse tall shrubland over *Triodia pungens* open hummock grassland and isolated *Eragrostis cumingii* tussock grasses *Cyperus squarrosus*sedges and *Stemodia viscosa* herbs
- ImTp: *Indigofera monophylla* and *Solanum phlomoides* sparse open shrubland over *Triodia pungens* and *Triodia basedowii* sparse hummock grasslans with *Mollugo molluginea* and *Bonamia linearis* isolated herbs
- PfTp: *Pluchea ferdinandi-muelleri* open low shrubland over *Triodia pungens* sparse hummock grassland and and **Cenchrus ciliaris*, *Eriachne lanata* and *Chrysopogon falla*xopen tussock grassland
- Tp: *Triodia pungens* open hummock
- Tw3: *Triodia wiseana* and *Triodia basedowii* hummock
- Tw4: *Triodia wiseana* hummock

DATA SOURCES:
SOURCE DATA: VEGETATION MAPPING (ECOLOGIA 2021)
AERIAL: ESRI BASEMAP 2018-2019
BASEMAP: GEOSCIENCE AUSTRALIA
SERVICE LAYERS: SOURCE: ESRI, MAXAR, GEOEYE, EARTHSTAR GEOGRAPHICS, CNES/AIRBUS DS, USDA, USGS, AEROGRID, IGN, AND THE GIS USER COMMUNITY

ecoscape

PREVIOUS VEGETATION MAPPING

NORTH STAR JUNCTION FLORA AND FAUNA SURVEY

FMG Fortescue
The New Force in Iron Ore

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

N

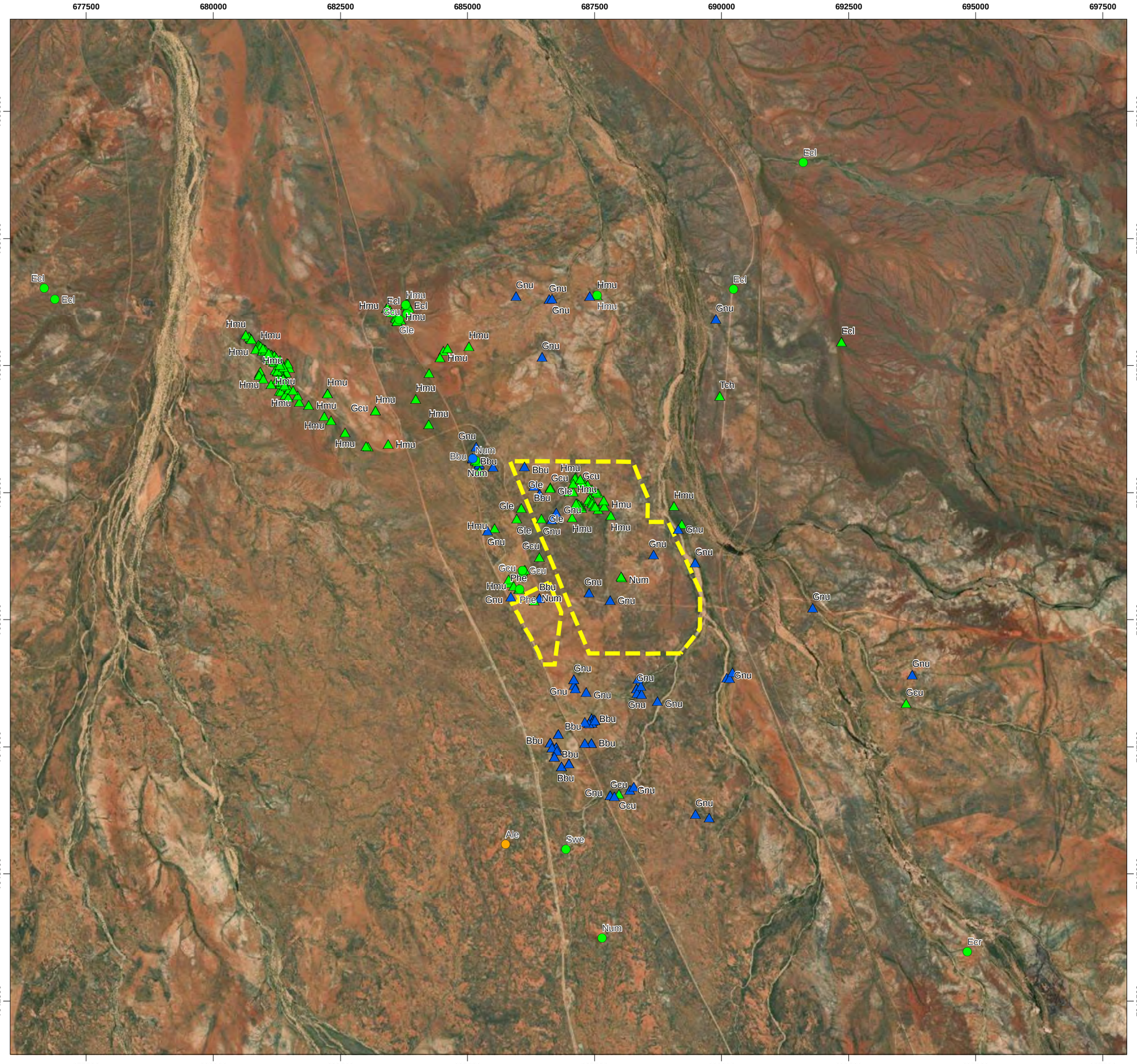
SCALE: 1:20,000 @ A3

0 0.15 0.3 0.45 0.6 0.75 km

PROJECT NO: 4641-21

REV	AUTHOR	APPROVED	DATE
00	LC	XX	14/07/2021

MAP 02



LEGEND

Survey Area

Conservation Listed Flora (DBCA 2020)

- Priority 1
- Priority 3
- Priority 4

Conservation Listed Flora (FMG 2020)

- Priority 3
- Priority 4

LABEL	TAXON	STATUS
Ale	*Acacia leeuweniana*	1
Bbu	*Bulbostylis burbidgeae*	4
Ecl	*Euphorbia clementii*	3
Gle	*Gomphrena leptophylla*	3
Gnu	*Goodenia nuda*	4
Gcu	*Gymnanthera cunninghamii*	3
Hmu	*Heliotropium muticum*	3
Num	*Nicotiana umbratica*	3
Phe	*Phyllanthus hebecarpus*	3
Swe	*Stylidium weeliwolli*	3
Tch	*Triodia chichesterensis*	3

DATASOURCES:
SOURCE DATA: CSF DATA FMG 2020 AND DBCA 2020
AERIAL: ESRI BASEMAP 2018-2019
BASEMAP: GEOSCIENCE AUSTRALIA
SERVICE LAYERS: SOURCE: ESRI, MAXAR, GEOEYE, EARTHSTAR GEOGRAPHICS, CNES/AIRBUS DS, USDA, USGS, AEROGRID, IGN, AND THE GIS USER COMMUNITY

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FLORA DATABASE SEARCH RESULTS

NORTH STAR JUNCTION FLORA & FAUNA SURVEY

FMG Fortescue
The New Force in Iron Ore

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

N

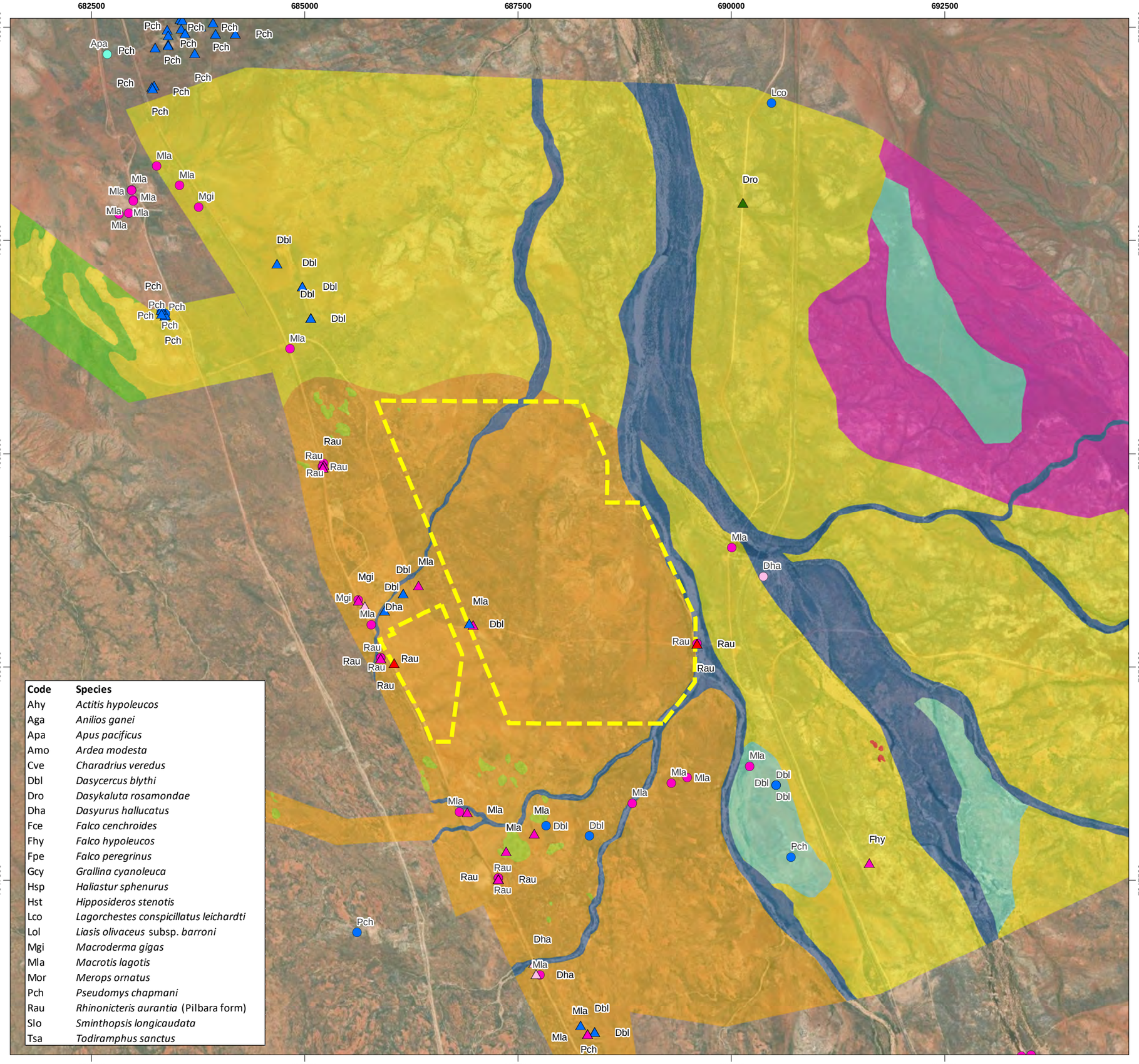
SCALE: 1:75,422 @ A3

0 0.6 1.2 1.8 2.4 3 km

PROJECT NO: 4641-21

REV	AUTHOR	APPROVED	DATE
00	AHC	SK	14/07/2021

MAP
03



Code	Species
Ahy	*Actitis hypoleucos*
Aga	*Anilios ganei*
Apa	*Apus pacificus*
Amo	*Ardea modesta*
Cve	*Charadrius veredus*
Dbl	*Dasycercus blythi*
Dro	*Dasykaluta rosamondae*
Dha	*Dasyurus hallucatus*
Fce	*Falco cenchroides*
Fhy	*Falco hypoleucos*
Fpe	*Falco peregrinus*
Gcy	*Grallina cyanoleuca*
Hsp	*Haliastur sphenurus*
Hst	*Hipposideros stenotis*
Lco	*Lagorchestes conspicillatus leichardti*
Lol	*Liasis olivaceus* subsp. *barroni*
Mgi	*Macroderma gigas*
Mla	*Macrotis lagotis*
Mor	*Merops ornatus*
Pch	*Pseudomys chapmani*
Rau	*Rhinonicteris aurantia* (Pilbara form)
Slo	*Sminthopsis longicaudata*
Tsa	*Todiramphus sanctus*

LEGEND

Survey Area

Conservation Listed Fauna (DBCA 2020)

- Endangered
- Vulnerable
- Migratory Species
- Priority 4

Conservation Listed Fauna (FMG2020)

- Critically Endangered
- Endangered
- Vulnerable
- Priority 4
- Other (Local endemism/restricted distribution - GS56)

Fauna Habitat (Ecologia 2012)

- Drainage Line/River/Creek (Minor / Major)
- Granite Outcrops
- Hills/Ranges/Plateaux
- Hummock grassland
- Plain (sand)
- Plain (shrubland)
- Rocky Escarpments (Ridges/Mesa/Cliffs/Outcrops/Breakaways)
- Tussock grassland

DATA SOURCES:
SOURCE DATA: CSF DATA FMG 2020 AND DBCA 202; FAUNA HABITAT (ECOLOGIA 2012)
AERIAL: ESRI BASEMAP2018-2019
BASEMAP: GEOSCIENCE AUSTRALIA
SERVICE LAYERS: SOURCE: ESRI, MAXAR, GEOEYE, EARTHSTAR GEOGRAPHICS, CNES/AIRBUS DS, USDA, USGS, AEROGRID, IGN, AND THE GIS USER COMMUNITY

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FAUNA HABITAT AND DATABASE SEARCH RESULTS

NORTH STAR JUNCTION FLORA AND FAUNA SURVEY

FMG Fortescue The New Force in Iron Ore

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

N

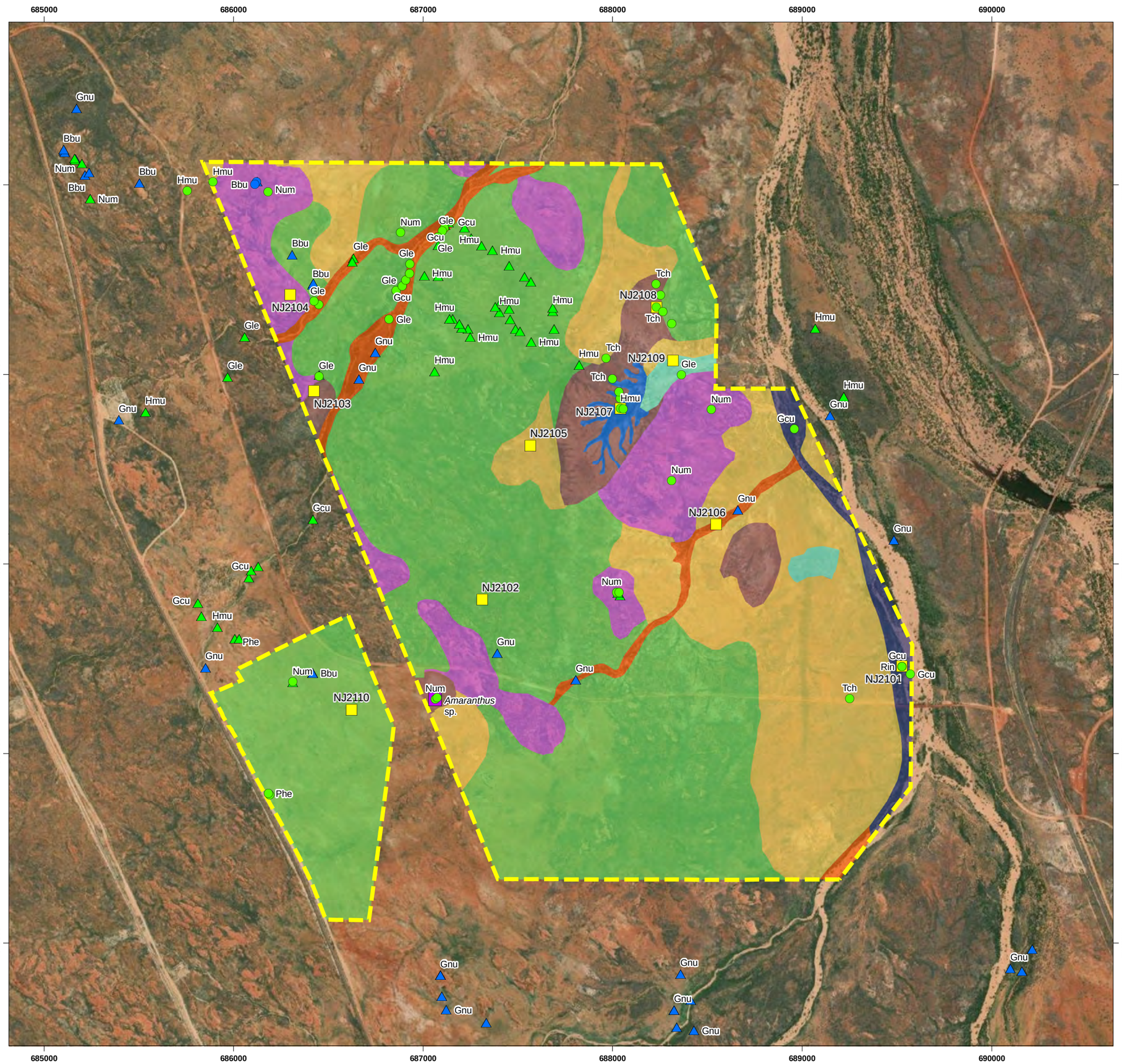
SCALE: 1:45,000 @ A3

0 0.35 0.7 1.05 1.4 1.75 km

PROJECT NO: 4641-21

REV	AUTHOR	APPROVED	DATE
00	LC	SB	14/07/2021

MAP 04



LEGEND

- Survey Area
- Quadrats

Conservation Listed Flora (Ecoscape, 2021)

- Priority 3
- Priority 4

Conservation Listed Flora (FMG, 2020)

- Priority 3
- Priority 4

Taxanomic Interest

Vegetation Types

- AaTw-*Acacia acradenia* tall open shrubland.
- AiTw-*Acacia inaequilatera* and *A. bivenosa* tall sparse shrubland.
- AoTl-*Acacia orthocarpa* and *Grevillea wickhamii* tall open shrubland.
- AtTe-*Acacia tumida* var. *pilbarensis* tall sparse shrubland.
- ChAcTe-*Corymbia hamersleyana* low open woodland.
- MaAtCc-*Melaleuca argentea* and *Eucalyptus camaldulensis* subsp. *refulgens* open woodland.
- Tl-*Triodia longiceps* and *T. epactia* low hummock
- Ts-*Triodia secunda* low hummock

LABEL	TAXON	STATUS
Bbu	*Bulbostylis burbidgeae*	3
Ecl	*Euphorbia clementii*	3
Gcu	*Gymnanthera cunninghamii*	3
Gle	*Gomphrena leptophylla*	3
Gnu	*Goodenia nuda*	4
Hmu	*Heliotropium muticum*	3
Num	*Nicotiana umbratica*	3
Phe	*Phyllanthus hebecarpus*	3
Rin	*Rothia indica* subsp. *australis*	3
Tch	*Triodia chichesterensis*	3
Tsu	*Terminalia supranitifolia*	3

DATASOURCES:
SOURCE DATA: VEGETATION MAPPING (ECOSCAPE, 2021),
CONSERVATION LISTED FLORA (FMG, 2020, ECOSCAPE, 2021)
AERIAL: ESRI BASEMAP 2018-2019
BASEMAP: GEOSCIENCE AUSTRALIA
SERVICE LAYERS: SOURCE: ESRI, MAXAR, GEOEYE, EARTHSTAR GEOGRAPHICS, CNES/AIRBUS DS, USDA, USGS, AEROGRID, IGN, AND THE GIS USER COMMUNITY

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VEGETATION TYPES, QUADRATS & CONSERVATION LISTED FLORA

NORTH STAR JUNCTION FLORA & FAUNA SURVEY

FMG Fortescue The New Force in Iron Ore

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

N

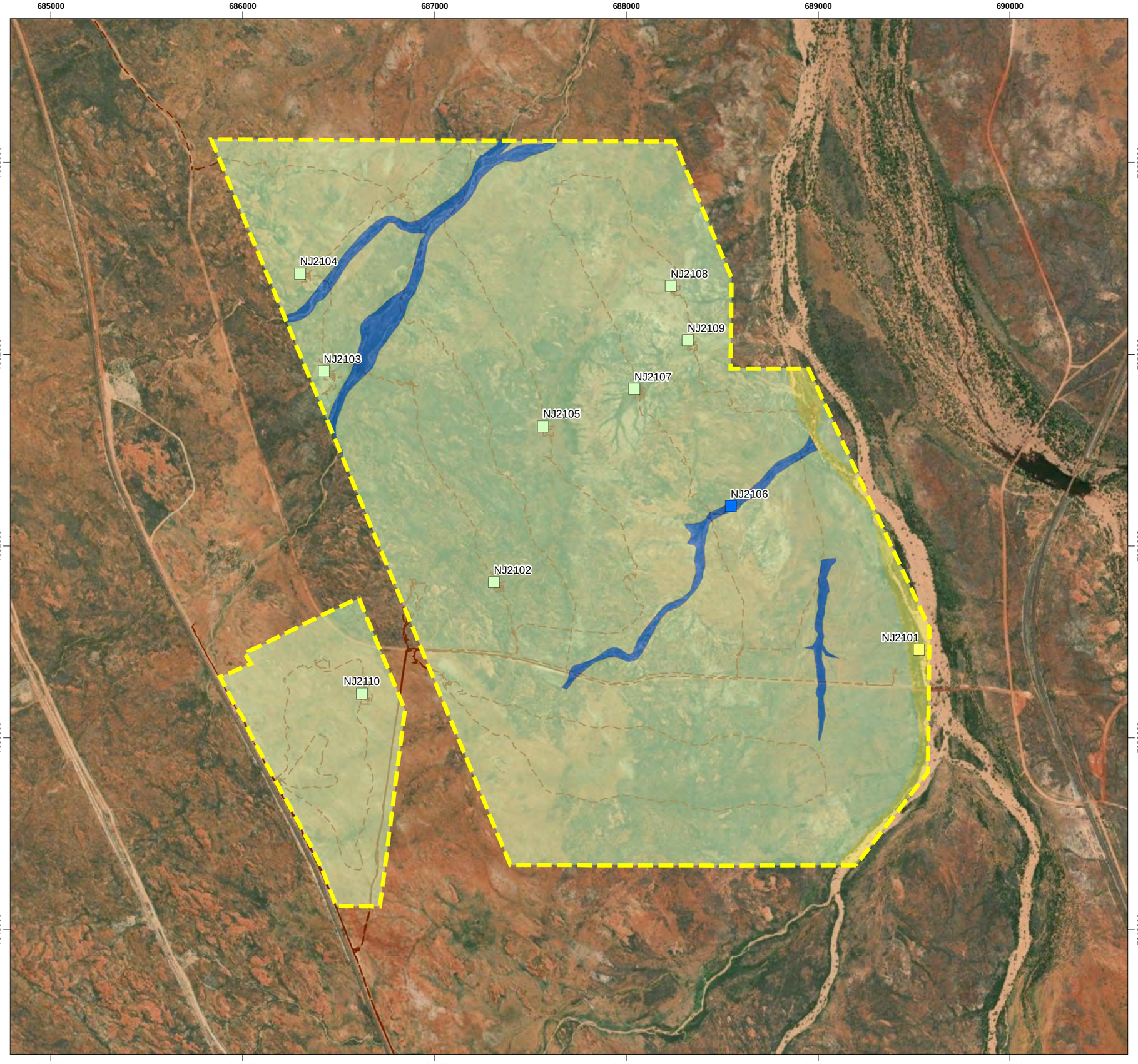
SCALE: 1:20,000 @ A3

0 200 400 600 800 m

PROJECT NO: 4641-21

REV	AUTHOR	APPROVED	DATE
0	AHC	SK	14/07/2021
1	AHC	SK	20/09/2021

MAP 05



LEGEND

- Survey Area
- Flora Tracks

Quadrat Condition

- Excellent
- Very Good
- Good

Vegetation Condition

- Excellent
- Very Good
- Good

DATASOURCES:
SOURCE DATA: VEGETATION MAPPING (ECOSCAPE, 2021)
AERIAL: ESRI BASEMAP 2018-2019
BASEMAP: GEOSCIENCE AUSTRALIA
SERVICE LAYERS: SOURCE: ESRI, MAXAR, GEOEYE, EARTHSTAR GEOGRAPHICS, CNES/AIRBUS DS, USDA, USGS, AEROGRID, IGN, AND THE GIS USER COMMUNITY

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VEGETATION CONDITION

NORTH STAR JUNCTION FLORA & FAUNA SURVEY

FMG Fortescue The New Force in Iron Ore

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

N

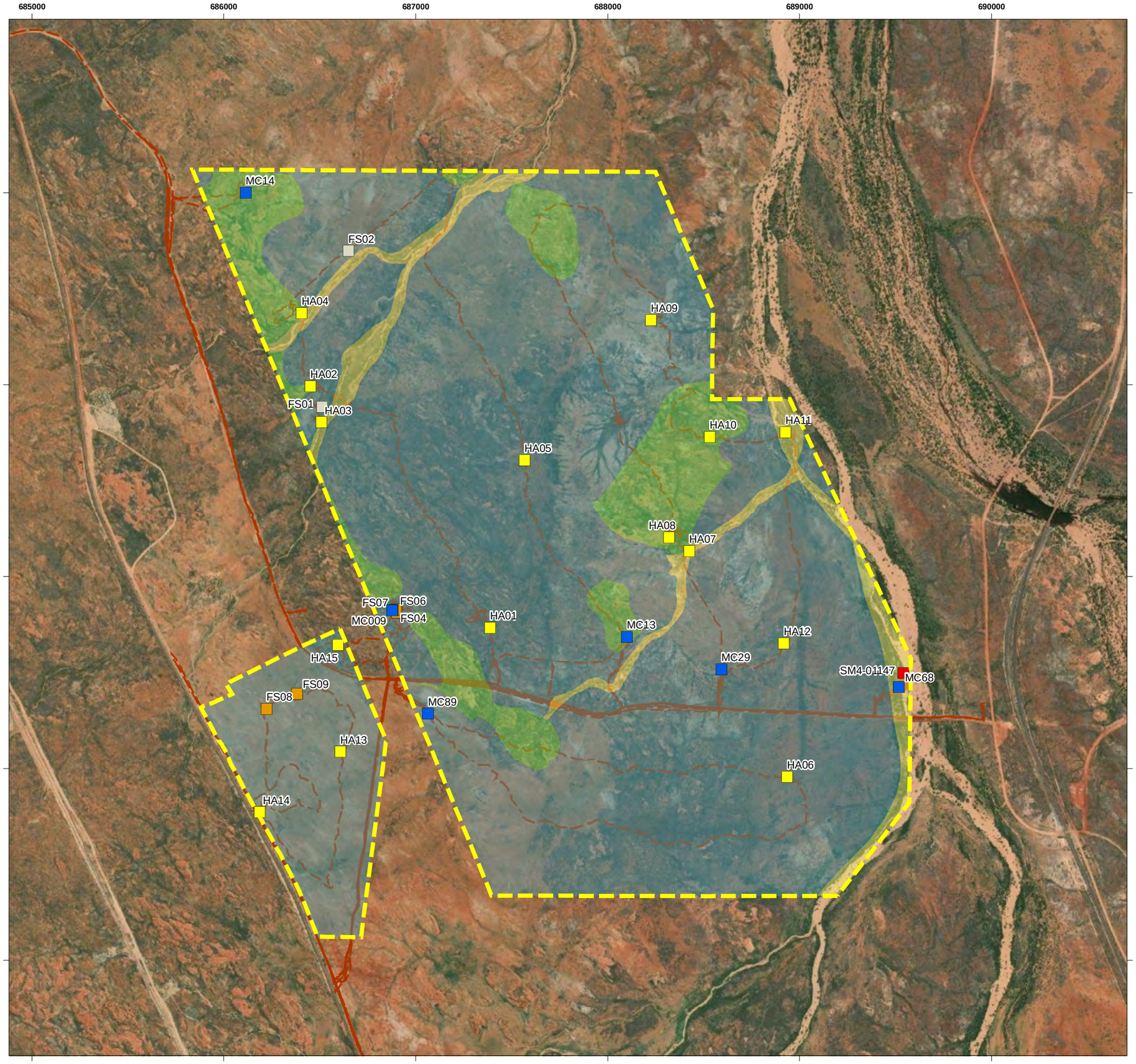
SCALE: 1:20,000 @ A3

0 0.15 0.3 0.45 0.6 0.75 km

PROJECT NO: 4641-21

REV	AUTHOR	APPROVED	DATE
0	AHC	SK	14/07/2021

MAP 06



LEGEND

- Survey Area
- Fauna Tracks

Fauna Sites

- Habitat Assessment Point
- SM Recorder
- Trail Camera
- Fauna Sighting - Bilby
- Fauna Sighting - Brush-Tailed Mulgara
- Fauna Sighting - Western Pepple-Mound Mouse

Fauna Habitat

- Creeklines
- Granite Outcrops
- Hummock Grasslands

DATASOURCES:
SOURCE DATA: FAUNA HABITAT (ECOSCAPE, 2021),
AERIAL: ESRI BASEMAP 2018-2019
BASEMAP: GEOSCIENCE AUSTRALIA
SERVICE LAYERS: SOURCE: ESRI, MAXAR, GEOEYE, EARTHSTAR GEOGRAPHICS, CNES/AIRBUS DS, USDA, USGS, AEROGRID, IGN, AND THE GIS USER COMMUNITY

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FAUNA HABITAT

NORTH STAR JUNCTION
FLORA & FAUNA SURVEY

Fortescue
The New Force in Iron Ore

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

N

SCALE: 1:20,000 @ A3

0 0.15 0.3 0.45 0.6 0.75 km

PROJECT NO: 4641-21

REV	AUTHOR	APPROVED	DATE
0	AHC	SK	29/07/2021

MAP
07

APPENDIX ONE LEGISLATIVE CONTEXT, DEFINITIONS AND CRITERIA

COMMONWEALTH ENVIRONMENT PROTECTION AND BIODIVERSITY CONSERVATION ACT 1999

The EPBC Act is a legal framework to protect and manage matters of national environmental significance (MNES) including important flora, fauna, ecological communities and heritage areas listed under the Act.

Threatened taxa (flora and fauna) are protected under the EPBC Act, which lists species and ecological communities that have been assessed as meeting the criteria to be listed as Critically Endangered, Endangered, Vulnerable, Conservation Dependant, Extinct, or Extinct in the Wild, as detailed in **Table 13**.

Threatened Ecological Communities protected under the EPBC Act are categorised as Critically Endangered, Endangered or Vulnerable, also detailed in this table.

Migratory species subject to international agreements are also protected under the EPBC Act. The definition of a migratory species under the Act follows that prescribed by the Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention) (Department of the Environment 2021):

> *Migratory species are the entire population or any geographically separate part of the population of any species or lower taxon of wild animals, a significant proportion of whose members cyclically and predictably cross one or more national jurisdictional boundaries.*

Species listed by the following international agreements are currently protected under the EPBC Act:

- Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention)
- China-Australia Migratory Bird Agreement (CAMBA)
- Japan-Australia Migratory Bird Agreement (JAMBA)
- Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA).

Table 13: EPBC Act categories for flora, fauna and ecological communities

Category	Threatened species	Threatened Ecological Communities
Extinct	A native species is eligible to be included in the extinct category at a particular time if, at that time, there is no reasonable doubt that the last member of the species has died.	n/a
Extinct in the wild	A native species is eligible to be included in the extinct in the wild category at a particular time if, at that time: (a) it is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; or (b) it has not been recorded in its known and/or expected habitat, at appropriate seasons, anywhere in its past range, despite exhaustive surveys over a time frame appropriate to its life cycle and form.	n/a
Critically Endangered (CE)	A native species is eligible to be included in the *critically endangered* category at a particular time if, at that time, it is facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with the prescribed criteria.	An ecological community is eligible to be included in the *critically endangered* category at a particular time if, at that time, it is facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with the prescribed criteria
Endangered (EN)	A native species is eligible to be included in the *endangered* category at a particular time if, at that time: (a) it is not critically endangered; and (b) it is facing a very high risk of extinction in the wild in the near future, as determined in accordance with the prescribed criteria.	An ecological community is eligible to be included in the *endangered* category at a particular time if, at that time: (a) it is not critically endangered; and (b) it is facing a very high risk of extinction in the wild in the near future, as determined in accordance with the prescribed criteria.

Category	Threatened species	Threatened Ecological Communities
Vulnerable (VU)	A native species is eligible to be included in the *vulnerable* category at a particular time if, at that time: (a) it is not critically endangered or endangered; and (b) it is facing a high risk of extinction in the wild in the medium term future, as determined in accordance with the prescribed criteria.	An ecological community is eligible to be included in the *vulnerable* category at a particular time if, at that time: (a) it is not critically endangered or endangered; and (b) it is facing a high risk of extinction in the wild in the medium term future, as determined in accordance with the prescribed criteria.
Conservation Dependent	A native species is eligible to be included in the conservation dependent category at a particular time if, at that time: (a) the species is the focus of a specific conservation program the cessation of which would result in the species becoming vulnerable, endangered or critically endangered; or (b) the following subparagraphs are satisfied: (i) the species is a species of fish; (ii) the species is the focus of a plan of management that provides for management actions necessary to stop the decline of, and support the recovery of, the species so that its chances of long-term survival in nature are maximised; (iii) the plan of management is in force under a law of the Commonwealth or of a State or Territory; (iv) cessation of the plan of management would adversely affect the conservation status of the species.	n/a

WESTERN AUSTRALIAN ENVIRONMENTAL PROTECTION ACT 1986

The Western Australian EP Act was created to provide for an Environmental Protection Authority (the EPA) that has the responsibility for:

- prevention, control and abatement of pollution and environmental harm
- conservation, preservation, protection, enhancement and management of the environment
- matters incidental to or connected with the above.

The EPA is responsible for providing the guidance and policy under which environmental assessments are conducted. It conducts environmental impact assessments (based on the information provided by the proponent), initiates measures to protect the environment and provides advice to the Minister responsible for environmental matters.

WESTERN AUSTRALIAN BIODIVERSITY CONSERVATION ACT 2016

The Western Australian BC Act provides for the conservation, protection and ecologically sustainable use of biodiversity and biodiversity components in Western Australia.

Threatened species (both flora and fauna) and ecological communities that meet the categories listed within the BC Act are protected under this legislation and require authorisation by the Minister to take or disturb. These are known as Threatened Flora, Threatened Fauna and Threatened Ecological Communities. The conservation categories of Critically Endangered, Endangered and Vulnerable are detailed in **Table 14**; these categories align with those of the EPBC Act. Some State-listed threatened species and ecological communities are provided with additional protection as they are also listed under the Commonwealth EPBC Act (see **Table 13** for conservation status category descriptions).

The most recent Western Australian flora and fauna listings were published in the Government Gazette on 11 September 2018 (Government of Western Australia 2018a).

PRIORITY-LISTED FLORA AND FAUNA

Flora are listed as PF where populations are geographically restricted or threatened by local processes, or where there is insufficient information to formally assign them to TF categories. Whilst PF are not specifically listed in the BC Act, some may qualify as being of special conservation interest and thereby have a greater level of protection than unlisted species.

There are three categories covering Western Australian-listed TF and four categories covering PF species which are outlined in **Table 14**. PF for Western Australia are regularly reviewed by the DBCA whenever new information becomes available, with species status altered or removed from the list when data indicates that they no longer meet these requirements.

Conservation significant fauna species are listed by the DBCA as Priority Fauna where populations are geographically restricted or threatened by local processes, or where there is insufficient information to formally assign them to threatened fauna categories. Whilst Priority Fauna are not specifically listed in the BC Act, these have a greater level of significance than other native species. The categories covering Priority Fauna species are outlined in **Table 14**.

Flora and fauna species may be listed as being of special conservation interest if they have a naturally low population, have a restricted natural range, are subject to or recovering from a significant population decline or reduction of range or are of special interest, and the Minister considers that taking may result in depletion of the species. Migratory species and those subject to international agreement are also listed under the Act. These are known as 'specially protected species' in the BC Act.

Table 14: Conservation codes for Western Australian flora and fauna (DBCA 2019b)

Conservation Codes for Western Australian Flora and Fauna	
Threatened, Extinct and Specially Protected fauna or flora[1] are species[2] which have been adequately searched for and are deemed to be, in the wild, threatened, extinct or in need of special protection, and have been gazetted as such. **The *Wildlife Conservation (Specially Protected Fauna) Notice 2018* and the *Wildlife Conservation (Rare Flora) Notice 2018* have been transitioned under regulations 170, 171 and 172 of the *Biodiversity Conservation Regulations 2018* to be the lists of Threatened, Extinct and Specially Protected species under Part 2 of the *Biodiversity Conservation Act 2016*.** **Categories of Threatened, Extinct and Specially Protected fauna and flora are:**	
T	**Threatened species** Listed by order of the Minister as Threatened in the category of critically endangered, endangered or vulnerable under section 19(1), or is a rediscovered species to be regarded as threatened species under section 26(2) of the *Biodiversity Conservation Act 2016* (BC Act). Threatened fauna is that subset of 'Specially Protected Fauna' listed under schedules 1 to 3of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018* for Threatened Fauna. Threatened flora is that subset of 'Rare Flora' listed under schedules 1 to 3of the *Wildlife Conservation (Rare Flora) Notice 2018* for Threatened Flora. The assessment of the conservation status of these species is based on their national extent and ranked according to their level of threat using IUCN Red List categories and criteria as detailed below.

Conservation Codes for Western Australian Flora and Fauna	
CR	**Critically endangered species** Threatened species considered to be "*facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with criteria set out in the ministerial guidelines*". Listed as critically endangered undersection 19(1)(a) of the BC Act in accordance with the criteria set out in section 20 and the ministerial guidelines. Published under schedule 1 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018* for critically endangered fauna or the *Wildlife Conservation (Rare Flora) Notice 2018* for critically endangered flora.
EN	**Endangered species** Threatened species considered to be "*facing a very high risk of extinction in the wild in the near future, as determined in accordance with criteria set out in the ministerial guidelines*". Listed as endangered under section 19(1)(b) of the BC Act in accordance with the criteria set out in section 21 and the ministerial guidelines. Published under schedule 2 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018* for endangered fauna or the *Wildlife Conservation (Rare Flora) Notice 2018* for endangered flora.
VU	**Vulnerable species** Threatened species considered to be "*facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with criteria set out in the ministerial guidelines*". Listed as vulnerable undersection 19(1)(c) of the BC Act in accordance with the criteria set out in section 22 and the ministerial guidelines. Published under schedule 3of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018* for vulnerable fauna or the *Wildlife Conservation (Rare Flora) Notice 2018* for vulnerable flora.
Extinct species **Listed by order of the Minister as extinct under section 23(1) of the BC Act as extinct or extinct in the wild.**	
EX	**Extinct species** Species where "*there is no reasonable doubt that the last member of the species has died*", and listing is otherwise in accordance with the ministerial guidelines (section 24 of the BC Act). Published as presumed extinct under schedule 4of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018* for extinct fauna or the *Wildlife Conservation (Rare Flora) Notice 2018* for extinct flora.
EW	Extinct in the wild species Species that "*is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; and it has not been recorded in its known habitat or expected habitat, at appropriate seasons, anywhere in its past range, despite surveys over a time frame appropriate to its life cycle and form*", and listing is otherwise in accordance with the ministerial guidelines (section 25of the BC Act). Currently there are no threatened fauna or threatened flora species listed as extinct in the wild. If listing of a species as extinct in the wild occurs, then a schedule will be added to the applicable notice.
Specially protected species **Listed by order of the Minister as specially protected under section 13(1) of the BC Act. Meeting one or more of the following categories: species of special conservation interest; migratory species; cetaceans; species subject to international agreement; or species otherwise in need of special protection.** **Species that are listed as threatened species (critically endangered, endangered or vulnerable) or extinct species under the BC Act cannot also be listed as Specially Protected species.**	
MI	**Migratory species** Fauna that periodically or occasionally visit Australia or an external Territory or the exclusive economic zone; or the species is subject of an international agreement that relates to the protection of migratory species and that binds the Commonwealth; and listing is otherwise in accordance with the ministerial guidelines (section 15of the BC Act). Includes birds that are subject to an agreement between the government of Australia and the governments of Japan (JAMBA), China (CAMBA) and The Republic of Korea (ROKAMBA), and fauna subject to the *Convention on the Conservation of Migratory Species of Wild Animals* (Bonn Convention), an environmental treaty under the United Nations Environment Program. Migratory species listed under the BC Act are a subset of the migratory animals that are known to visit Western Australia, protected under the international agreements or treaties, excluding species that are listed as Threatened species. Published as migratory birds protected under an international agreement under schedule 5 of the Wildlife Conservation (Specially Protected Fauna) Notice 2018.
CD	**Species of special conservation interest (conservation dependent fauna)** Fauna of special conservation need being species dependent on ongoing conservation intervention to prevent it becoming eligible for listing as threatened, and listing is otherwise in accordance with the ministerial guidelines (section 14of the BC Act). Published as conservation dependent fauna under schedule 6 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018.*
OS	**Other specially protected species** Fauna otherwise in need of special protection to ensure their conservation, and listing is otherwise in accordance with the ministerial guidelines (section 18of the BC Act). Published as other specially protected fauna under schedule 7of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018*.

Conservation Codes for Western Australian Flora and Fauna	
P	**Priority species** Possibly threatened species that do not meet survey criteria, or are otherwise data deficient, are added to the Priority Fauna or Priority Flora Lists under Priorities 1, 2 or 3. These three categories are ranked in order of priority for survey and evaluation of conservation status so that consideration can be given to their declaration as threatened fauna or flora. Species that are adequately known, are rare but not threatened, or meet criteria for near threatened, or that have been recently removed from the threatened species or other specially protected fauna lists for other than taxonomic reasons, are placed in Priority 4. These species require regular monitoring. Assessment of Priority codes is based on the Western Australian distribution of the species, unless the distribution in WA is part of a contiguous population extending into adjacent States, as defined by the known spread of locations.
1	**Priority 1: Poorly-known species** Species that are known from one or a few locations (generally five or less) which are potentially at risk. All occurrences are either: very small; or on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, road and rail reserves, gravel reserves and active mineral leases; or otherwise under threat of habitat destruction or degradation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes. Such species are in urgent need of further survey.
2	**Priority 2: Poorly-known species** Species that are known from one or a few locations (generally five or less), some of which are on lands managed primarily for nature conservation, e.g. national parks, conservation parks, nature reserves and other lands with secure tenure being managed for conservation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under threat from known threatening processes. Such species are in urgent need of further survey.
3	**Priority 3: Poorly-known species** Species that are known from several locations, and the species does not appear to be under imminent threat, or from few but widespread locations with either large population size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat. Species may be included if they are comparatively well known from several locations but do not meet adequacy of survey requirements and known threatening processes exist that could affect them. Such species are in need of further survey.
4	**Priority 4: Rare, Near Threatened and other species in need of monitoring** (a) Rare. Species that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection but could be if present circumstances change. These species are usually represented on conservation lands. (b) Near Threatened. Species that are considered to have been adequately surveyed and that are close to qualifying for vulnerable but are not listed as Conservation Dependent. (c) Species that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.
[1] The definition of flora includes algae, fungi and lichens. **[2] Species includes all taxa (plural of taxon - a classificatory group of any taxonomic rank, e.g. a family, genus, species or any infraspecific category i.e. subspecies or variety, or a distinct population).**	

THREATENED AND PRIORITY ECOLOGICAL COMMUNITIES

Western Australian TECs are protected under the BC Act and are categorised much like those of the EPBC Act. Western Australian definitions and criteria for TECs are shown in **Table 15**.

Currently described TECs are listed on the DBCA website, with the most recent list endorsed by the Minister for Environment in June 2018 (DBCA 2018).

DBCA also maintains a list of Priority Ecological Communities (PECs). PECs include potential TECs that do not meet survey criteria, or that are not adequately defined. They are not protected under legislation but are taken into consideration as part of the environmental approvals process.

Currently described PECs are listed on the DBCA website, with the most recent list dated 20 March 2021 (Species and Communities Program, DBCA 2021). Definitions and criteria for PECs are shown in **Table 15**.

Table 15: DBCA definitions and criteria for TECs and PECs (Department of Environment and Conservation 2013)

Criteria	Definition
Threatened Ecological Communities	
Presumed Totally Destroyed (PD)	An ecological community that has been adequately searched for but for which no representative occurrences have been located. The community has been found to be totally destroyed or so extensively modified throughout its range that no occurrence of it is likely to recover its species composition and/or structure in the foreseeable future. An ecological community will be listed as presumed totally destroyed if there are no recent records of the community being extant and either of the following applies (A or B): A. Records within the last 50 years have not been confirmed despite thorough searches of known or likely habitats or B. All occurrences recorded within the last 50 years have since been destroyed
Critically Endangered (CR)	An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or that was originally of limited distribution and is facing severe modification or destruction throughout its range in the immediate future, or is already severely degraded throughout its range but capable of being substantially restored or rehabilitated. An ecological community will be listed as Critically Endangered when it has been adequately surveyed and is found to be facing an extremely high risk of total destruction in the immediate future. This will be determined on the basis of the best available information, by it meeting any one or more of the following criteria (A, B or C): A. The estimated geographic range, and/or total area occupied, and/or number of discrete occurrences since European settlement have been reduced by at least 90% and either or both of the following apply (i or ii): i. geographic range, and/or total area occupied and/or number of discrete occurrences are continuing to decline such that total destruction of the community is imminent (within approximately 10 years); ii. modification throughout its range is continuing such that in the immediate future (within approximately 10 years) the community is unlikely to be capable of being substantially rehabilitated. B. Current distribution is limited, and one or more of the following apply (i, ii or iii): i. geographic range and/or number of discrete occurrences, and/or area occupied is highly restricted and the community is currently subject to known threatening processes which are likely to result in total destruction throughout its range in the immediate future (within approximately 10 years); ii. there are very few occurrences, each of which is small and/or isolated and extremely vulnerable to known threatening processes; iii. there may be many occurrences but total area is very small and each occurrence is small and/or isolated and extremely vulnerable to known threatening processes. C. The ecological community exists only as highly modified occurrences that may be capable of being rehabilitated if such work begins in the immediate future (within approximately 10 years).
Endangered (EN)	An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or was originally of limited distribution and is in danger of significant modification throughout its range or severe modification or destruction over most of its range in the near future. An ecological community will be listed as Endangered when it has been adequately surveyed and is not Critically Endangered but is facing a very high risk of total destruction in the near future. This will be determined on the basis of the best available information by it meeting any one or more of the following criteria (A, B, or C): A. The geographic range, and/or total area occupied, and/or number of discrete occurrences have been reduced by at least 70% since European settlement and either or both of the following apply (i or ii): i. the estimated geographic range, and/or total area occupied and/or number of discrete occurrences are continuing to decline such that total destruction of the community is likely in the short term future (within approximately 20 years); ii. modification throughout its range is continuing such that in the short term future (within approximately 20 years) the community is unlikely to be capable of being substantially restored or rehabilitated. B. Current distribution is limited, and one or more of the following apply (i, ii or iii): i. geographic range and/or number of discrete occurrences, and/or area occupied is highly restricted and the community is currently subject to known threatening processes which are likely to result in total destruction throughout its range in the short term future (within approximately 20 years); ii. there are few occurrences, each of which is small and/or isolated and all or most occurrences are very vulnerable to known threatening processes; iii. there may be many occurrences but total area is small and all or most occurrences are small and/or isolated and very vulnerable to known threatening processes. The ecological community exists only as very modified occurrences that may be capable of being substantially restored or rehabilitated if such work begins in the short-term future (within approximately 20 years).

Criteria	Definition
Vulnerable (VU)	An ecological community that has been adequately surveyed and is found to be declining and/or has declined in distribution and/or condition and whose ultimate security has not yet been assured and/or a community that is still widespread but is believed likely to move into a category of higher threat in the near future if threatening processes continue or begin operating throughout its range. An ecological community will be listed as Vulnerable when it has been adequately surveyed and is not Critically Endangered or Endangered but is facing a high risk of total destruction or significant modification in the medium to long-term future. This will be determined on the basis of the best available information by it meeting any one or more of the following criteria (A, B or C): A. The ecological community exists largely as modified occurrences that are likely to be capable of being substantially restored or rehabilitated. B. The ecological community may already be modified and would be vulnerable to threatening processes, is restricted in area and/or range and/or is only found at a few locations. C. The ecological community may be still widespread but is believed likely to move into a category of higher threat in the medium to long term future because of existing or impending threatening processes.
Priority ecological communities	
Priority One	*Poorly known ecological communities* Ecological communities with apparently few, small occurrences, all or most not actively managed for conservation (e.g. within agricultural or pastoral lands, urban areas, active mineral leases) and for which current threats exist. Communities may be included if they are comparatively well-known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under immediate threat from known threatening processes across their range.
Priority Two	*Poorly known ecological communities* Communities that are known from few small occurrences, all or most of which are actively managed for conservation (e.g. within national parks, conservation parks, nature reserves, state forest, unallocated Crown land, water reserves, etc.) and not under imminent threat of destruction or degradation. Communities may be included if they are comparatively well known from one or more localities, but do not meet adequacy of survey requirements, and / or are not well defined, and appear to be under threat from known threatening processes.
Priority Three	*Poorly known ecological communities* i. Communities that are known from several to many occurrences, a significant number or area of which are not under threat of habitat destruction or degradation or; ii. Communities known from a few widespread occurrences, which are either large or within significant remaining areas of habitat in which other occurrences may occur, much of it not under imminent threat, or; iii. Communities made up of large, and/or widespread occurrences, that may or may not be represented in the reserve system, but are under threat of modification across much of their range from processes such as grazing by domestic and/or feral stock, and inappropriate fire regimes. Communities may be included if they are comparatively well known from several localities, but do not meet adequacy of survey requirements and / or are not well defined, and known threatening processes exist that could affect them.
Priority Four	Ecological communities that are adequately known, rare but not threatened or meet criteria for Near Threatened, or that have been recently removed from the threatened list. These communities require regular monitoring. i. Rare. Ecological communities known from few occurrences that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change These communities are usually represented on conservation lands. ii. Near Threatened. Ecological communities that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for Vulnerable. iii. Ecological communities that have been removed from the list of threatened communities during the past five years.
Priority Five	*Conservation Dependent Ecological Communities* Ecological Communities that are not threatened but are subject to a specific conservation program, the cessation of which would result in the community becoming threatened within five years.

FLORA CRITERIA

OTHER SIGNIFICANT FLORA

According to the Flora and Vegetation Technical Guidance (EPA 2016) other than being listed as Threatened or Priority Flora, a species can be considered as significant if it is considered to be:

- locally endemic or association with a restricted habitat type (e.g. Groundwater Dependent Ecosystems, Sheet Flow Dependent Vegetation)
- a new species or has anomalous features that indicate a potential new species
- at the extremes of range, recently discovered range extensions (generally considered greater than 100 km or in a different bioregion), or isolated outliers of the main range)
- unusual species, including restricted subspecies, varieties or naturally occurring hybrids
- relictual status, being representative of taxonomic groups that no longer occur widely in the broader landscape.

INTRODUCED FLORA

Introduced plant species, known as weeds, are plants that are not indigenous to an area and have been introduced either directly or indirectly (unintentionally) through human activity. Species are regarded as introduced if they are listed as 'alien' on *FloraBase* (Western Australian Herbarium [WAH] 1998-2021) and are designated with an asterisk (*) in this document.

Weeds of National Significance

At a national level there are 32 weed species listed as Weeds of National Significance (WoNS) (Weeds Australia & Centre for Invasive Species Solutions 2021). The Commonwealth *Australian Weeds Strategy 2017-2027* (Invasive Plants and Animals Committee 2016) describes broad goals and objectives to manage these species.

Declared Pest Plants

The Western Australian Organism List (WAOL) details organisms listed as Declared Pests under the *Biosecurity and Agriculture Management Act 2007* (BAM Act). Under the BAM Act, Declared Pests are listed as one of the three categories, or exempt:

- C1 (exclusion), that applies to pests not established in Western Australia; control measures are to be taken to prevent their entry and establishment
- C2 (eradication), that applies to pests that are present in Western Australia but in low numbers or in limited areas where eradication is still a possibility
- C3 (management), that applies to established pests where it is not feasible or desirable to manage them in order to limit their damage
- exempt (no category).

VEGETATION CRITERIA

OTHER SIGNIFICANT VEGETATION

According to the Flora and Vegetation Technical Guidance (EPA 2016) other than being listed as a TEC or PEC, vegetation can be considered as significant if it is considered to have:

- restricted distribution
- a degree of historical impact from threatening processes
- a role as a refuge
- provides an important function required to maintain ecological integrity of a significant ecosystem.

Groundwater Dependent and Sheet Flow Dependent Mulga vegetation may be considered as significant and are described below.

Groundwater Dependent Vegetation

Groundwater Definition

Groundwater is water that is found in the saturated zone of the soil, where all soil pores are filled with water. The water table is the upper surface of the saturated zone in an unconfined aquifer. Groundwater may also occur as a perched aquifer located above unsaturated rock formations as a result of a discontinuous permeable layer or held under pressure in a confined aquifer (Goulburn-Murray Water 2010).

Groundwater Dependent Ecosystems Definition

Groundwater Dependent Ecosystems (GDEs) have been defined as ecosystems that are dependent on groundwater for their survival at some stage or stages of their lifecycle, however groundwater use cannot be equated with groundwater dependence (Eamus 2009). In some contexts (including that of a flora and vegetation assessment), GDEs are also known as Groundwater Dependent Vegetation (GDV).

Hatton and Evans (1998) identified four types of GDEs based on their geographic setting: terrestrial vegetation (vegetation communities and dependent fauna that have seasonal or episodic dependence on groundwater), river base flow systems (aquatic and riparian ecosystems that exist in or adjacent to streams that are fed by groundwater base flow), aquifer and cave ecosystems, and wetlands.

Eamus *et al.* (2006) identified three primary classes based on type of groundwater reliance:

1. Aquifer and cave ecosystems.
2. All ecosystems dependent on the surface expression of groundwater:
    a) river base flows
    b) wetlands, swamplands
    c) seagrass beds in estuaries
    d) floodplains
    e) mound springs
    f) riparian vegetation
    g) saline discharge to lakes
    h) low lying forests.
3. All ecosystems dependent on the subsurface presence of groundwater, often accessed via the capillary fringe (non-saturated zone above the water table) when roots penetrate this zone:
    a) River Red Gum (*Eucalyptus camaldulensis*) forests
    b) Banksia woodlands
    c) Riparian vegetation in the wet/dry tropics.

GDEs in arid areas, including the Pilbara region, are generally determined to be vegetation associated with riparian areas. GDEs dependent on the surface expression of groundwater (Eamus *et al.* 2006 class 2) includes vegetation associated with wetlands (permanent or semi-permanent pools) within riparian areas, and generally includes *Melaleuca argentea* in association with other species described below.

GDEs associated with the subsurface presence of groundwater (Eamus *et al.* 2006 class 3) includes riparian vegetation characterised by the phreatophytic species described below.

Direct impacts on GDEs (clearing), and indirect impacts, including from dewatering and reinjection, frequently feature as being a significant environmental impact in mining approvals documents e.g. Office of the Appeals Convenor (2016a, 2016b), Rio Tinto (2016).

Phreatophytic Species

Phreatophytic species rely on groundwater sources for water intake (Maunsell Australia Pty Ltd 2006) essentially the water requirements of phreatophytes are greater than can be provided from the surface soil profile (e.g. riparian vegetation) or they are dependent on free water availability (e.g. wetland species). They frequently show low tolerance to extended water stress due to a lack of physiological and/or morphological adaptation to drought and respond to significant water deficit by a decline in health and eventual death (*ibid.).*

Obligate phreatophytes are dependent on free access to water (i.e. they are wetland species) whereas facultative phreatophytes can switch their water source between the soil surface profile in times of rain, to groundwater in times of drought when the soil surface profile (vadosphere) is depleted (Grierson 2010).

Phreatophytic species likely to occur in the Pilbara include:

- *Eucalyptus camaldulensis sens. lat.*, which is regarded as a facultative phreatophyte that is dependent on groundwater for part of its lifecycle and/or in times of drought. This species has been reported to be tolerant of groundwater falls of up to 4 m per year (Maunsell Australia Pty Ltd 2006), has both lateral and sinker roots and is tolerant of waterlogging (Grierson 2010).
- *Eucalyptus victrix*, which may be regarded as a facultative phreatophyte. It is considered to be relatively drought tolerant and likely to be tolerant of gradual declines to the water table (to a degree) (Maunsell Australia Pty Ltd 2006). *Eucalyptus victrix* has lateral and sinker roots (i.e. a dimorphic root system) but is not tolerant of waterlogging (Grierson 2010). There is some conjecture that this species is actually a vadophyte (i.e. relies on water from within the soil surface profile, and is independent of groundwater) or, at best, weakly phreatophytic (Resource and Environmental Management Pty Ltd 2007). Depth to groundwater is likely to be an important indicator of groundwater dependence (Equinox Environmental 2017).
- wetland species such as *Melaleuca argentea*
- *Melaleuca xerophila* may be groundwater dependent in some areas (Markey 2016).

Vegetation containing *Eucalyptus camaldulensis sens. lat.* and *Melaleuca argentea* is generally considered to represent a GDE.

However, there is supporting evidence that, in some circumstances, *Eucalyptus victrix* does not always depend on groundwater (Batini 2009; Eamus 2009; EPA 2010; Resource and Environmental Management Pty Ltd 2007). Depth to groundwater provides guidance to determining if the vegetation is likely to be groundwater dependent or not. Where the depth to groundwater is more than 10 m below the soil surface *Eucalyptus victrix* is unlikely to be able to access the resource (Barron *et al.* 2012); therefore *Eucalyptus victrix*-dominated vegetation is not likely to be groundwater dependent. However, where the depth to groundwater is less than 10 m, or where depth to groundwater is unknown but is potentially in this range, *Eucalyptus victrix*-dominated vegetation is considered to be potentially groundwater dependent (i.e. representative of a potential GDE).

Atlas of Groundwater Dependent Ecosystems

The Groundwater Dependent Ecosystems Atlas (BoM 2021b) indicates the presence of known GDEs and Inflow Dependent Ecosystems (IDEs) in Australia.

An Inflow Dependent Ecosystem is one in which the vegetation within the landscape is likely to be accessing water in addition to rainfall, from soil or surface water or groundwater, assessed using remotely sensed data. The likelihood of a landscape using additional water is rated from one to 10 (low to high), with a rating above six indicating that a landscape is likely to be inflow dependent (BoM 2021b).

ENVIRONMENTALLY SENSITIVE AREAS

There are a number of areas within Western Australia identified as being of environmental significance within which the exemptions to the Native Vegetation Clearing Regulations do not apply. These are referred to as Environmentally Sensitive Areas (ESAs), and are declared under section 51B of the EP Act and described in the *Environmental Protection (Environmentally Sensitive Areas) Notice*.

CONSERVATION ESTATE

The National Reserve System is a network of protected areas managed for conservation under international guidelines. The objective of placing areas of bushland into the Conservation Estate is to achieve and maintain a comprehensive, adequate and representative reserve system for Western Australia. The Conservation and Parks Commission is the vesting body for conservation lands, forest and marine reserves that are managed by DBCA (Government of Western Australia 2018b).

APPENDIX TWO FIELD SURVEY CRITERIA

Table 16: NVIS structural formation terminology, terrestrial vegetation (NVIS Technical Working Group & DotEE 2017)

	Cover characteristics							
	Foliage cover *	70-100	30-70	10-30	<10	» 0 (scattered)	0-5 (clumped)	unknown
	Cover code	d	c	i	r	bi	bc	unknown
Growth Form	**Height Ranges (m)**	**Structural Formation Classes**						
tree, palm	<10,10-30, >30	closed forest	open forest	woodland	open woodland	isolated trees	isolated clumps of trees	tree, palm
tree mallee	<3, <10, 10-30	closed mallee forest	open mallee forest	mallee woodland	open mallee woodland	isolated mallee trees	isolated clumps of mallee trees	tree mallee
shrub, cycad, grass-tree, tree-fern	<1,1-2,>2	closed shrubland	shrubland	open shrubland	sparse shrubland	isolated shrubs	isolated clumps of shrubs	shrub, cycad, grass-tree, tree-fern
mallee shrub	<3, <10, 10-30	closed mallee shrubland	mallee shrubland	open mallee shrubland	sparse mallee shrubland	isolated mallee shrubs	isolated clumps of mallee shrubs	mallee shrub
heath shrub	<1,1-2,>2	closed heathland	heathland	open heathland	sparse heathland	isolated heath shrubs	isolated clumps of heath shrubs	heath shrub
chenopod shrub	<1,1-2,>2	closed chenopod shrubland	chenopod shrubland	open chenopod shrubland	sparse chenopod shrubland	isolated chenopod shrubs	isolated clumps of chenopod shrubs	chenopod shrub
samphire shrub	<0.5,>0.5	closed samphire shrubland	samphire shrubland	open samphire shrubland	sparse samphire shrubland	isolated samphire shrubs	isolated clumps of samphire shrubs	samphire shrub
hummock grass	<2,>2	closed hummock grassland	hummock grassland	open hummock grassland	sparse hummock grassland	isolated hummock grasses	isolated clumps of hummock grasses	hummock grass
tussock grass	<0.5,>0.5	closed tussock grassland	tussock grassland	open tussock grassland	sparse tussock grassland	isolated tussock grasses	isolated clumps of tussock grasses	tussock grass
other grass	<0.5,>0.5	closed grassland	grassland	open grassland	sparse grassland	isolated grasses	isolated clumps of grasses	other grass
sedge	<0.5,>0.5	closed sedgeland	sedgeland	open sedgeland	sparse sedgeland	isolated sedges	isolated clumps of sedges	sedge
rush	<0.5,>0.5	closed rushland	rushland	open rushland	sparse rushland	isolated rushes	isolated clumps of rushes	rush
herb	<0.5,>0.5	closed herbland	herbland	open herbland	sparse herbland	isolated herbs	isolated clumps of herbs	herb
fern	<1,1-2,>2	closed fernland	fernland	open fernland	sparse fernland	isolated ferns	isolated clumps of ferns	fern
bryophyte	<0.5	closed bryophyte-land	bryophyte-land	open bryophyteland	sparse bryophyteland	isolated bryophytes	isolated clumps of bryophytes	bryophyte
lichen	<0.5	closed lichenland	lichenland	open lichenland	sparse lichenland	isolated lichens	isolated clumps of lichens	lichen
vine	<10,10-30, >30	closed vineland	vineland	open vineland	sparse vineland	isolated vines	isolated clumps of vines	vine

Table 17: NVIS height classes (NVIS Technical Working Group & DotEE 2017)

Height		Growth form				
Height Class	**Height Range (m)**	**Tree, vine (M & U), palm (single-stemmed)**	**Shrub, heath shrub, chenopod shrub, ferns, samphire shrub, cycad, tree-fern, grass-tree, palm (multi-stemmed)**	**Tree mallee, mallee shrub**	**Tussock grass, hummock grass, other grass, sedge, rush, forbs, vine (G)**	**Bryophyte, lichen, seagrass, aquatic**
8	>30	tall	NA	NA	NA	NA
7	10-30	mid	NA	tall	NA	NA
6	<10	low	NA	mid	NA	NA
5	<3	NA	NA	low	NA	NA
4	>2	NA	tall	NA	tall	NA
3	1-2	NA	mid	NA	tall	NA
2	0.5-1	NA	low	NA	mid	tall
1	<0.5	NA	low	NA	low	low
Source: (based on Walker & Hopkins 1990)						

Table 18: Vegetation condition scale for the Eremaean and Northern Botanical Provinces (EPA 2016)

Condition rating	Description
Pristine	Pristine or nearly so, no obvious signs of disturbance or damage caused by human activities since European settlement.
Excellent	Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species. Damage to trees caused by fire, the presence of non-aggressive weeds and occasional vehicle tracks.
Very Good	Vegetation structure altered, obvious signs of disturbance. Disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing.
Good	Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate it. Disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing.
Degraded	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. Disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds at high density, partial clearing, dieback and grazing.
Completely Degraded	The structure of the vegetation is no longer intact and the area is completely or almost completely without native species. These areas are often described as 'parkland cleared' with the flora comprising weed or crop species with isolated native trees and shrubs.

APPENDIX THREE DESKTOP ASSESSMENT RESULTS AND LIKELIHOOD ASSESSMENTS

Table 19: Flora database search results, habitat and likelihood assessment

Light blue shading indicates possible likelihood; dark blue shading indicates species is known (recorded) from the survey area

WAH	TPFL	FMG/IBO	Species name	Habitat from *FloraBase* (WAH 1998-2021)	Flowering	Likelihood of occurrence	
						Desktop	Post-survey
			Threatened Flora				
X	X	X	*Quoya zonalis*	Ironstone hill slopes, base of breakaways and gullies. Skeletal red-brown clay loam or sandy loam soil.	Jul-Oct	Highly Unlikely	Highly Unlikely
			DBCA Priority 1				
X	X		*Acacia leeuweniana*	Gritty, skeletal red-grey sandy loam, light orange-brown gravelly sand, granite. In rock fissures in outcrops, among boulders.	May	Possible	Unlikely
			DBCA Priority 3				
X		X	*Abutilon* sp. Pritzelianum (S. van Leeuwen 5095)	Plains, floodplains, sand dunes. Red-brown or orange-brown sandy or loamy soil.	Apr-Sep	Possible	Possible
X	X		*Acacia levata*	Hillslopes. Sand or sandy loam over granite.	May	Possible	Unlikely
X			*Eragrostis crateriformis*	Creek banks, depressions. Clayey loam or clay.	Jan-Jul	Unlikely	Highly unlikely
X	X	X	*Euphorbia clementii*	Flats/plains, rocky slopes, drainage lines. Red-brown or orange clay loam with ironstone gravel.	May-Jul	Possible	Possible
X			*Fimbristylis sieberiana*	Pool edges, sandstone cliffs. Mud, skeletal soil pockets.	May-Jun	Unlikely	Highly Unlikely
X			*Gomphrena leptophylla*	Sand, sandy to clayey loam, granite, quartzite. Open flats, sandy creek beds, edges salt pans & marshes, stony hillsides.	Mar-Sep	Recorded	Recorded
X	X	X	*Gymnanthera cunninghamii*	Sandy soils.	Jan-Dec	Recorded	Recorded
X		X	*Heliotropium muticum*	Plains/sandplains. Brown to orange or red sand or sandy loam, sometimes with gravel.	May-Nov	Recorded	Recorded
X		X	*Nicotiana umbratica*	Rocky outcrops with shallow soils.	Apr-Jun	Recorded	Recorded
X		X	*Phyllanthus hebecarpus*	Granite outcrops, drainage lines. Skeletal brown sand or red sandy loam.		Possible	Recorded
X			*Rothia indica* subsp. *australis*	Sandhills and sandy flats. Sandy soils.	Apr-Aug	Possible	Recorded
X		X	Stylidium weeliwolli	Edges of watercourses. Gritty red/brown sand or clay soil.	Aug-Sep	Unlikely	Unlikely
X		X	*Terminalia supranitifolia*	Drainage lines, cliffs, slopes, rocky outcrops. Red-brown clay loam or sandy soil.	May-Dec	Highly Unlikely	Highly Unlikely
X		X	*Triodia basitricha*	Hill tops, rocky plains and in gullies. Gravelly soils, red-brown clay loam over ironstone.	May-Jul	Highly Unlikely	Highly Unlikely
X		X	*Triodia chichesterensis*	Plains, low hills. Orange sandy soil or brown clay loam, sometimes gravelly.	Mar-May	Possible	Recorded
			DBCA Priority 4				
X	X	X	*Bulbostylis burbidgeae*	Granite outcrops, cliff bases, slopes. Brown skeletal clay-loam soils.	Mar-Aug	Recorded	Recorded
X		X	*Goodenia nuda*	Seasonally inundated clay soils and drainage lines.	Apr-Aug	Recorded	Recorded
X		X	*Ptilotus mollis*	Stony hills and screes.	May, Sep	Highly Unlikely	Highly Unlikely

Table 20: Fauna database results and likelihood assessments

Blue shading indicates high likelihood; darker blue indicates species is known (recorded) from the survey area.

Species	Common name	Conservation status		Database				Likelihood of occurrence	
		EPBC Act	WA	PMST	DBCA	*NatureMap*	FMG	Desktop	Post-survey
Mammals									
Dasycercus blythi	Brush-tailed Mulgara, Ampurta	-	P4		X	X	X	Recorded	Recorded
Dasyurus hallucatus	Northern Quoll	EN	EN	Known	X	X	X	High	High
Hipposideros stenotis	Northern Leaf-nosed Bat		P2		X			Low	Low
Lagorchestes conspicillatus leichardti	Spectacled Hare-wallaby	-	P3		X	X	X	High	High
Leggadina lakedownensis	Short-tailed Mouse	-	P4			X		Very low	Very low
Macroderma gigas	Ghost Bat	VU	VU	Breeding likely	X	X	X	High	High (foraging)
Macrotis lagotis	Bilby, Dalgyte	VU	VU	Known	X		X	Recorded	Recorded
Pseudomys chapmani	Western Pebble-mound Mouse	-	P4		X	X	X	High	Recorded
Rhinonicteris aurantia	Orange Leaf-nosed Bat	-	P4		X	X		Low	Low
Rhinonicteris aurantia Pilbara form	Pilbara Leaf-nosed Bat	VU	VU	Known	X	X	X	Recorded	High (foraging)
Sminthopsis longicaudata	Long-tailed Dunnart	-	P4		X	X	X	Low	Low
Birds									
Amytornis striatus subsp. *striatus*	Striated Grasswren (inland)	-	P4			X		Low	Low
Apus pacificus	Fork-tailed Swift	MI	MI	Likely		X		High	High
Ardea ibis	Cattle Egret	MA		May				Very low	Very low
Calidris acuminata	Sharp-tailed Sandpiper	MI	MI	May				Very low	Very low
Calidris ferruginea	Curlew Sandpiper	CR & MI	CR	May				Very low	Very low
Calidris melanotos	Pectoral Sandpiper	MI	MI	May				Very low	Very low
Charadrius veredus	Oriental Plover	MI	MI	May	X	X		Very low	Very low
Falco hypoleucos	Grey Falcon	VU	VU		X	X	X	High	High
Falco peregrinus	Peregrine Falcon	-	OS		X	X		High	High
Glareola maldivarum	Oriental Pratincole	MI	MI	May				Very low	Very low
Haliaeetus leucogaster	White-bellied Sea-eagle	MA		Likely				Very low	Very low
Hirundo rustica	Barn Swallow	MI	MI	May				Very low	Very low
Merops ornatus	Rainbow Bee-eater	MA		May				Medium	Medium

Species	Common name	Conservation status		Database				Likelihood of occurrence	
		EPBC Act	WA	PMST	DBCA	*NatureMap*	FMG	Desktop	Post-survey
Motacilla cinerea	Grey Wagtail	MI	MI	May				Very low	Very low
Motacilla flava	Yellow Wagtail	MI	MI	Likely				Very low	Very low
Numenius madagascariensis	Eastern Curlew	CR & MI	CR	May				Very low	Very low
Pandion haliaetus	Osprey	MA		May				Low	Low
Pezoporus occidentalis	Night Parrot	EN	CR	May				Very low	Very low
Rostratula benghalensis australis	Australian Painted Snipe	EN	EN	May				Very low	Very low
Tringa glareola	Wood Sandpiper	MI	MI			X		Very low	Very low
Tringa nebularia	Common Greenshank	MI	IA				X	Very low	Very low
Tringa hypoleucos	Common Sandpiper	MI	MI	May	X	X	X	Very low	Very low
Reptiles									
Anilios ganei	Gane's Blind Snake (Pilbara)	-	P1		X	X	X	Low	Low
Ctenotus nigrilineatus	Pin-striped Fine-snout Skink	-	P1			X		Very low	Very low
Liasis olivaceus barroni	Pilbara Olive Python	VU	VU	Likely	X	X	X	Medium	Low

APPENDIX FOUR FIELD SURVEY RESULTS

Table 21: Flora inventory (site x species matrix)

Family	Species	Naturalised	Cons. code	NJ2101	NJ2102	NJ2103	NJ2104	NJ2105	NJ2106	NJ2107	NJ2108	NJ2109	NJ2110	Opportunistic
Aizoaceae	*Trianthema pilosum*			X										
	Trianthema triquetrum													X
Amaranthaceae	*Amaranthus* sp.													X
	Gomphrena cunninghamii						X							X
	Gomphrena leptoclada						X		X					X
	Gomphrena leptophylla		3											X
	Ptilotus astrolasius			X		X				X	X			X
	Ptilotus axillaris								X	X				X
	Ptilotus calostachyus										X			X
	Ptilotus fusiformis			X										
Apocynaceae	*Cynanchum viminale*													X
	Gymnanthera cunninghamii		3	X										X
Araliaceae	*Trachymene oleracea* subsp. *oleracea*						X			X				X
Asteraceae	*Flaveria trinervia*	*							X					X
	Pluchea dentex								X					X
	Pluchea ferdinandi-muelleri												X	X
	Pluchea rubelliflora								X					
	Pluchea tetranthera				X					X				
	Podolepis capillaris													X
	Pterocaulon sphacelatum													X
	Rhodanthe margarethae													X
	Streptoglossa bubakii									X				
Boraginaceae	*Heliotropium crispatum*													X
	Heliotropium cunninghamii				X								X	
	Heliotropium muticum		3							X				X
	Heliotropium tenuifolium			X										
Byblidaceae	*Byblis pilbarana*				X									X
Caryophyllaceae	*Polycarpaea corymbosa* var. *corymbosa*			X	X		X							
	Polycarpaea holtzei				X		X							
	Polycarpaea longiflora													X
Celastraceae	*Stackhousia intermedia*				X									X
Chenopodiaceae	*Salsola australis*													X
	Sclerolaena densiflora													X
Cleomaceae	*Arivela uncifera*													X
	Arivela viscosa			X										X
Combretaceae	*Terminalia circumalata*													X
Commelinaceae	*Commelina ensifolia*													X
Convolvulaceae	*Bonamia alatisemina*				X					X				X
	Bonamia erecta				X				X	X				X

Family	Species	Naturalised	Cons. code	NJ2101	NJ2102	NJ2103	NJ2104	NJ2105	NJ2106	NJ2107	NJ2108	NJ2109	NJ2110	Opportunistic
	Bonamia pannosa			X										
	Bonamia pilbarensis										X			X
	Evolvulus alsinoides var. *decumbens*			X										
	Evolvulus alsinoides var. *villosicalyx*						X							
	Ipomoea muelleri			X										
	Polymeria ambigua									X				
Cucurbitaceae	*Cucumis variabilis*			X										X
	Trichosanthes cucumerina			X										X
Cyperaceae	*Bulbostylis barbata*			X	X								X	
	Bulbostylis burbidgeae		4											X
	Cyperus blakeanus													X
	Cyperus cunninghamii subsp. *cunninghamii*													X
	Cyperus hesperius													X
	Cyperus ixiocarpus			X										
	Cyperus squarrosus								X					X
	Cyperus vaginatus													X
	Fimbristylis dichotoma				X	X	X	X					X	
	Fuirena ciliaris													X
Droseraceae	*Drosera finlaysoniana*			X										
Euphorbiaceae	*Euphorbia australis* var. *hispidula*			X			X		X					
	Euphorbia coghlanii			X					X			X		
	Euphorbia tannensis subsp. *eremophila*													X
	Microstachys chamaelea			X										
Fabaceae	*Acacia acradenia*									X				
	Acacia adsurgens													X
	Acacia ampliceps								X					
	Acacia ancistrocarpa													X
	Acacia bivenosa					X			X	X	X			
	Acacia colei var. *colei*								X					
	Acacia coriacea subsp. *pendens*													X
	Acacia inaequilatera				X	X				X	X			X
	Acacia maitlandii				X	X	X			X			X	X
	Acacia orthocarpa				X	X	X			X			X	X
	Acacia pyrifolia var. *pyrifolia*			X										
	Acacia stellaticeps				X				X				X	X
	Acacia trachycarpa			X					X					
	Acacia tumida var. *pilbarensis*			X			X							
	Cajanus cinereus								X					X
	Crotalaria cunninghamii			X										
	Crotalaria medicaginea var. *neglecta*													X
	Crotalaria novae-hollandiae subsp. *novae-hollandiae*													X

Family	Species	Naturalised	Cons. code	NJ2101	NJ2102	NJ2103	NJ2104	NJ2105	NJ2106	NJ2107	NJ2108	NJ2109	NJ2110	Opportunistic
	Cullen stipulaceum													X
	Indigofera colutea													X
	Indigofera hirsuta													X
	Indigofera linifolia													X
	Indigofera monophylla				X				X	X			X	X
	Isotropis atropurpurea			X					X	X				
	Petalostylis labicheoides								X	X				X
	Rhynchosia minima													X
	Rothia indica subsp. *australis*		3	X										
	Senna artemisioides subsp. *helmsii*								X					
	Senna artemisioides subsp. *oligophylla*								X					X
	Senna glutinosa subsp. *glutinosa*									X	X			
	Senna glutinosa subsp. *pruinosa*													X
	Senna notabilis			X					X	X				
	Senna symonii													X
	Senna venusta													X
	Swainsona kingii								X					
	Tephrosia rosea var. *clementii*								X				X	
	Tephrosia sp. Bungaroo Creek (M.E. Trudgen 11601)						X						X	
	Tephrosia sp. NW Eremaean (S. van Leeuwen et al. PBS 0356)													X
	Tephrosia virens						X							
	Zornia muelleriana subsp. *congesta*						X							
Goodeniaceae	*Dampiera candicans*													X
	Goodenia lamprosperma			X					X					
	Goodenia microptera				X					X			X	
	Goodenia muelleriana								X					
	Goodenia stobbsiana									X	X			X
	Scaevola amblyanthera var. *centralis*								X					
	Scaevola browniana					X	X							
Gyrostemonaceae	*Codonocarpus cotinifolius*													X
Haloragaceae	*Gonocarpus ephemerus*													X
Lamiaceae	*Clerodendrum tomentosum*													X
Lauraceae	*Cassytha capillaris*					X			X	X			X	
Loganiaceae	*Mitrasacme connata*													X
Loranthaceae	*Amyema preissii*													X
Lythraceae	*Ammannia baccifera*													X
Malvaceae	*Abutilon cunninghamii*			X										
	Abutilon lepidum						X							
	Abutilon sp. Dioicum (A.A. Mitchell PRP 1618)								X					
	Abutilon sp. Pilbara (W.R. Barker 2025)													X
	Corchorus aff. *lasiocarpus*								X					

Family	Species	Naturalised	Cons. code	NJ2101	NJ2102	NJ2103	NJ2104	NJ2105	NJ2106	NJ2107	NJ2108	NJ2109	NJ2110	Opportunistic
	Corchorus parviflorus			X		X			X	X	X			X
	Corchorus sp.						X						X	
	Corchorus tridens								X					
	Gossypium australe													X
	Hibiscus austrinus			X					X					
	Hibiscus coatesii													X
	Hibiscus leptocladus													X
	Hibiscus sturtii var. *campylochlamys*			X			X		X					X
	Melhania oblongifolia								X					
	Seringia nephrosperma													X
	Sida clementii			X					X					
	Sida sp. Pilbara (A.A. Mitchell PRP 1543)													X
	Triumfetta maconochieana													X
	Triumfetta propinqua			X					X					
	Triumfetta ramosa												X	X
	Waltheria indica			X					X					
Menispermaceae	*Tinospora smilacina*													X
Molluginaceae	*Trigastrotheca molluginea*			X		X	X	X		X				X
Montiaceae	*Calandrinia pumila*													X
	Calandrinia tepperiana			X					X					
Moraceae	*Ficus brachypoda*													X
Myrtaceae	*Corymbia hamersleyana*								X					X
	Eucalyptus camaldulensis subsp. *refulgens*			X										
	Eucalyptus leucophloia subsp. *leucophloia*			X										
	Eucalyptus victrix			X										
	Melaleuca argentea			X										
	Melaleuca glomerata								X					
Nyctaginaceae	*Boerhavia coccinea*													X
Orobanchaceae	*Buchnera linearis*			X					X					
	Striga curviflora													X
Phyllanthaceae	*Flueggea virosa* subsp. *melanthesoides*			X										
	Phyllanthus hebecarpus		3											X
	Phyllanthus maderaspatensis								X					
Plantaginaceae	*Stemodia grossa*								X	X				X
	Stemodia viscosa			X					X					
Poaceae	*Aristida holathera* var. *holathera*			X			X		X				X	
	Cenchrus ciliaris	*		X					X					X
	Chrysopogon fallax			X					X	X				
	Cymbopogon ambiguus													X
	Dactyloctenium radulans													X
	Digitaria ctenantha								X					

Family	Species	Naturalised	Cons. code	NJ2101	NJ2102	NJ2103	NJ2104	NJ2105	NJ2106	NJ2107	NJ2108	NJ2109	NJ2110	Opportunistic
	Enneapogon caerulescens													X
	Eragrostis cumingii			X			X		X					
	Eragrostis dielsii								X					
	Eragrostis tenellula								X					
	Eriachne aristidea						X						X	X
	Eriachne ciliata						X							
	Eriachne mucronata						X							
	Eriachne obtusa			X	X	X		X	X	X			X	
	Eriachne pulchella subsp. *dominii*					X	X				X			
	Eulalia aurea			X					X					
	Heteropogon contortus			X					X					
	Paraneurachne muelleri									X				
	Paspalidium clementii						X							
	Paspalidium rarum			X										
	Perotis rara													X
	Schizachyrium fragile				X									
	Setaria surgens			X					X					
	Sporobolus actinocladus													X
	Sporobolus australasicus								X	X				X
	Themeda triandra			X					X					
	Triodia chichesterensis		3								X			X
	Triodia epactia			X	X	X	X	X	X	X			X	X
	Triodia lanigera				X						X		X	X
	Triodia longiceps							X	X			X		
	Triodia secunda											X		X
	Triodia wiseana					X				X	X			X
	Tripogonella loliiformis						X							
	Yakirra australiensis				X								X	
Polygalaceae	*Polygala longifolia*				X									
Portulacaceae	*Portulaca cyclophylla*													X
	Portulaca oleracea			X										X
	Portulaca pilosa	*		X										X
Proteaceae	*Grevillea pyramidalis* subsp. *leucadendron*			X		X								X
	Grevillea wickhamii			X			X		X	X			X	
	Hakea lorea subsp. *lorea*								X	X				X
Pteridaceae	*Cheilanthes sieberi* subsp. *sieberi*						X							
Rubiaceae	*Dolichocarpa crouchiana*									X				
	Scleromitrion galioides			X										
	Synaptantha tillaeacea var. *tillaeacea*			X										
Sapindaceae	*Dodonaea coriacea*													X
Solanaceae	*Nicotiana umbratica*		3											X

Family	Species	Naturalised	Cons. code	NJ2101	NJ2102	NJ2103	NJ2104	NJ2105	NJ2106	NJ2107	NJ2108	NJ2109	NJ2110	Opportunistic
	Solanum diversiflorum			X										
Stylidiaceae	*Stylidium desertorum*													X
Violaceae	*Afrohybanthus aurantiacus*			X			X		X	X				
Zygophyllaceae	*Tribulus hirsutus*									X				X
	Tribulus occidentalis													X
	Tribulus platypterus						X							X
	Tribulus suberosus											X		

Table 22: Fauna sites (GDA94, Zone 50)

Site Name	Site Type	Species Recorded at Site	Easting	Northing
FS01	Burrow / Mound	Western Pebble-mound Mouse	686511.7707	7651883.954
FS02	Burrow / Mound	Western Pebble-mound Mouse	686649.0157	7652696.152
FS03	Tracks / Diggings / Scratching	Echidna	686826.448	7652823.025
FS04	Tracks / Diggings / Scratching	Bilby	686879.5026	7650825.062
FS05	Tracks / Diggings / Scratching	Dog	686906.532	7650409.071
FS06	Burrow / Mound	Brush-tailed Mulgara	686901.6892	7650813.294
FS07	Burrow / Mound	Brush-tailed Mulgara	686896.7718	7650828.188
FS08	Tracks / Diggings / Scratching	Brush-tailed Mulgara	686221.895	7650310.001
FS09	Tracks / Diggings / Scratching	Brush-tailed Mulgara	686381.5133	7650388.136
FS10	Tracks / Diggings / Scratching	Cat	686496.711	7649827.969
FS11	Tracks / Diggings / Scratching	*Varanus* sp.	686959.038	7650853.5
HA01	Habitat Assessment Point	n/a	687386.7383	7650732.798
HA02	Habitat Assessment Point	n/a	686451.7296	7651990.937
HA03	Habitat Assessment Point	n/a	686509.4194	7651804.919
HA04	Habitat Assessment Point	n/a	686404.9677	7652371.494
HA05	Habitat Assessment Point	n/a	687566.6589	7651605.518
HA06	Habitat Assessment Point	n/a	688935.887	7649956.3
HA07	Habitat Assessment Point	n/a	688425.3445	7651132.384
HA08	Habitat Assessment Point	n/a	688320.261	7651203.241
HA09	Habitat Assessment Point	n/a	688226.2153	7652336.659
HA10	Habitat Assessment Point	n/a	688532.4646	7651727.112
HA11	Habitat Assessment Point	n/a	688927.1798	7651752.14
HA12	Habitat Assessment Point	n/a	688918.5579	7650651.232
HA13	Habitat Assessment Point	n/a	686606.7862	7650086.602
HA14	Habitat Assessment Point	n/a	686187.2507	7649772.908
HA15	Habitat Assessment Point	n/a	686594.438	7650643.94
MC13	Trail Camera	n/a	686877.8228	7650823.421
MC14	Trail Camera	n/a	688099.73	7650685.442
MC29	Trail Camera	n/a	686114.6258	7652999.969
MC68	Trail Camera	n/a	688593.9234	7650515.887
MC89	Trail Camera	n/a	689518.4921	7650424.179
SM4-01147	Ultrasonic Recorded (SM4)	n/a	687063.9507	7650284.698

APPENDIX FIVE FLORISTIC QUADRAT DATA

NJ2101

Staff SOK **Date** 25/05/2021 **Season** E

Revisit

Type Q 50 m x 50 m

Location

MGA Zone 50 689526 **mE** 7650461 **mN** **Lat.** -21.2376 **Long.** 118.8263

Habitat River

Aspect N/A **Slope** N/A

Soil Type Light brown sand

Rock Type Nil

Loose Rock 0 % cover **Litter** 20 % cover ; 0-5 cm in depth

Bare ground 50 % cover **Weeds** 25 % cover

Vegetation U ^*Melaleuca argentea*,^*Eucalyptus camaldulensis* subsp. *refulgens*\^tree\6\r;M+ ^*Acacia tumida* var. *pilbarensis*,^*Acacia trachycarpa*\^shrub\4\i;G ^*Cenchrus ciliaris*,^*Triodia epactia*\^tussock grass,hummock grass\1\c

Veg. Condition Good

Disturbance Weeds, grazing

Fire Age >5 years

Notes

Species	WA Cons.	Height (m)	Cover (%)	Count
Abutilon cunninghamii		0.3	<1	
Acacia pyrifolia var. *pyrifolia*		1	<1	
Acacia trachycarpa		4	10	
Acacia tumida var. *pilbarensis*		6	15	

Afrohybanthus aurantiacus		0.5	<1	
Aristida holathera var. *holathera*		0.5	<1	
Arivela viscosa		0.3	<1	
Bonamia pannosa		0.1	<1	
Buchnera linearis		0.4	<1	
Bulbostylis barbata		0.3	<1	
Calandrinia tepperiana		0.2	<1	
**Cenchrus ciliaris*		0.5	25	
Chrysopogon fallax		1	3	
Corchorus parviflorus		0.6	<1	
Crotalaria cunninghamii		1	<1	
Cucumis variabilis		0.7	<1	
Cyperus ixiocarpus		0.5	<1	
Drosera finlaysoniana		0.1	<1	
Eragrostis cumingii		0.2	<1	
Eriachne obtusa		0.5	<1	
Eucalyptus camaldulensis subsp. *refulgens*		8	2	
Eucalyptus leucophloia subsp. *leucophloia*			<1	
Eucalyptus victrix			<1	
Eucalyptus victrix			<1	
Eulalia aurea		0.8	<1	
Euphorbia australis var. *hispidula*		0.2	<1	
Euphorbia coghlanii		0.4	<1	
Evolvulus alsinoides var. *decumbens*		0.3	<1	
Flueggea virosa subsp. *melanthesoides*		2	<1	
Goodenia lamprosperma		0.3	<1	
Grevillea pyramidalis subsp. *leucadendron*		2	<1	
Grevillea wickhamii		2	<1	
Gymnanthera cunninghamii	P 3	1	<1	1
Heliotropium tenuifolium		0.3	<1	
Heteropogon contortus		0.6	<1	
Hibiscus austrinus		1.5	<1	
Hibiscus sturtii var. *campylochlamys*		0.3	<1	
Ipomoea muelleri		0.5	<1	
Isotropis atropurpurea		0.5	<1	
Melaleuca argentea		6	3	
Microstachys chamaelea		0.5	<1	
Paspalidium rarum		0.2	<1	

Polycarpaea corymbosa var. *corymbosa*		0.2	<1
Portulaca oleracea		0.1	<1
**Portulaca pilosa*		0.3	<1
Ptilotus astrolasius		0.4	<1
Ptilotus fusiformis		0.3	<1
Rothia indica subsp. *australis*	P 3	0.1	<1
Scleromitrion galioides		0.2	<1
Senna notabilis		0.3	<1
Setaria surgens		0.4	<1
Sida clementii		1	<1
Solanum diversiflorum		0.3	<1
Stemodia viscosa		0.4	<1
Synaptantha tillaeacea var. *tillaeacea*		0.1	<1
Themeda triandra		0.5	<1
Trianthema pilosum		0.1	<1
Trichosanthes cucumerina			<1
Trigastrotheca molluginea		0.2	<1
Triodia epactia		0.4	2
Triumfetta propinqua		1.4	<1
Waltheria indica		0.6	<1

NJ2102

Staff SOK **Date** 26/05/2021 **Season** E

Revisit

Type Q 50 m x 50 m

Location

MGA Zone 50 687311 **mE** 7650813 **mN** **Lat.** -21.2347 **Long.** 118.8049

Habitat Flat

Aspect N/A **Slope** N/A

Soil Type Light red brown sand

Rock Type Granite

Loose Rock 2-10 % cover; 6-20 mm in size **Litter** 10 % cover ; 0-2 cm in depth

Bare ground 50 % cover **Weeds** 0 % cover

Vegetation M ^*Acacia orthocarpa*\^shrub\4\i;G+ ^^*Triodia lanigera*,*Acacia stellaticeps*,*Indigofera monophylla*\^hummock grass,shrub\2\c

Veg. Condition Excellent

Disturbance Minimal

Fire Age >5 years

Notes

Species	WA Cons.	Height (m)	Cover (%)	Count
Acacia inaequilatera		1	<1	
Acacia maitlandii		1.5	<1	
Acacia orthocarpa		2.5	10	
Acacia stellaticeps		0.7	10	
Bonamia alatisemina		0.3	<1	

Bonamia erecta	0.4	<1
Bulbostylis barbata	0.2	<1
Byblis pilbarana	0.1	<1
Eriachne obtusa	0.3	<1
Fimbristylis dichotoma	0.3	<1
Goodenia microptera	0.3	<1
Heliotropium sp.	0.2	<1
Indigofera monophylla	0.5	2
Pluchea tetranthera	0.3	<1
Polycarpaea corymbosa var. *corymbosa*	0.1	<1
Polycarpaea holtzei	0.1	<1
Polygala longifolia	0.1	<1
Schizachyrium fragile	0.3	<1
Stackhousia intermedia	0.3	<1
Triodia epactia	0.5	2
Triodia lanigera	0.5	40
Yakirra australiensis	0.2	<1

NJ2103

Staff SOK **Date** 26/05/2021 **Season** E

Revisit

Type Q 50 m x 50 m

Location

MGA Zone 50 686424 **mE** 7651913 **mN** **Lat.** -21.2248 **Long.** 118.7962

Habitat Flat, slightly raised

Aspect N/A **Slope** N/A

Soil Type Light brown loam

Rock Type Calcrete, Quartz

Loose Rock 50-90 % cover; 6-20 mm in size **Litter** 2 % cover ; 0-1 cm in depth

Bare ground 60 % cover **Weeds** 0 % cover

Vegetation M+ ^*Acacia inaequilatera*,^*Acacia bivenosa*\^shrub\4\r;G ^*Triodia wiseana*\^hummock grass\1\c

Veg. Condition Excellent

Disturbance Minimal

Fire Age >5 years

Notes

Species	WA Cons.	Height (m)	Cover (%)	Count
Acacia bivenosa		2.5	2	
Acacia inaequilatera		2.5	4	
Acacia maitlandii		2.5	<1	
Acacia orthocarpa		2.5	<1	
Cassytha capillaris		0.3	<1	

Corchorus parviflorus	0.5	<1
Eriachne obtusa	0.4	<1
Eriachne pulchella subsp. *dominii*	0.2	<1
Fimbristylis dichotoma	0.3	<1
Grevillea pyramidalis subsp. *leucadendron*	2.5	<1
Ptilotus astrolasius	0.4	<1
Scaevola browniana	0.3	<1
Trigastrotheca molluginea	0.2	<1
Triodia epactia	0.4	<1
Triodia wiseana	0.5	45

NJ2104

Staff SOK **Date** 26/05/2021 **Season** E

Revisit

Type Q 50 m x 50 m

Location

MGA Zone 50 686300 **mE** 7652421 **mN** **Lat.** -21.2202 **Long.** 118.7950

Habitat Undulating

Aspect N/A **Slope** N/A

Soil Type Light red brown sandy loam

Rock Type Granite

Loose Rock 10-20 % cover; 20-60 mm in size **Litter** 3 % cover ; 0-2 cm in depth

Bare ground 80 % cover **Weeds** 0 % cover

Vegetation M+ ^*Acacia tumida* var. *pilbarensis*\^shrub\4\r;G ^*Triodia epactia*\^hummock grass\2\i

Veg. Condition Excellent

Disturbance Minimal

Fire Age >5 years

Notes

Species	WA Cons.	Height (m)	Cover (%)	Count
Abutilon lepidum		0.2	<1	
Acacia maitlandii		2	<1	
Acacia orthocarpa		2	<1	
Acacia tumida var. *pilbarensis*		2.5	4	
Afrohybanthus aurantiacus		0.4	<1	

Aristida holathera var. *holathera*	0.4	<1
Cheilanthes sieberi subsp. *sieberi*	0.2	<1
Corchorus sp.	1	<1
Eragrostis cumingii	0.2	<1
Eriachne aristidea	0.2	<1
Eriachne ciliata	0.2	<1
Eriachne mucronata		<1
Eriachne pulchella subsp. *dominii*	0.2	<1
Euphorbia australis var. *hispidula*	0.1	<1
Evolvulus alsinoides var. *villosicalyx*	0.2	<1
Fimbristylis dichotoma	0.3	<1
Gomphrena cunninghamii	0.2	<1
Gomphrena leptoclada	0.2	<1
Grevillea wickhamii	0.5	<1
Hibiscus sturtii var. *campylochlamys*	0.4	<1
Paspalidium clementii	0.2	<1
Polycarpaea corymbosa var. *corymbosa*	0.2	<1
Polycarpaea holtzei		<1
Scaevola browniana	0.4	<1
Tephrosia sp. Bungaroo Creek (M.E. Trudgen 11601)	0.5	<1
Tephrosia virens	1.5	<1
Trachymene oleracea subsp. *oleracea*	0.2	<1
Tribulus platypterus	0.4	<1
Trigastrotheca molluginea	0.2	<1
Triodia epactia	0.6	15
Tripogonella loliiformis	0.1	<1
Zornia muelleriana subsp. *congesta*	0.1	<1

NJ2105

Staff SOK **Date** 26/05/2021 **Season** E

Revisit

Type Q 50 m x 50 m

Location

MGA Zone 50 687565 **mE** 7651625 **mN** **Lat.** -21.2273 **Long.** 118.8073

Habitat Flat

Aspect N/A **Slope** N/A

Soil Type Light red brown sandy loam

Rock Type Nil

Loose Rock 0 % cover **Litter** 2 % cover ; 0-1 cm in depth

Bare ground 65 % cover **Weeds** 0 % cover

Vegetation G+ ^*Triodia longiceps*,^*Triodia epactia*\^hummock grass\1\c

Veg. Condition Excellent

Disturbance Minimal

Fire Age >5 years

Notes

Species	WA Cons.	Height (m)	Cover (%)	Count
Eriachne obtusa		0.3	<1	
Fimbristylis dichotoma		0.4	<1	
Trigastrotheca molluginea		0.1	<1	
Triodia epactia		0.5	2	
Triodia longiceps		0.5	35	

NJ2106

Staff SOK **Date** 27/05/2021 **Season** E

Revisit

Type Q 50 m x 50 m

Location

MGA Zone 50 688545 **mE** 7651209 **mN** **Lat.** -21.2310 **Long.** 118.8168

Habitat Creek

Aspect N/A **Slope** N/A

Soil Type Light red brown sand

Rock Type Granite

Loose Rock 2-10 % cover; 6-20 mm in size **Litter** 3 % cover ; 0-2 cm in depth

Bare ground 55 % cover **Weeds** <1 % cover

Vegetation U ^*Corymbia hamersleyana*\^tree\6\r;M+ ^*Acacia colei* var. *colei*,^\^shrub\4\r;G ^^*Triodia epactia*, *Triodia longiceps*,*Chrysopogon fallax*\^hummock grass,tussock grass\2\c

Veg. Condition Very Good

Disturbance Grazing, weeds

Fire Age >5 years

Notes

Species	WA Cons.	Height (m)	Cover (%)	Count
Abutilon sp. Dioicum (A.A. Mitchell PRP 1618)		1	<1	
Acacia ampliceps		2	1	
Acacia bivenosa		2	<1	
Acacia colei var. *colei*		3	3	
Acacia stellaticeps		0.8	<1	

Acacia trachycarpa	2.5	5
Afrohybanthus aurantiacus	0.5	<1
Aristida holathera var. *holathera*	0.4	<1
Bonamia erecta	0.5	<1
Buchnera linearis	0.4	<1
Cajanus cinereus	1.5	<1
Calandrinia tepperiana	0.2	<1
Cassytha capillaris	0.4	<1
**Cenchrus ciliaris*	0.5	<1
Chrysopogon fallax	1	2
Corchorus parviflorus	0.5	<1
Corchorus tridens	0.1	<1
Corymbia hamersleyana	4	2
Cyperus squarrosus	0.1	<1
Digitaria ctenantha	0.3	<1
Eragrostis cumingii	0.2	<1
Eragrostis dielsii	0.1	<1
Eragrostis tenellula	0.3	<1
Eriachne obtusa	0.3	<1
Eulalia aurea	0.7	<1
Euphorbia australis var. *hispidula*	0.1	<1
Euphorbia coghlanii	0.4	<1
**Flaveria trinervia*	0.5	<1
Gomphrena leptoclada	0.2	<1
Goodenia lamprosperma	0.4	<1
Goodenia lamprosperma	0.4	<1
Goodenia muelleriana	0.3	<1
Grevillea wickhamii	2.5	<1
Hakea lorea subsp. *lorea*	2	<1
Heteropogon contortus	0.8	<1
Hibiscus austrinus	1	1
Hibiscus sturtii var. *campylochlamys*	0.4	<1
Indigofera monophylla	0.4	<1
Isotropis atropurpurea	0.5	<1
Melaleuca glomerata	1	<1
Melhania oblongifolia	0.5	<1
Petalostylis labicheoides	2	<1
Phyllanthus maderaspatensis	0.4	<1

Pluchea dentex	0.4	<1
Pluchea rubelliflora	0.3	<1
Ptilotus axillaris	0.3	<1
Scaevola amblyanthera var. *centralis*	0.3	<1
Senna artemisioides subsp. *helmsii*	1	<1
Senna artemisioides subsp. *oligophylla*	1.5	<1
Senna notabilis	0.3	<1
Setaria surgens	0.4	1
Sida clementii	0.5	<1
Sporobolus australasicus	0.3	<1
Stemodia grossa	0.4	<1
Stemodia viscosa	0.4	<1
Swainsona kingii		<1
Tephrosia rosea var. *clementii*	1	<1
Themeda triandra	0.7	<1
Triodia epactia	0.5	35
Triodia longiceps	0.4	5
Triumfetta propinqua	1	<1
Waltheria indica	0.4	<1

NJ2107

Staff SOK **Date** 27/05/2021 **Season** E

Revisit

Type Q 50 m x 50 m

Location

MGA Zone 50 688042 **mE** 7651820 **mN** **Lat.** -21.2255 **Long.** 118.8118

Habitat Flat

Aspect N/A **Slope** N/A

Soil Type Light brown loam

Rock Type Quartz

Loose Rock 10-20 % cover; 6-20 mm in size **Litter** 5 % cover ; 0-2 cm in depth

Bare ground 50 % cover **Weeds** 0 % cover

Vegetation M+ ^*Acacia acradenia*\^shrub\4\i;G ^*Triodia wiseana*,^*Triodia epactia*\^hummock grass\1\c

Veg. Condition Excellent

Disturbance Minimal

Fire Age >5 years

Notes

Species	WA Cons.	Height (m)	Cover (%)	Count
Acacia acradenia		2.5	15	
Acacia bivenosa		3	<1	
Acacia inaequilatera		0.6	<1	
Acacia maitlandii		3	<1	
Acacia orthocarpa		3	<1	

Afrohybanthus aurantiacus		0.4	<1	
Bonamia alatisemina		0.2	<1	
Bonamia erecta		0.4	<1	
Cassytha capillaris		0.4	<1	
Chrysopogon fallax		1	<1	
Corchorus parviflorus		0.5	<1	
Dolichocarpa crouchiana		0.1	<1	
Eriachne obtusa		0.5	<1	
Goodenia microptera		0.4	<1	
Goodenia stobbsiana		0.5	<1	
Grevillea wickhamii		0.5	<1	
Hakea lorea subsp. *lorea*		3	<1	
Heliotropium muticum	P 3	0.3	<1	1
Indigofera monophylla		0.5	<1	
Isotropis atropurpurea		0.8	<1	
Paraneurachne muelleri		0.4	<1	
Petalostylis labicheoides		2	<1	
Pluchea tetranthera		0.4	<1	
Polymeria ambigua		0.2	<1	
Ptilotus astrolasius		0.4	<1	
Ptilotus axillaris		0.4	<1	
Senna glutinosa subsp. *glutinosa*		1	<1	
Senna notabilis		0.1	<1	
Sporobolus australasicus		0.1	<1	
Stemodia grossa		0.5	<1	
Streptoglossa bubakii		0.6	<1	
Trachymene oleracea subsp. *oleracea*		0.3	<1	
Tribulus hirsutus		0.2	<1	
Trigastrotheca molluginea		0.2	<1	
Triodia epactia		0.5	15	
Triodia wiseana		0.5	30	

NJ2108

Staff SOK **Date** 27/05/2021 **Season** E

Revisit

Type Q 50 m x 50 m

Location

MGA Zone 50 688231 **mE** 7652356 **mN** **Lat.** -21.2206 **Long.** 118.8136

Habitat Flat, slightly raised

Aspect N/A **Slope** N/A

Soil Type Light brown loam

Rock Type Quartz

Loose Rock 50-90 % cover; 6-20 mm in size **Litter** 2 % cover ; 0-1 cm in depth

Bare ground 65 % cover **Weeds** 0 % cover

Vegetation M ^*Acacia bivenosa*,^*Acacia inaequilatera*\^shrub\4\r;G+ ^*Triodia chichesterensis*,^*Triodia wiseana*\^hummock grass\1\c

Veg. Condition Excellent

Disturbance Minimal

Fire Age >5 years

Notes

Species	WA Cons.	Height (m)	Cover (%)	Count
Acacia bivenosa		2.5	1	
Acacia inaequilatera		2.5	<1	
Bonamia pilbarensis		0.1	<1	
Corchorus parviflorus		0.6	<1	
Eriachne pulchella subsp. *dominii*		0.2	<1	

Goodenia stobbsiana		0.4	<1
Ptilotus astrolasius		0.4	<1
Ptilotus calostachyus		0.4	<1
Senna glutinosa subsp. *glutinosa*		0.8	<1
Triodia chichesterensis	P 3	0.4	25
Triodia lanigera		0.5	1
Triodia wiseana		0.5	5

NJ2109

Staff SOK **Date** 27/05/2021 **Season** E

Revisit

Type Q 50 m x 50 m

Location

MGA Zone 50 688319 **mE** 7652073 **mN** **Lat.** -21.2232 **Long.** 118.8145

Habitat Flat

Aspect N/A **Slope** N/A

Soil Type Brown clay loam

Rock Type Nil

Loose Rock 0 % cover **Litter** 3 % cover ; 0-1 cm in depth

Bare ground 65 % cover **Weeds** 0 % cover

Vegetation G+ ^*Triodia secunda*\^hummock grass\1\c

Veg. Condition Excellent

Disturbance Minimal

Fire Age >5 years

Notes

Species	WA Cons.	Height (m)	Cover (%)	Count
Euphorbia coghlanii		0.3	<1	
Triodia longiceps		0.4	<1	
Triodia secunda		0.3	35	

NJ2110

Staff SOK **Date** 27/05/2021 **Season** E

Revisit

Type Q 50 m x 50 m

Location

MGA Zone 50 686622 **mE** 7650232 **mN** **Lat.** -21.2400 **Long.** 118.7983

Habitat Flat

Aspect N/A **Slope** N/A

Soil Type Light red brown loamy sand

Rock Type Granite

Loose Rock 2-10 % cover; 20-60 mm in size **Litter** 1 % cover ; 0-1 cm in depth

Bare ground 75 % cover **Weeds** 0 % cover

Vegetation M ^*Acacia orthocarpa*,^*Grevillea wickhamii*\^shrub\3\r;G+ ^^*Triodia lanigera*,*Acacia stellaticeps*, *Triodia epactia*\^hummock grass,shrub\1\i

Veg. Condition Excellent

Disturbance Fire

Fire Age 2-5 years

Notes

Species	WA Cons.	Height (m)	Cover (%)	Count
Acacia maitlandii		0.6	<1	
Acacia orthocarpa		2	2	
Acacia stellaticeps		0.5	5	
Aristida holathera var. *holathera*		0.4	<1	
Bulbostylis barbata			<1	

Cassytha capillaris	0.3	<1
Corchorus sp.	0.5	3
Eriachne aristidea	0.3	<1
Eriachne obtusa	0.3	<1
Fimbristylis dichotoma	0.3	<1
Goodenia microptera	0.3	<1
Grevillea wickhamii	2	1
Heliotropium sp.	0.2	<1
Indigofera monophylla	0.4	<1
Pluchea ferdinandi-muelleri	0.4	<1
Tephrosia rosea var. *clementii*	0.6	<1
Tephrosia sp. Bungaroo Creek (M.E. Trudgen 11601)	0.5	<1
Triodia epactia	0.4	5
Triodia lanigera	0.4	15
Triumfetta ramosa	0.5	<1
Yakirra australiensis	0.2	<1

APPENDIX SIX FAUNA HABITAT ASSESSMENT DATA

Table 23: Fauna Habitat assessment point data

Sampling Point No	Habitat Unit Name	Habitat Description	Soil Type	Litter Cover	Fire Age	Disturbance	Easting	Northing	Image
HA01	Hummock Grassland	Spinifex grassland with *Acacia stellaticeps*	Sandy Clay	10	>5 years	Low	687376.362	7650751.519	
HA02	Hummock Grassland	Spinifex grassland	Sand		<5 years	Low	686452.136	7651990.156	
HA03	Drainage Line/River/Creek (Minor)	Acacia shrubs over grasses	Sand	10	>10 years	High	686508.692	7651804.927	

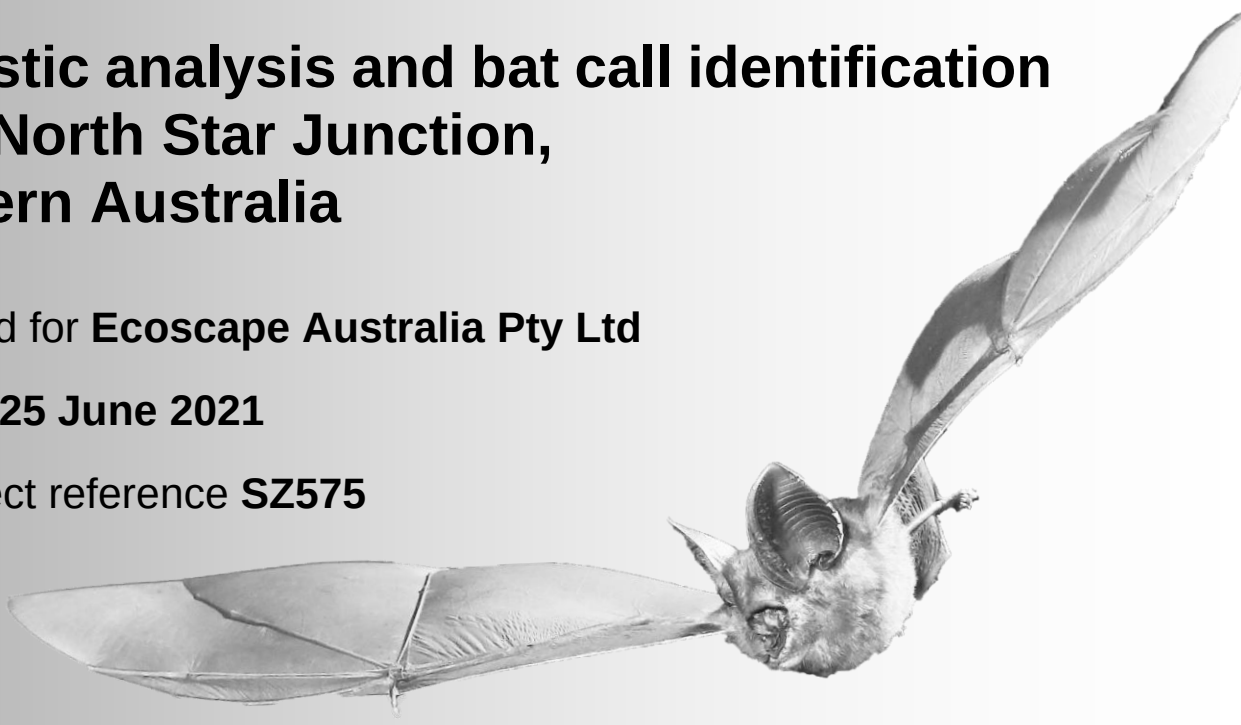
Sampling Point No	Habitat Unit Name	Habitat Description	Soil Type	Litter Cover	Fire Age	Disturbance	Easting	Northing	Image
HA04	Granite Outcrops	Granite outcrop	NA	10	>5 years	Low	686406.022	7652372.921	
HA05	Hummock Grassland	Spinifex grassland with Acacia stellataceps	Sand	10	<5 years	Low	687565.727	7651605.75	
HA06	Hummock Grassland	Spinifex grassland	Clay	10	>5 years	Moderate	688934.777	7649959.08	
HA07	Drainage Line/River/Creek (Minor)	Mixed Acacia shrubs over spinifex and buffel grass	Sand	25	>5 years	High -weeds, some cattle evidence	688422.535	7651131.863	

Sampling Point No	Habitat Unit Name	Habitat Description	Soil Type	Litter Cover	Fire Age	Disturbance	Easting	Northing	Image
HA08	Granite Outcrops	Granite outcrop fringed by mixed tall Acacia and spinifex	NA	10	>5 years	Moderate	688319.426	7651202.918	
HA09	Hummock Grassland	Spinifex grassland on stony plain	Clay	10	>5 years	Moderate	688224.14	7652336.793	
HA10	Hummock Grassland	Spinifex grassland at the base of granite outcrop	Clay	10	>5 years	Moderate	688533.919	7651727.206	
HA11	Drainage Line/River/Creek (Minor)	Riparian woodland vegetation including Eucaalypt over Acacia woodland	Sand	50	>5 years	High	688926.256	7651753.147	
HA12	Hummock Grassland	Spinifex grassland	Clayey sand	10	>5 years	Moderate	688918.447	7650650.679	

Sampling Point No	Habitat Unit Name	Habitat Description	Soil Type	Litter Cover	Fire Age	Disturbance	Easting	Northing	Image
HA13	Hummock Grassland	Spinifex grassland	Sand	10	<5 years	Moderate	686606.688	7650087.157	
HA14	Granite Outcrops	Granite outcrop	Sand	25	<5 years	Moderate	686185.907	7649773.477	
HA15	Hummock Grassland	Spinifex grassland with Acacia stellataceps	Clayey sand	10	>5 years	Moderate - edge effect, roads nearby	686596.573	7650640.039	

APPENDIX SEVEN BAT CALL ANALYSIS REPORT

Acoustic analysis and bat call identification from North Star Junction, Western Australia



Prepared for **Ecoscape Australia Pty Ltd**

Version **25 June 2021**

SZ project reference **SZ575**

Prepared by **Dr Kyle Armstrong and Yuki Konishi**

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This report should be included as an appendix in any larger submission to Government, and cited as:

Specialised Zoological (2021). Acoustic analysis and bat call identification from North Star Junction, Western Australia. Unpublished report by Specialised Zoological for Ecoscape Australia Pty Ltd, 25 June 2021, project reference SZ575.

Summary

Bat identifications from acoustic recordings are provided from the North Star Junction area, in the Pilbara region of Western Australia. The identification of bat species from full spectrum WAV-format recordings of their echolocation calls was based on measurements of characteristic frequency, observation of pulse shape, and the pattern of harmonics. Five species of bat were identified unambiguously as being present (**Tables 1** and **2**). The Ghost Bat *Macroderma gigas* (Megadermatidae) and Pilbara Leaf-nosed Bat *Rhinonicteris aurantia* (Rhinonycteridae) were specifically targeted in the analysis but were not detected. Representative echolocation calls for each identification are illustrated (**Figure 1**), as recommended by the Australasian Bat Society (ABS 2006). Further details are available should verification be required.

Methods

The data provided were recorded in full spectrum WAV format with Wildlife Acoustics Song Meter SM4BAT bat detectors (sampling rate 384 kHz, set to turn on automatically at sunset and off at sunrise).

A multi-step acoustic analysis procedure developed to process large full spectrum echolocation recording datasets from insectivorous bats (Armstrong and Aplin 2014; Armstrong et al. 2016) was applied to the recordings made on the survey. Firstly, the WAV files were scanned for bat echolocation calls using several parameter sets in the software SCAN'R version 1.8.3 (Binary Acoustic Technology), which also provides measurements (SCAN'R parameters) from each putative bat pulse. The outputs were then used to determine if putative bat pulses measured in SCAN'R could be identified to species. This was done using a custom [R] language script that performed three tasks:

1. undertook a Discriminant Function Analysis on training data from representative calls from the Pilbara;

2. from the measurements of each putative bat pulse from SCAN'R, calculated values for the first two Discriminant Functions that could separate the echolocation call types derived from the analysis of training data, and plotted these resulting coordinates over confidence regions for the defined call types; and

3. facilitated an inspection in a spectrogram of multiple examples of each call type for each recording night by opening the original WAV files containing pulses of interest in Adobe Audition CS6 version 5.0.2.

Species were identified based on information in McKenzie and Bullen (2009) and the authors' own unpublished material; and nomenclature follows Jackson and Groves (2015).

Limitations

The identifications presented in this report have been made within the following context:

1. The identifications made herein were based on the ultrasonic acoustic data recorded and provided by a 'third party' (the client named on the front of this report).
2. The scope of this report extended to providing information on the identification of bat species in bulk ultrasonic recordings. Further comment on these species and the possible impacts of a planned project on bat species were not part of the scope.
3. In the case of the present report, the recording equipment was not set up and supplied by Specialised Zoological. The equipment was operated by the third party during the survey.
4. Other than the general location of the study area, Specialised Zoological has not been provided with detailed information of the survey area, has not made a visit to observe the habitats available for bats, nor have we visited the specific project areas on a previous occasion.
5. Specialised Zoological has had no input into the overall design and timing of this bat survey, recording site placement, nor the degree of recording site replication.
6. While Specialised Zoological has made identifications to the best of our ability given the available materials, and reserves the right to re-examine the data and revise any identification following a query, it is the client's and / or proponent's responsibility to provide supporting evidence for any identification, which might require follow-up trapping effort or non-invasive methods such as video recordings. Specialised Zoological bears no liability for any follow-up work that may be required to support an identification based initially on the analysis of acoustic recordings undertaken and reported on here.
7. There are a variety of factors that affect the 'detectability' of each bat species, given the frequency, power and shape characteristics of their calls. Further information on the analysis and the various factors that can impinge on the reliability of identifications can be provided upon request.
8. The analysis of ultrasonic recordings is one of several methods that can be used to survey for bats, and comprehensive surveys typically employ more than one method. If an identification in the present report is ambiguous or in question, a trapping programme would help to resolve the presence of the possibilities in the project area.
9. The most reliable way of detecting the Ghost Bat with bat detectors is to place the equipment with the microphone facing into a potential cave roosting site. The echolocation calls of this species are of low amplitude, and therefore most detectable when a Ghost Bat flies close to the bat detector as it exits the underground structure. If there is uncertainty about whether Ghost Bats are present in a cave, then video recordings can be a useful addition to the survey. The detection of Ghost Bats with bat detectors away from cave entrances is less reliable.
10. Predictions about whether the Pilbara Leaf-nosed Bat roosts within a particular surveyed cave (where a bat detector was placed at the entrance), or somewhere nearby, based on the time of first detection should be considered indicative only. If unambiguous information of diurnal roosting of this species is required, diurnal roosting can be confirmed using the entrance sheeting method that is described in DEWHA (2010).

References

ABS (2006). Recommendations of the Australasian Bat Society Inc for reporting standards for insectivorous bat surveys using bat detectors. *The Australasian Bat Society Newsletter* 27: 6–9. [ISSN 1448-5877]

Armstrong, K.N. and Aplin, K.P. (2014). Identifying bats in an unknown acoustic realm using a semi-automated approach to the analysis of large full spectrum datasets. Oral presentation at the 16th Australasian Bat Society Conference 22–25 April 2014, Townsville, Queensland. *The Australasian Bat Society Newsletter* 42: 35–36.

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Jackson, S.M. and Groves, C.P. (2015). *Taxonomy of Australian mammals*. CSIRO Publishing, Victoria.

McKenzie, N.L. and Bullen, R.D. (2009). The echolocation calls, habitat relationships, foraging niches and communities of Pilbara microbats. Records of the Western Australian Museum Supplement 78: 123–155.

Table 1. Species identified in the present survey from all sites combined.

EMBALLONURIDAE	
Common Sheath-tailed Bat	*Taphozous georgianus*
VESPERTILIONIDAE	
Gould's Wattled Bat	*Chalinolobus gouldii*
Little Broad-nosed Bat	*Scotorepens greyii*
Finlayson's Cave Bat	*Vespadelus finlaysoni*
MOLOSSIDAE	
Greater Northern Free-tailed Bat	*Chaerephon jobensis*

Table 2. Species identifications, with the degree of confidence indicated by a code. Date and recording unit number correlates with site; see *Table 1* for full species names.

		C. gouldii	***C. jobensis***	***S. greyii***	***T. georgianus***	***V. finlaysoni***
SM4BAT 1147	50K 689541 7650496					
25/05/2021		X	—	—	—	—
26/05/2021		X	—	—	X	X
27/05/2021		—	X	X	—	X

Definition of confidence level codes

— Not detected.

X Unambiguous identification of the species at the site based on measured call characteristics and comparison with available reference material. Greater confidence in this ID would come only after capture and supported by morphological measurements or a DNA sequence.

NC Needs Confirmation. Either call quality was poor, or the species cannot be distinguished reliably from another that makes similar calls. Alternative identifications are indicated in the *Comments on identifications* section of this report. If this is a species of conservation significance, further survey work might be required to confirm the record.

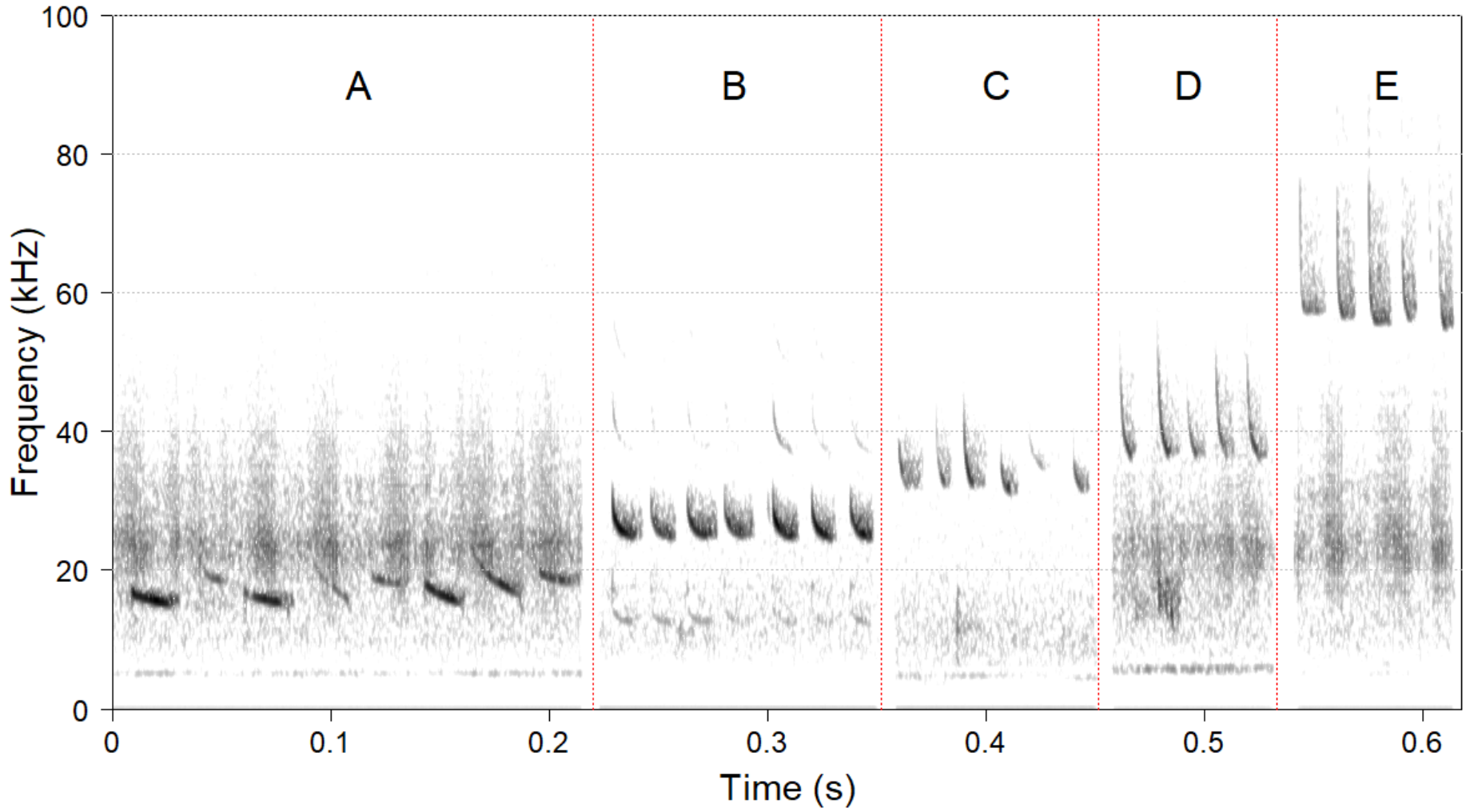

Figure 1. Representative echolocation call sequence portions of the species identified (**A**: *Chaerephon jobensis*; **B**: *Taphozous georgianus*; **C**: *Chalinolobus gouldii*; **D**: *Scotorepens greyii*; **E**: *Vespadelus finlaysoni*; time between pulses has been compressed).